CONTRACT NO.: SEPCO,CHINA/SK/1160201/252

OFF-SHORE SUPPLY CONTRACT

BETWEEN

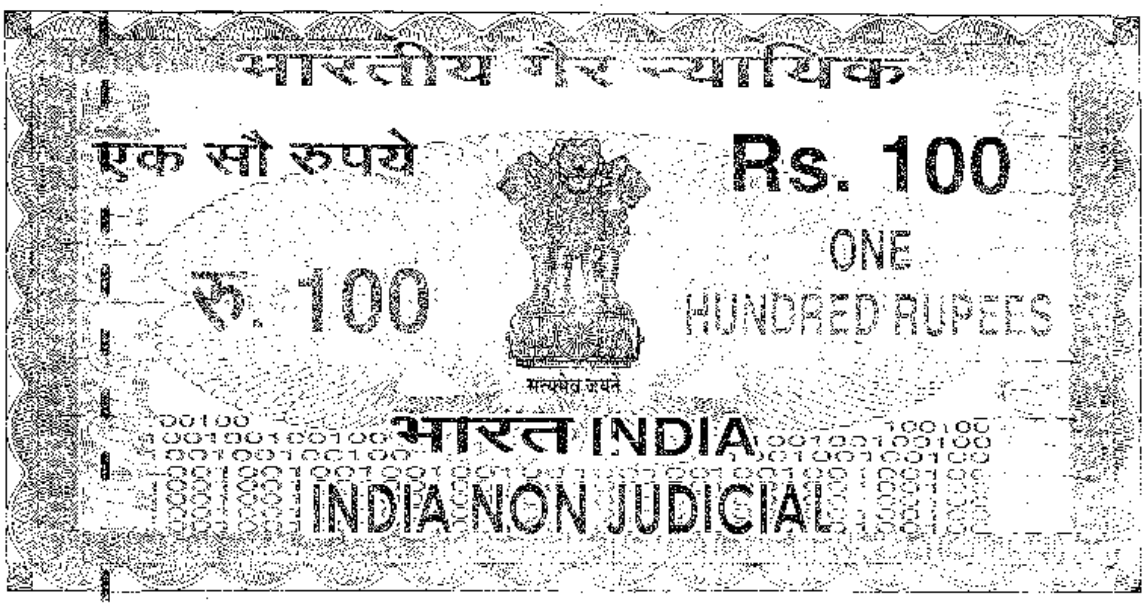
WARDHA POWER COMPANY PRIVATE LIMITED

AND

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

REGARDING

3600MW POWER PLANT AT NARIYARA, JANJGIR-CHAMPA, CHATTISGARH



ఆంధ్రప్రదేశ్ आन्ध्र प्रदेश **ANDHRA PRADESH**

R 476125

Sl. No. : 12960 Date.:05/3/2009. Rs.:100/-
Sold To Krishna
S/o. Ramaiah. R/o. Hyd.
To Whom Wardha Power Company Private Limited.
(Chattisgarh)

K. RAMA CHANDRAVATHI
STAMP VENDOR (L. No:27/99, RL.No. 16/2008).
6-3-387, Beside Banjara Durbar Hotel, Panjagutta
HYDERABAD - 500 082. Phone. No. 23351799

This Off-Shore Supply Contract is made and executed on this the 1st day of April, 2009 at Hyderabad, by and between:

WARDHA POWER COMPANY PRIVATE LIMITED (WPCPL) a company duly incorporated and existing under and by virtue of the laws of the Republic of India and having its Registered Office at 8-2-293/82/A/431/A Road No.22, Jubilee Hills, Hyderabad 500033, India; (hereinafter referred to as **"Purchaser"** which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns) as party of the first part;

and

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO) a company duly incorporated and existing under and by virtue of the laws of China and having its Registered Office at No.150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as **"Supplier"**, which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns) as party of the second part;

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as

the "Parties".

RECITALS

WHEREAS

A. The Purchaser is setting up a 3600 MW Coal based Power Plant (**"Power Plant"** / **"Project"**) on build, own and operate basis at Nariyara, Janjgir – Champa Dist, Chattisgarh State, India (**"Site"**) for the purpose of generating and selling electrical energy. The Purchaser is the ultimate Purchaser of the Power Plant equipment being supplied by Supplier.

B. The Supplier is engaged in the business of undertaking procurement activities, delivering various kinds of plant and equipments and providing services for various power plants.

C. The Purchaser is purchasing certain Plant and Equipment as per the Technical Specifications set out in Schedule 2 of the Contract for installation at the Purchaser's Power Plant, proposed to be located at the Site.

D. The Purchaser proposes to engage the Supplier to design, engineer, manufacture, procure, assemble, shop test, pack and supply the Plant and Equipment for the Power Plant.

E. The Supplier has agreed to design, engineer, manufacture, procure, assemble, shop test, pack and supply and ship the Plant and Equipment to the Delivery Point, in accordance with the Technical Specifications set out in Schedule 2 to the Contract ("Supplies").

F. The Supplier desires to procure the Plant and Equipment either directly or through its Sub-Suppliers and Affiliates and ship the same on price basis in Article 10 in accordance with the Payment Terms set out in Article 12 and subject to the terms and conditions set forth herein.

G. The Supplier has satisfied itself by careful examination as to the nature and magnitude of the Contract and the availability of resources and has obtained necessary information as to

the matters in connection with the performance of the Contract.

H. The Supplier hereby confirms and warrants that the Supplier has the necessary expertise and resources to perform its obligations under the Contract and that it has supplied similar plants, equipments and other materials for various coal based power plants; and

I. The Purchaser has agreed to award to the Supplier and the Supplier has agreed to undertake the Supplies based on the understanding recorded in the Letter of Award dated Feb 26,2009 and annexed hereto as Annexure-1 ["LoA"] and the Parties desire to document the terms and conditions under which the Supplier will make the Supplies, being these presents.

J. The Purchaser and the Supplier wish to enter into the Contract to set forth the terms and conditions under which the Supplier will make the Supplies.

NOW, THEREFORE, THE CONTRACT WITNESSETH as follows:

1. DEFINITIONS

1.1 Definitions

The following terms shall have the meanings specified in this Article and as used in the Contract (including the Recitals above) unless where the context otherwise requires:

"Acceptance Tests" shall mean Trial Runs, Initial Operations, Reliability Run Tests, and Performance Guarantee Tests, as described in Schedule 2 [Technical Specifications], which certify that Plant and Equipment has satisfied the defined criteria during the Acceptance Tests.

"Affiliate" in relation to any Party, means a Person that controls, is controlled by, or is under common control with such Party. As used in this definition the term "control" means, with respect to a Person that is a legal entity, the ownership, directly or indirectly, of more than 50% of the voting securities of such Person or, with respect to a Person that is not a legal entity, the power to direct the management or policies of such Person, whether by operation of law, by contract, or otherwise.

"Applicable Clearances" shall mean any consent, license, approval, permit or other authorisation of whatsoever nature which is required to be granted by any Competent Authority, for such matters as may be necessary in connection with the Project or the performance of the obligations of the Supplier and/or the Purchaser under the Contract.

"Applicable Law" means the Constitution of India and any act, rule, regulations, directive, notification, order or instruction having the force of law enacted or issued by any Competent Authority in India.

"Articles" means the Articles or Sub-Articles of the Contract.

"Bank Guarantee" shall have the meaning as ascribed to it in Article 11.5 of the Contract.

"Business days" shall mean day on which banks are legally permitted to be open for business in India for banking.

"Change" means any addition to, deletion from, or modification to the quality, function, capability, capacity, composition, or intent of the Supply or the Equipment or the materials as presently delineated in the Contract, so long as the change requested is reasonably related to the equipment. materials, including any such addition, deletion, suspension or other modification that requires a change in one or more of the Contract Price, Guaranteed Completion Date, the Delivery Schedule, or the Performance Guaranteed Value. Correction of errors or omissions or Miss Outs by Supplier shall not be deemed a Change and shall be performed at Supplier's sole cost and expense.

"Change Order/Variation" means a written order to Supplier signed by Purchaser and Supplier during the execution and delivery of Scope of Supplies under the Contract authorizing a Change and, if appropriate, an adjustment in one or more of, the Contract Price, Guaranteed Completion Date, the Delivery Schedule, or the Performance Guaranteed Value or any other amendment of the terms and conditions of the Contract.

"Change in Law" shall mean (a) any enactment or issuance of any new Applicable Law; or (b) any amendment, alteration, modification or repeal of any existing Applicable Law; or (c) any

change in the application or interpretation of any Applicable Law by any Competent Authority which is contrary to the existing accepted application or interpretation thereof, in each case with respect to a) , b) and c) above coming into effect after Feb 21, 2009 and which was not reasonably foreseeable by the Supplier on the date of the Contract. Provided that, the statutory variations in taxes and duties shall not constitute a Change in Law.

"Claim" shall have the meaning set forth in Article 28.5

"Competent Authority" means any local or State Government or Union Territory in India or the Government of India or any department, instrumentality or agency thereof or any corporation (to the extent acting in a legislative, judicial or administrative capacity and not as a contracting party with the Purchaser or the Supplier) or commission under the direct or indirect control of such local or State Government or Union Territory or the Government of India or any political subdivision thereof or any court, tribunal or judicial or quasi-judicial body within India.

"Commissioning" shall mean, in relation to each part, the first successful integrated operation of all the Equipment and materials supplied by the Supplier in accordance with the Contract after all initial adjustment, trials, cleaning and re-assembly, if any, required on completion of installation at the Site, have been completed and the plant / equipment has been first Synchronised with the Grid for each Unit as per Project Schedule.

"Commissioning Certificate" shall mean the fully executed certificate issued by Purchaser to Supplier certifying the Commissioning Date.

"Commissioning Date" shall mean the date on which the Commissioning has been completed. The scheduled Commissioning Date for the purpose shall be the first Synchronization Date for each Unit as per Project Schedule.

"Commercial Operations Date/Taking Over Date" shall mean the date on successful completion of Reliability Run Test of each Unit.

"Complete Plant or Plant" shall mean the equipment and materials capable to generate electric power meeting the Performance Guaranteed Values, such as Boiler with Auxiliaries, Turbine with

Auxiliaries, Generator with Auxiliaries, Transformers, complete plant DCS system, Auxiliary/Start-up Boiler and Control and Instrumentation System for these, Coal Handling System, Fuel Oil Handling System , Pulverizers, Stacker–cum- Reclaimer, Ash Handling System, Raw Water Treatment System, DM Water System, Potable and Service Water System, Cooling Water System, Auxiliary Cooling Water System, Cooling Tower, CW Treatment Plant, Fire Protection System, Compressed Air System, Air conditioning System, Ventilating System, EOT Crane, Hoists, Pipings, Hangers, Supports, Valves, Fittings, Painting and Protective Coatings, Effluent Treatment Plant, Reverse Osmosis (RO) Plant System, supplies related to Ash Dyke , Evaporation Pond , Reservoir, lab equipments, workshop equipments, Electrical System including switchyard, control and instrumentation system and other systems / equipments / tools & tackles complete as further defined in the Technical Specifications except CNC Lathe Machine, training simulator and CCTV...

"Conditions" shall mean the general terms and conditions of the Contract.

"Confidential Information" shall mean information now or hereafter owned by or otherwise within the possession or control of a Party, including patented and unpatented inventions, business and trade secrets, know-how, techniques, data, specifications, as-built drawings, blue prints, manuals, flow sheets, designs, engineering information, construction information, operation criteria and other intangible information related to the Project.

"Contract" shall mean this document, and attached Annexures/Schedules, including any supplement(s) subsequently written and modification(s) thereto.

"Contract Price" means the Contract Price as set forth in Article 10.

"Contract Period" shall mean the time for completion of the Supplies as stated in the Contract.

"Consequential Damages" shall mean indirect, punitive, special or incidental damages, including but not limited to, the loss of profits or revenue, loss of use of the Equipment or materials or any associated equipment, cost of capital and/or financing, down time costs, loss of opportunity, loss of goodwill, and claims of customers for damages of like nature.

"Consumables" shall mean all lubricants, lubrication and control oils, additives, greases, filters,

PVK

demineralising resins, water treatment chemicals and the like required for operation of the Project.

"Codes" shall mean the following, but not limited to the following, including all latest Amendments, and / or replacements, if any:

(a) Indian Boiler Act and Rules and Regulations made thereunder including those laid down by the State of Chhattisgarh;
(b) The Electricity Act 2003 and rules and regulations made thereunder;
(c) Indian Factory Act and rules and regulations made thereunder;
(d) Indian Explosives Act and rules and regulations made thereunder;
(e) Indian Petroleum Act and rules and regulations made thereunder;
(f) A.S.M.E. Test codes;
(g) A.I.E.E. Test Codes;
(h) American Society of materials testing codes (ASTM);
(i) Indian Standards (IS);
(j) MoEF, Center and CECB, Chattisgarh rules (Pollution Control Board);
(k) Other internationally recognised standards and/or rules and regulations touching the subject matter of the contract;
(l) Applicable Environment Protection Laws, Rules, Regulations and Notifications for the time being in force in India;

"Date of Contract Signing" shall mean the date on which both the Parties have signed the Contract.

"Day" shall mean Gregorian calendar day or days of twenty-four (24) hours each for the Contract Period.

"Delivery Date" shall mean the day on which the last of the Equipment and replacements therefor, if any, is delivered to the Delivery Point.

"Delay Liquidated Damages" shall have the meaning as set forth in Article 23.1.

"Delivery Point" shall mean any designated Indian sea/air ports, where the Plant and Equipment

shall be supplied and delivered by the Supplier.

"Delivery Schedule" means the master delivery program of Plant and Equipment under the Contract, in line with Project Schedule, as provided by the Supplier and approved by the Purchaser and as may be amended from time to time.

"Drawings" shall mean the, drawings, diagrams, plans, specifications related to Plant and Equipment and its parameters, supporting fuel and power lines, pressure, temperature ranges, foundation support points for the units/modules, and other information furnished by the Supplier to the Purchaser or vice versa in connection with execution and completion of engineering design and fabrication of the Plant and Equipment for the Power Plant.

"Dispute" shall have the meaning as set forth in Article 28 of the Contract.

"Directive" shall mean any requirement, instruction, direction, order, regulation, code, standard or rule of any Competent Authority, which is legally binding and any modification, extension or replacement thereof from time to time, in force.

"Engineer" means the Officer appointed from time to time in accordance with Article 4.4 by the Purchaser/Lender and notified in writing by the Purchaser to the Supplier to act as Engineer for the purpose of the Contract. Unless any change is notified, the project head of the Purchaser shall act as the Engineer.

"Engineer's Representative" shall mean resident Engineer or project manager or an assistant of the Engineer appointed from time to time by the Engineer to exercise the powers, discretion, functions, and authorities vested in him.

"Equipment" shall mean all of the equipment, materials, apparatus, tools & tackles, structures, supplies and other goods provided or required by the terms of the Contract to be provided by Supplier. The term Equipment or Major Equipment shall include those items set forth in Technical Specifications.

"Equipment Documents" shall mean, Drawings, designs, data sheets, calculations, computer

data (insofar as stored in computer diskettes/ Compact Disc) other than the proprietary information, samples, patterns, models, type tests as applicable, Quality Assurance Program (QAP), inspection reports, test reports, IBR approved third party certificate, erection drawings and instructions, operation and maintenance manuals, and other manuals and information of a similar nature, to be submitted by the Supplier / Sub-Suppliers.

"Final Acceptance" has the meaning as set forth in Article 25.

"Final Acceptance Certificate" means the certificate as specified in Article 25.2.

"Financing Entity" shall mean any Person providing finance to the Purchaser in connection with the Project under the Loan Contract(s).

"Force Majeure" has the meaning as set forth in Article 26.1.

"Good Industry Practice" means the exercise of that degree of skill, diligence and prudence which would reasonably and ordinarily be expected from a skilled and experienced Supplier, equipment manufacturer or operator applying the standards generally adopted by Indian and/or international suppliers, equipment manufacturers and operators in the construction or operation of coal based power plant or the manufacture of equipment thereof, except insofar as necessary to comply with any Applicable Law.

"Guaranteed Completion Date" means the date as provided in Article 4.19.1.

"IBR" shall mean requirements under Indian Boiler Act and Rules and Regulations made thereunder including those laid down by the State of Chhattisgarh

"Indemnified Party" shall have the meaning set forth in Article 20.3.

"Initial Operation" shall mean the first integral operation of the complete Unit supplied under the Contract with all incidental and auxiliary equipments or systems.

"Inspector" shall mean the Purchaser or any person / firm appointed by or duly authorised by the

Purchaser or appointed by the Supplier on approval of the Purchaser from time to time to inspect the Plant and Equipment and/or the Works in totality according to the terms and conditions of the Contract.

"Item" shall mean any item being a part of the Plant and Equipment to be supplied by the Supplier in accordance with Schedule 2.

"KW" shall mean electrical kilowatts.

"KWh" shall mean electrical kilowatt-hours.

"Kick-off Meeting" shall mean the very first meeting held between the Parties after the signing of the contract.

"Lender" shall include the services enabling or Institutions or financing entities providing construction, interim or long-term financing (including any refinancing thereof), (i) for KSK Energy Ventures Limited (sponsors) for the supplies and / or (ii) the Purchaser or sponsor for the set-up, procurement and construction of Power Plant.

"Loan Contract" shall mean the contract or contracts to be entered into by the Purchaser for the provision of finance in connection with the Project.

"Law" shall mean any law, act, ordinance, code, rule, resolution, regulation, order, specified standards or criteria contained in any applicable Permit, or other legislative, administrative or judicial action or decision of any Governmental Authority in force and effect during the term of the Contract.

"Latent Defect" shall mean, in respect of each Item, the defects which are inherent or not visible at the time of Taking Over of the said Items/s of the Plant and Equipment and which were undetected at the expiry of the respective Warranty Period relating to the said Items of the Plant and Equipment.

"Lien(s)" shall mean any lien, claim, charge, encumbrance, cause of action, security interest,

mortgage or other possessory or non-possessory interest in on or against real, tangible or intangible property as administered under Applicable Law arising out of, due to, or otherwise as a result of the Supplier's acts or omissions, including any lien recorded or held by any Sub Supplier or any other person entitled to a lien under Applicable Law.

"Mechanical Completion" shall mean when all the Equipment supplied is installed and tested / pre-commissioned in accordance with Engineering Documents / Instruction Manuals and documented through protocols, as set forth in the Technical Specifications and confirmed by a Certificate of Purchaser, date of which shall happen before Commissioning Date.

"Miss Outs" shall mean the Scope of Supply and related Technical Specifications which are not detailed in the Technical Specifications but which are essentially required to complete the Scope of Supply, as per applicable standards, but shall not include any variations or additions outside the Miss Outs, which are instructed to be carried out by or on behalf of the Purchaser.

"Month" means any calendar month.

"MW" shall mean mega watt i.e. 1000 electrical kilowatts.

"O&M Contractor" shall mean the Person with which Purchaser has entered into or will enter into an Agreement to provide operation and maintenance services to the Power Plant for the period immediately following its completion.

"Purchaser's Contractor" shall mean the other Contractors/suppliers engaged by the Purchaser for execution of specific supplies, services and works with respect to the project, which are outside the scope of work under the Contract.

"Purchaser Event of Default" shall have the meaning set forth in Article 27.2.

"Purchaser Indemnified Party" shall have the meaning set forth in Article 20.1.B.

"Purchaser's Representative" shall mean the Person nominated by the Purchaser from time to time by notice in writing to the Supplier to act as Purchaser's representative for the purposes of the

Contract.

"Party" means the Purchaser or the Supplier, as the case may be and "Parties" shall mean both of them.

"Payment Term" or "Terms of Payment" shall have the meaning given to it in Article 12.

"Performance Guaranteed Values" means the guaranteed levels of performance of the Plant and Equipment as set out in Article 22.5.4.

"Performance Guarantee Tests" means the tests to be conducted so as to establish the Performance Guarantee parameters in the manner set forth in Article 22.5.4.

"Performance Guarantee Test Certificate" shall mean a certificate issued to the Supplier certifying that the Plant and Equipment has successfully passed the Performance Guarantee Tests.

"Performance Liquidated Damages" means the damages relating to the performance of the Plant and Equipment set out in Article 23.2.

"Person" shall mean any natural person, firm, corporation, company, voluntary association, partnership, joint venture, trust, incorporated organisation, unincorporated organisation, Competent Authority or other entity.

"Plant and Equipment" shall mean the list of those equipments to be supplied and delivered by the Supplier in accordance with the Technical Specifications as specified in Schedule 2 of the Contract.

"Progress Reports" has the meaning as set forth in Article 4.19.12.

"Project or Power Plant" shall mean the 3600MW coal based power plant to be set up on Build, Own and Operate (**"BOO"**) basis at the Site.

"Project Schedule" means the schedule (bar chart/PERT Chart) of the entire Power Plant as provided in Schedule 2.

"Quality Assurance Programme (QAP)" or "Quality Plan" has the meaning given to it in Article 4.19.11.

"Reliability Run Test" shall mean as defined in Article 22.5.3 as well as in Technical Specifications.

"Requirements" shall mean under the contract all Applicable Laws, Supplier Permits, Good Industry Practices, Scope of Supplies, and Technical Specifications, patents, licenses and all terms, conditions and other provisions of the Contract.

"Schedules" Means the schedules 1 to 2 of the Contract including any amendments thereto.

"Scope of Supplies" means and includes the supply of the Plant and Equipment and other materials to be supplied by the Supplier in accordance with Schedules 2 and Article 2.3.

"Shop Tests" shall mean the Shop tests on each Item of the Plant and Equipment performed by Supplier at its Shop, or at its Sub Suppliers' or Affiliates' Shop as per approved QAP.

"Site" shall mean the site in Nariyara, Janjgir – Champa Dist, Chattisgarh State, India where the Purchaser intends to locate the Power Plant.

"Sub-Supplier" means any Person (other than the Supplier or the Purchaser) to whom the Supplier has sub-contracted any part of his Scope of Supply or with whom the Supplier has entered into any contract for the supply of goods, services, materials or equipment in connection with the Scope of Work, including any such Person's legal successors in title or permitted assigns and, unless otherwise stated, all sub-suppliers and suppliers of any tier to such Person.

"Sub-Contracts" has the meaning given in Article 2.2.1.

"Supplier Indemnified Party" has the meaning given in Article 20.1.A.

"Supervisory Personnel" shall mean the supervisory personnel deputed by the Supplier or any other manufacturer who has supplied the material either through or on behalf of the Supplier or under whose supervision the Works pertaining to the Contract is carried out.

"Supplier's Representative" shall mean the Person nominated by the Supplier from time to time by notice in writing to the Purchaser to act as Supplier's representative for the purposes of the Contract which may include from time to time a representative of a Sub-Supplier.

"Supplier's Works" means the place of work used by the supplier, its manufacturers, contractors, collaborators or sub- suppliers for the performance of the Works.

"Synchronisation / Synchronised" means the event of the Unit(s) getting connected with the external utility grid smoothly for long term operation in the grid by injecting electrical energy into such grid, with the event being recognized by such grid.

"Taking Over" means the taking over of the care, custody and control of the Plant and Equipment and/or each Unit (where applicable) by the Purchaser (Take Over shall have the same meaning as Taking Over).

"Taking Over Certificates shall mean, a certificate issued to the Supplier by the Purchaser certifying that Taking Over has been accomplished.

"Technical Dispute" shall have the meaning as ascribed to it in Article 28.3 of the Contract.

"Technical Expert" shall have the meaning as ascribed to it in Article 28.3 of the Contract.

"Technical Specifications"/"Specifications" means the technical specifications set out in Schedule 2, setting out a description, quantity and signed on behalf of the Parties as of the date of the Contract and forming an integral part of the Contract.

"Trial Run" means the first operation of the Item and or Unit forming part of the Plant and Equipment.

"Unit" means any one of the six Units forming the entire Plant and Equipment proposed to be set up at the Site.

"Unit Price" shall be a sum of USD 305,274,000 being one-sixth of the Contract Price.

"Warranty Period" has the meaning given in Article 18.

"Works" or "Supplies" shall mean the design, engineering, manufacture, procurement, shop testing, inspection, seaworthy packing and supply of the Plant and Equipment.

"Year" means a calendar year of 12 (twelve) consecutive calendar months.

"Zero Date/Effective Date" shall have the meaning as set forth in Article 4.19.3 of the Contract.

1.2 **Rules of Interpretation**

1.2.1 Words importing persons shall include firms, Companies, corporations and associated or body of individuals, whether incorporated or not.

1.2.2 Words importing singular only shall also include the plural and vice a versa where the context so requires.

1.2.3 The headings and sub headings are inserted for convenience and are to be ignored for the purposes of construction of the Contract.

1.2.4 The Schedules to these Conditions form part of the Contract and will be in full force and effect as if they were expressly set out in the body of these Conditions.

1.2.5 When the words 'Approved' 'Subject to Approval', 'Satisfactory ', Equal to 'Proper', 'Requested' 'As directed', 'when directed', 'Determined by', 'Accepted", 'Permitted' or words and phrases of like import are used, the approval, judgement, direction or the like is understood to be a function of the Purchaser.

1.2.6 Wherever provision is made for the giving of notice, approval or consent by any Person, unless otherwise specified such notice, approval or consent shall be in writing and the words "notify" and "approve" shall be construed accordingly.

1.2.7 The invalidity or unenforceability of any portion or provision of the Contract shall not affect the validity or enforceability of any other portion or provision. Any invalid or unenforceable portion or provision shall be deemed severed from the Contract. The Parties agree in such circumstances to interpret and to negotiate an equitable amendment to the provisions of the Contract to give effect to the underlying purposes of the Contract.

1.2.8 **Contract Documents:**

The term "Contract Documents" shall mean and include the following, which shall be deemed to form an integral part of the Contract:

1. Schedule 1 – Cash Flow
2. Schedule 2 – Technical Specifications
3. Annexure 1 – LoA – Letter of Award
4. Annexure 2 – Format of Advance Payment Bank Guarantee
5. Annexure 3 – Format of Performance Bank Guarantee

2. RELATIONSHIP OF PURCHASER, SUPPLIER AND SUB SUPPLIERS

2.1 Assignment and Sub-Contract

2.1.1 Assignment by the Supplier

The Supplier shall not without the prior written consent of the Purchaser assign to any Person any benefit of or obligation under the Contract in whole or in part.

2.1.2 Assignment by the Purchaser

The Purchaser shall not without the prior written consent of the Supplier, assign to any person any benefit of or obligation under the Contract in whole or in part save that the Supplier hereby consents to the creation by the Purchaser of a security assignment of the Contract in favour of any Lender (or a trustee acting on behalf of one or more Lenders) and hereby undertakes to execute upon the request of the Purchaser such documents as may be reasonably and customarily required to give effect to any such assignment. Any stamp duty and all costs and expenses payable in respect of such documents shall be for the account of the Purchaser. Further, save and except to group companies or the current promoters of the Purchaser (the "Promoters") where assignment shall be effective with prior notice to the Supplier, in all other cases the Purchaser shall not assign to any Person any benefit of or obligation under the Contract in whole or in part without prior written consent of the Supplier.

2.2 Sub-Contracting and Sub- Supplies

2.2.1 The Supplier may, sub-contract any part of the Contract, provided that the Supplier obtain written consent from the Purchaser for the list of Major Sub-Supplier. The Supplier shall have the right to have any of the Supplies accomplished by Sub-Suppliers pursuant to written sub-contracts between Supplier and such Sub-Suppliers (or in the case of Sub-Suppliers who are also Supplier's affiliates, pursuant to whatever method Supplier chooses). However, the creation of any sub-contract relationship shall not relieve the supplier of any of its obligations under the Contract.

2.2.2 The Supplier shall be solely responsible for the engagement, payment and management of Sub-Suppliers in the performance of the Works, and for all acts and omissions of Sub-Suppliers. No contractual relationship or privity of contract shall exist between Purchaser and any Sub -Supplier with respect to the Works. No Sub-Supplier is intended to be or shall be deemed a third-party beneficiary of the Contract

Provided that the Supplier shall obtain the approva of Purchaser of the list of Sub Suppliers who shall provide Supplies or materials aggregating to in excess of USD 2 Million (such Sub Supplier being a "Major Sub-Supplier").

2.2.3 The Purchaser reserves the right to reject a Sub-Supplier if the financial and technical performance of such Sub-Supplier is found to have deteriorated before the award of a Sub-Contract by the Supplier to the Sub-Supplier. In the case of Sub Supplier(s) not already identified in the Contract, the experience list of the Sub-Supplier(s) under consideration by the Supplier shall be furnished to the Purchaser for approval prior to procurement of all such Items as covered under the Scope of Supplies under the Contract. The Purchaser shall provide their decision in this regard within 7 (seven) Business days from the Supplier furnishing details of the Sub-Supplier.

2.2.4 The Supplier shall ensure that all Sub-Contracts with the Sub-Suppliers are made in writing. It is understood and agreed between the Parties that if the terms of the contracts with the Sub- Suppliers, including those relating to Delivery Date and performance for any Item, shall meet at the minimum the equivalent terms of the Contract as signed with the Purchaser.

2.2.5 The (un priced) copies of the Sub-Contracts with Major Sub-Supplier including the complete technical specifications shall be submitted to the Purchaser by the Supplier within 4 months from the date of such supplies order is placed. The Quality Assurance Program of the Sub-Supplier(s) shall be as per the approved Quality Assurance Program under the Contract.

2.2.6 Under any Sub-Contract with the Sub-Suppliers, the Supplier shall provide that, pursuant to the terms in form and substance to the Purchaser, the rights of the Supplier under such Sub-Contract are assignable to the Purchaser successors and assigns and the Lenders upon the Purchaser's written request following termination of the Contract or after Warranty period completion.

2.2.7 In the event of termination of the Contract, based on Purchaser's request, the Supplier shall use best efforts to procure that a Sub-Supplier (other than in relation to minor or immaterial Sub-Contracts) enter into a direct Contract with the Purchaser wherein the Sub-Supplier, upon settlement of all payments payable as per Contract, to the Supplier under the Contract shall agree that all rights and obligations of the Supplier under such Sub-Contract are transferred to the Purchaser.

Provided however that to the extent that the supplier relies on any of its rights under Sub-

Contracts as the basis of a claim against a Sub-Supplier prior to the termination of the Contract, the Supplier and the Purchaser shall mutually discuss and agree upon treatment of such rights.

2.2.8 No obligation/liabilities of the Supplier arising out of any default or non-compliance of the terms of Contract between such Sub-Supplier(s) and the Supplier shall be transferred to the Purchaser.

2.2.9 Any sub-contracting of the Contract fully, or any rights there under fully by the Supplier without the prior written consent of the Purchaser shall be null and void such sub-contracting shall not relieve the Supplier from any obligation, duty or responsibility under the Contract.

2.2.10 The Supplier shall be responsible for the engagement, management and compensation of Sub-Suppliers, the agents, servants, representatives or employees of such Sub-Suppliers in the performance of the work, acts, defaults and neglects of any Sub-Suppliers, the agents, servants, representatives, or employees of such Sub-Suppliers as fully as if they were the acts defaults or neglects of the Supplier. The Supplier shall assure that all Sub-Suppliers comply with all pertinent provisions of the Contract in their performance of the Works. The Supplier shall remain fully and primarily responsible for the performance of all Scope of Supply delegated to Sub-Suppliers, the agents, servants, representatives or employees, and shall be fully responsible for all acts, defaults, neglects, omissions or faults of any Sub-Supplier as if they were the acts, omissions or faults of the Supplier.

2.3 Scope of Work/Scope of Supply

2.3.1 The Scope of Work to be carried out by the Supplier shall include but not be limited to design, engineering, manufacture, procurement, assembling, shop testing, seaworthy packing, forwarding and delivery of the Plant and Equipment including commissioning spares, Consumables on CFR basis up to the Delivery Point, for the Project, more specifically detailed in Schedule 2 ("Scope of Supply").

2.3.2 The Plant and Equipment supplied shall be complete in all respects with all mountings, fixtures and standard accessories, commissioning spares that are required to be supplied in

accordance with Good Industry Practices including Miss Outs, even if it is not specifically detailed in the Technical Specifications. The Supplier shall not be eligible for any extra payment in respect of such mountings, fixtures, fittings, and accessories and commissioning spares as may be needed for safe and reliable operation of the Plant and Equipment or if required under applicable Codes though they may not have been included in the Contract. Various Items of the Plant and Equipment supplied shall be interchangeable with one another.

2.3.3 The Supplier shall sequence his Supplies in accordance with the Delivery Schedule matching the Project Schedule approved by the Purchaser to meet the requirements of erection at Site and to facilitate achieving completion of successful Reliability Run Test/Taking Over of the Units by the respective Guaranteed Completion Date and satisfactory completion of Performance Guarantee Tests thereon and Purchaser's Final Taking Over of the Units.

2.3.4 The obligations of the Supplier under this The Contract shall include single point responsibility for all necessary co-ordination in respect of the independent supplies & allied activities to be performed to ensure that the Project is completed in every respect as contemplated. Thus the Supplier needs to ensure that the Scope of Supplies is completed in accordance with the Guaranteed Dates, the Technical Specifications and the Performance Guaranteed Values and the overall performance of the Supplies as agreed.

3. SUPPLIER TO INFORM HIMSELF FULLY

3.1 The Supplier is deemed to have carefully examined the Technical Specifications mentioned in Schedule 2 to his entire satisfaction before signing of the Contract. The Supplier is deemed to have made independent enquiries and satisfied himself for all the required information, inputs, conditions, circumstances and factors having effect on the Contract Price and on execution of the Works covered in the Contract.

3.2 The Supplier is also deemed to have familiarized himself with various acts and laws prevailing in India and have considered them fully while signing the Contract.

3.3 The Purchaser shall not permit any change in Project Schedule or any financial adjustment arising due to lack of information on the part of the Supplier. Any information obtained by the Supplier from the Purchaser, which is not in writing, shall not in any way relieve the Supplier of the Supplier's responsibility to fulfill his obligation under the Contract.

3.4 The Supplier shall be deemed to have inspected the Site and its surroundings and to have satisfied itself as to all technical, commercial, geographical, topological, social and general condition of and all circumstances affecting the Site including the nature of the ground and sub-soil, the form and nature of the Site, the extent and nature of the supply and materials necessary for the delivery of the Plant and Equipment at Site.

3.5 The Supplier shall not, except as expressly provided in the Contract and save to the extent of any misrepresentation or misinformation given to it by or on behalf of the Purchaser, be entitled to any extension of time for any of the Items listed in the Project Schedule or to any adjustment of the Contract Price on the grounds of misinterpretation or misunderstanding of any such matter. Any information obtained by the Supplier from the Purchaser, which is not in writing, shall not in any way relieve the Supplier of his responsibility to fulfill his obligation under the Contract.

4. SUPPLIER'S OBLIGATIONS

4.1 Scope of Work/ Scope of Supply

The Supplier shall supply the Plant and Equipment in accordance with the Technical Specifications in Schedule 2 and perform all its other obligations as provided under the Contract.

4.2 Conformance to Requirements

The Supplier shall supply the Plant and Equipment to the Purchaser in accordance with all Requirements and Good Industry Practice. The Supplier shall perform all the Works in a good and workmanlike manner. All the materials used in the manufacture of the Plant and Equipment shall be selected from the best available sources for the purpose conforming to

internationally acceptable standards set out for such material, considering strength, durability and free from defects and imperfection and of recent manufacture and unused. Liberal factors of safety shall be used throughout and especially for all parts subject to alternating stresses or shocks. The Supplier shall supply all Plant and Equipment and systems as per design, which are part of the Supplies with safety conforming to acceptable level of safety as per standard set out for such Plant and Equipment dependability, efficiency and economy, in each case using qualified, competent and, where necessary, licensed personnel. The Supplier shall deliver Plant and Equipment and other items necessary for start-up and Commissioning and Taking Over of the Power Plant.

4.3 Completeness of Equipment:

The Equipment supplied shall be complete in all respects with all mountings, fixtures and standard accessories, Commissioning spares that are required to be supplied in accordance with Good Industry Practices, including Miss Outs, even if it is not specifically detailed in the Technical Specifications. The Supplier shall not be eligible for any extra payment in respect of such mountings, fixtures, fittings, and accessories and commissioning spares as may be needed for safe and reliable operation of the Equipment or if required under applicable Code except for those deviations already agreed or if required for completion of the Plant as per the Contract though they may not have been included in the Contract.

Parts of all similar Equipment supplied shall be interchangeable with one another.

4.4 Engineer

4.4.1 The Supplier shall undertake coordination of the Supplies and inform the Purchaser on the progress of the Works. The Purchaser/Lender shall nominate a competent and qualified person (**"Engineer"**) who shall be a single point contact between the Purchaser and the Supplier in all matters relating to the Contract. The name and contact details of such Engineer shall be furnished to the Supplier during Kick-off Meeting.

4.4.2 Compliance with the Engineer's Decision

The Supplier shall proceed with the Works in coordination with the Engineer and during the course of activities , the decisions, instructions and orders given by the Engineer subject to and in accordance with the Contract, including provisions for Variations as set out in Article 19 hereof shall be binding and complied with by the Supplier. In respect of all matters, which are left to the decision of the Purchaser including the granting or withholding of the certification, the decision of the Engineer shall be final.

4.5 Drawings of the Plant and Equipment

4.5.1 The Supplier shall supply and deliver all the drawings (as provided for in the Technical Specification) mechanical, electrical, C&I, data sheets other than proprietary information and the like for approval of the Purchaser along with the design calculations and general write up wherever involved other than proprietary information. All electrical, C&I and mechanical drawings shall be properly coordinated.

4.5.2 While scrutinizing the Drawings, the Purchaser shall indicate the corrections to be made in these Drawings which the Supplier shall incorporate or justify its correctness.

4.5.3 The Supplier then shall submit the revised drawings for approval of the Purchaser. On approval of the same, Supplier shall furnish 8 (eight) hard copies and soft copy on CD of these approved Drawings to the Purchaser as per the distribution to be intimated. Approval of any drawings by Purchaser shall not absolve responsibilities of Supplier to comply with requirements of codes/rules/competent authority in existence without any extra cost to Purchaser.

4.5.4 Any delay in approval of Drawings by Purchaser, due to submission of incorrect data, non-submission of data, non-updating the Drawings in line with the corrections indicated shall be to the Supplier's account. During the currency of the Contract, if any approved Drawings are required to be modified, such details of the modifications required to be carried out shall be separately maintained and executed only after obtaining Purchaser's approval.

4.5.5 Within one month from successful completion of Reliability Run Test of each Unit, the Supplier shall incorporate all the changes necessitated in the drawings for the systems

completed for that Unit and submit 2(two) sets and one soft copy in CD of all the "As Built" drawings along with Data sheets, computer data (insofar as stored in computer diskettes/Compact Disc) other than the proprietary information, type tests as applicable, inspection reports, test reports, IBR approved third party certificate, erection drawings and instructions, and other manuals and information of a similar nature for the records of the Purchaser. As the Drawings shall be approved based on the basic information furnished by the Supplier, approval by the Purchaser shall not absolve the Supplier of his responsibilities towards correctness of design and performance of the Plant and Equipment.

The Supplier shall alsc submit 6(six) sets and one soft copy in CD of all the Equipment Documents on completion of supplies.

4.5.6 The Supplier shall be responsible for and shall perform, at its own cost, any alterations or remedial work to the Supplies required due to any discrepancies, errors or omissions in the Drawings or other particulars supplied by it whether such Drawings or particulars have been approved or not by Purchaser.

4.5.7 If any dimensions figured upon a Drawing or a plan differ from those obtained by scaling Drawings or plans, the dimensions as figured on the Drawing or plan shall be taken as correct figures. All additional or incidental costs or damages which the Purchaser may have incurred on account of changes made by the Supplier in the Drawings provided by the Supplier after they have been approved by the Purchaser, shall be recovered from the Supplier.

4.5.8 The sizing calculations of the Plant and Equipment other than the proprietary information shall be provided by the Supplier to the Purchaser as per the list that is mutually agreed during the Kick-off Meeting. For Items under such list, sizing calculations shall be submitted, before proceeding with ordering / manufacturing of such Items, for Purchaser's approval

4.5.9 The Supplier shall also prepare and supply Equipment Documents pertaining to the Plant Equipment in sufficient detail to satisfy the requirements of the Contract and applicable Codes. The Supplier shall prepare such documents in accordance with Project Schedule, which shall be agreed to between the Purchaser and the Supplier. The Supplier shall

submit, within 45 (forty five) days from Zero Date or during Kick-off Meeting whichever is earlier, list of documents identifying those documents under approval and information categories for the Purchaser's approval.

4.5.10 The Purchaser shall approve the list with comments, if any, within 14 (fourteen) Days of receipt of such list. In case of documents under approval category, the Purchaser shall either approve or comment within 14 (fourteen) days of receipt of first submission. For subsequent submissions, if any, the Purchaser shall similarly respond within 10 (ten) days of respective receipt(s).

4.5.11 No manufacturing activities covered under approval category of documents shall commence prior to Purchaser's approval of such documents. In the event that the Supplier commences such manufacturing, it shall take into account Purchaser's comments at its risk and expense. The Supplier shall not depart from any approved documents unless the Supplier has first submitted to the Purchaser an amended document and obtained the Purchaser's approval thereof.

4.5.12 The documents under approval category, once approved by the Purchaser, shall be submitted to the Purchaser within a reasonable period, not exceeding 45 (forty five) Days from the date of such approval in 6 (Six) copies and one soft copy in CD for Purchaser's reference and records. However, in case these approved drawings are required to be submitted to any competent authority, then these shall be submitted to Purchaser at an earlier date as mutually agreed. Purchaser shall provide suitable reasons for such expeditious requirements.

4.5.13 Any errors, omissions, ambiguities, inconsistencies, inadequacies and other defects in the documents shall be rectified by the Supplier at the Supplier's cost and without any entitlement to extension of time or any addition in the Contract Price.

4.5.14 Any approval and/or consent issued by the Purchaser in relation to all the Drawings and /or the documents shall not relieve the Supplier of its obligations under the Contract. Any approval and/or consent given by the Purchaser shall not be considered representations concerning the propriety, fitness or usefulness of any proposed action by the Supplier, and

shall not affect Supplier's obligation to strictly comply with the terms of the Contract.

4.6 Manuals

4.6.1 Operation and Maintenance Manuals

For all the Items supplied by the Supplier, the Supplier shall submit to the Purchaser 10 (ten) sets of the Operation and Maintenance (O&M) Manuals and one soft copy in CD. The Manuals shall contain the operational features of the Item/s trouble shooting, maintenance schedules for preventive maintenance, detail dimensional drawings, cross sectional drawings, method of assembly and the like to make the Purchaser's staff acquainted with the Item/s supplied as well as to enable them to operate and maintain the same in prescribed manner. The O&M Manuals shall contain all information for ordering of the spares, like part name, part no., address of the Supplier with phone number, fax number and other necessary details. The Supplier shall ensure that these O&M Manuals are made available to the Purchaser well before starting of Initial Operation of the Unit/s and/or the Plant and Equipment.

4.6.2 Erection Manuals

In order to enable the Engineer appointed by the Purchaser to supervise the Works properly, Supplier shall furnish 6 (Six) copies of Erection Manuals for each Unit and one soft copy in CD depicting therein the erection procedure, special precautions to be taken, various clearance to be maintained, erection checks and tests to be carried out before the Unit is put to Initial Operation.

4.7 Paints and Consumables

4.7.1 It shall be the responsibility of the Supplier to supply all the paints as required.

4.7.2 It shall be the responsibility of the Supplier to supply all consumables other than Coal, Raw water, LDO, HFO and start-up power up to completion of Reliability Run Test. The Supplier shall furnish specifications of all such consumables to enable the Purchaser to purchase the

future requirements of such paints, consumables, oils and lubricants well in advance.

4.8 Packing, Forwarding and Shipment

4.8.1 The Supplier, after proper surface treatment shall pack and crate all the Items of the Plant and Equipment for seaworthy packing (Phytosanitary /fumigation to be done in case of packing of goods in wooden boxes / pallets and shall furnish a certificate from the competent agency certifying that Phytosanitary /fumigation has been done) wherever applicable, in a manner suitable for export to a tropical humid climate region in accordance with the internationally accepted export practices, and in such manner so as to protect it from damage, corrosion and deterioration in transit and during it's transportation by sea, air and/or land, till the time of shipment reaching Delivery Point.

4.8.2 Each Item of the Plant and Equipment shall be painted, greased and/or provided with a suitable protective coating as required to prevent rust or damage due to bad weather. Before packing the Items as required, the Plant and Equipment shall undergo the Supplier's standard preservation measures to protect it during shipment.

4.8.3 The Supplier shall give all information concerning the weight, size and content of each package including any other information the Purchaser may require.

4.8.4 The Supplier shall ensure that the dimensions of the packages conform to the requirements of the carriers viz. railways or any other mode of transport in India. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperature, salt and precipitation during transit and open storage. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the final destination, the ability of the connecting roads/bridges enroute to withstand the weight, and the absence of heavy handling facilities at all points in transit.

4.8.5 The Supplier shall prepare detailed packing list of the packages, containers, bundles and loose materials forming each and every consignment dispatched to the Purchaser.

4.8.6 The packing, marking and documentation within and outside the packages shall comply

strictly with such special requirements as shall be expressly provided for in the Contract and/or in any subsequent instructions by the Purchaser.

4.8.7 The packing material shall become property of the Purchaser on receipt of material at Site.

4.8.8 Supplier shall manufacture or otherwise procure the Equipment. Supplier shall then timely dispatch and provide for the marine transport of the Equipment. Should Supplier encounter delays in manufacturing, procuring or transporting the Equipment, it shall, as necessary, initiate steps to remedy such delays and keep the Purchaser informed.

4.8.9 The method of material identification Unit wise shall be mutually discussed and agreed in the kick-off meeting for the purpose of easy identification of material during transit and storage.

4.8.10 Permits

Supplier shall obtain and maintain any and all Permits, visa, necessary or desirable for the manufacture, export, shipment and transport of the Equipment ("Supplier Permits). Supplier shall obtain and maintain the Supplier Permits at Supplier's sole cost and expense. Supplier shall also cause all its Sub-Suppliers to maintain their Permits.

4.9 Storage and Identification

4.9.1 Until such time as risk of loss with respect to the Plant and Equipment has passed from Supplier to Purchaser, the Supplier shall properly store and ensure maintenance of the Plant and Equipment and shall protect such Items against weather hazards, water, humidity, sand, fire, theft, damage, and similar hazards, all in accordance with the Requirements.

4.9.2 The Supplier shall use reasonable means to prevent at all times any damage or loss whatsoever to the Plant and Equipment. All the major Items of the Plant and Equipment shall be labeled with permanently affixed nameplates that will include the manufacturer's name, Item model number and serial number. Such identification system shall correspond

to the information contained in warranties maintenance requirements and records, as well all related certificates and documentation relating to the given Plant and Equipment that the Supplier delivers to Purchaser with the Plant and Equipment.

4.10 Supplier's Representative and Personnel

4.10.1 The Supplier shall provide all requisite superintendence during Supply envisaged under the Contract until proper completion of the Suppliers obligation under the Contract. Such superintendence shall be through experienced and qualified personnel, with prior experience in similar Plant and Equipment setup and adequate knowledge (including knowledge of operations to be carried out, preventive steps and procedures on accidents) facilitating timely implementation of the Project.

4.10.2 The Supplier shall provide superintendence to comply with the Delivery Schedule solely at its cost to complete the performance under the Contract.

4.10.3 The Supplier shall not recruit, or attempt to recruit, its staff and labour from amongst the employees of the Purchaser. Likewise, the Purchaser shall not recruit, or attempt to recruit, its staff and labour from amongst persons in the service of Supplier.

4.10.4 The Supplier shall, if applicable, comply with all the relevant labour laws applying to its employees, including Laws relating to minimum wages, contract labour (regulation & prohibition), workmen's compensation and occupational health & safety . The Supplier shall promptly pay and afford to its employees all their rights under employment with the Supplier. The Supplier shall be required to ensure that all such employees obey all Applicable Laws, including those concerning safety. The Supplier undertakes to include in each of its sub contracts a provision that the Sub-Supplier will comply with the foregoing labour Laws and worker's rights requirements with respect to its employees and that of any Sub-Suppliers. Nothing contained in any part of this Contract shall be construed to create any privity of relationship between the Purchaser and the Supplier or the Sub-Supplier or the employees, if any, deployed by the Supplier or the Sub-Supplier for the purpose of performance of the Scope of Supplies, including but not limited to principal-agent, master-servant and employer-employee.

4.10.5 The Supplier shall endeavor to depute / designate English-speaking personnel (**"Supplier's Representative"**) who shall be responsible for the performance of the Works by Supplier and shall be authorized to execute Variation/Change Orders and to act on behalf of Supplier. The Supplier shall provide Purchaser with the name, current address, telephone and facsimile numbers of such personnel.

4.10.6 No obligation of the Supplier pursuant to this Article shall be construed as obligating Purchaser to inspect or review the Supplier's labour and employment practices. Inspection or review of the supplies, procedures, methodologies and the like or the Supplier's facilities by Purchaser or Purchaser's Representative shall not (a) constitute either (i) an approval, endorsement or confirmation of the Supplier's or any Sub Supplier's labour or employment practices or (ii) an acknowledgment by any such Person that labour or employment practices satisfies any of the Requirements; or (b) relieve the Supplier from any of its obligations under this Article or any Applicable Law. or (ii) liability or responsibility under any of the Requirements.

4.11 Shop Assembly

Shop Assembly to the extent necessary shall be performed by the Supplier to assure proper fitting of the various parts and for checking the correctness of clearances and dimensions. parts thus assembled shall be match-marked for re-assembly at Site, prior to dismantling for shipment. A detailed description of intended shop assemblies shall be submitted along with the Quality Assurance Programme, wherever possible.

4.12 Shop Testing

4.12.1 The Supplier or its Sub Suppliers and/or Affiliates shall perform the standard Shop Tests. Upon successful completion of the standard Shop Test the Supplier shall provide the Purchaser with a shop testing certificate detailing the standard Shop Test and the results thereof. In addition, the Purchaser reserves the right to require the Supplier to perform one or more formal Shop Tests of any or all of the item/s of the Plant and Equipment that the Purchaser or the Purchaser's Representative may attend.

4.12.2 The Purchaser shall give the Supplier written notice of the Purchaser's desire for such Shop Tests prior to the proposed readiness to shipment. Should the Purchaser require a formal Shop Tests, the Supplier shall provide Purchaser with at least ten (10) Days (or such other period as may be agreed upon by the Supplier and Purchaser) prior written notice of the time and place for the conduct of such formal Shop Tests; provided that, in the case of any retesting shortly following a failed Shop Test, such notice to the Purchaser may be oral and within such reasonable period prior to such retest as shall provide the Purchaser with a reasonable opportunity to attend.

4.12.3 The Supplier shall allow Purchaser to attend any other Shop Tests whether conducted by the Supplier or a Sub-Supplier, and use reasonable efforts to enhance the ability of Purchaser to attend such tests. If Purchaser fails to attend any such Shop Test within 7 days after receipt of notice by Purchaser, then such test shall be deemed waived by Purchaser and Purchaser shall rely on the test report submitted by Supplier. In case of change in shop test schedule, Supplier shall inform Purchaser one week in advance of such change.

4.12.4 The Supplier shall promptly forward to Purchaser duly certified reports of all the Shop Tests (including IBR approved third party certificates) and copies of the data upon which the reports are based.

4.12.5 If the Purchaser does not attend a test after having received notice thereof in accordance with the provisions of the Contract, or if Purchaser and the Supplier agree that Purchaser shall not attend a particular Shop Test, the Supplier agree in writing without prejudice to the Purchaser's right to receive the Item/s materials of required quality set out in the specifications to meet the required level of performances, the Supplier may proceed with the test.

4.12.6 If, as a result of inspection, examination or testing, it is determined that any or all Item/s of the Plant and Equipment, materials, supplies or workmanship is not in accordance with the Contract, the Purchaser may reject the same. If the Purchaser rejects the same, it shall notify the Supplier promptly, stating its reasons. The Supplier shall then promptly repair the

defect and ensure that the Item supplied complies with the Contract.

4.12.7 If, due to rejection by the Purchaser, all or any Item/s of the Plant and Equipment requires retesting to verify compliance with the Contract, the necessary inspections, examinations and tests shall be repeated under the same terms and conditions, at no additional cost to the Purchaser. If such correction and retesting (other than Acceptance Tests) cause the Purchaser to incur additional costs directly related to such retesting, such costs shall be reimbursed to Purchaser by the Supplier.

4.12.8 Notwithstanding the above, the Supplier shall be solely responsible for complying with the Requirements under the Contract including the quality parameters with respect to the Supplies.

4.12.9 Inspection, Testing and Expediting. Supplier or its Sub Suppliers and/or Affiliates shall perform all inspection, expediting, testing, quality assurance and logistic services, by appropriate and technically qualified personnel or internationally accredited agencies if so required by the Purchaser, required to perform the Scope of Supplies. Supplier shall provide, at its own cost, all documents and other information reasonably necessary for the testing of the Equipment when installed at/on the Site.

4.13 Consultation with Purchaser, no release from responsibility

Inspection or review by Purchaser or Purchaser's Representative shall not (a) constitute either (i) an approval, endorsement or confirmation of any design or engineering materials, manual, test, Plant and Equipment or any Item thereof, Supplies, program, method of procedure or other work done, or (ii) an acknowledgment by any such Person that any design or engineering materials, manual, test, Plant and Equipment or any Item thereof, Supplies, program, method of procedure or other work done satisfies any of the Requirements; or (b) relieve the Supplier from any (i) of its obligations to perform the Supplies or furnish the Plant and Equipment in accordance with all the Requirements, or (ii) liability or responsibility for injuries to persons or damage to property.

4.14 Commissioning Spares and Consumables and Purchaser inputs

4.14.1 All the Commissioning Spares required to be supplied shall be properly protected and packed for long storage at Site under prevailing conditions and delivered by the Supplier in new and unused condition.

4.14.2 The Commissioning Spares shall be capable of being inter-changed with the parts for which they are intended to be a replacement.

4.14.3 In case of any failure in any original part / component of the Item or the Unit or the Plant and Equipment, as the case may be, and where such failures are due to faulty design, material and workmanship, spare parts, if any, supplied for such components / parts shall also be replaced without any extra cost to the Purchaser. Such replaced Spares shall have the same warranty period as applicable to the replacement of defective parts and material.

4.14.4 The Supplier shall provide all Commissioning spare parts, as required to meet the Plant and Equipment requirements.

4.14.5 The Supplier shall provide all tools & tackles related to the Supplies and other items to meet the actual Site requirements for enabling Commissioning and Final Acceptance of the Power Plant.

4.14.6 The Supplier shall supply at its own cost all consumable and first fill of lubricants and thereafter until date of Reliability Run Test completion. Purchaser shall provide only four inputs free of cost, namely raw coal, raw water, LDO/HFO and start-up power at 400KV for testing, commissioning and Reliability Run Test, subject to guaranteed cap provided by the Supplier as follows

S. No.	ITEM	QTY. (For Three Units)	UNIT	Required for
1	Design Coal	1650000	tons	Testing, commissioning & up to the successful completion of RRT.

S. No.	ITEM	QTY. (For Three Units)	UNIT	Required for
2	LDO	13770	tons	Testing, commissioning & up to the successful completion of RRT.
3	HFO	21000	tons	Testing, commissioning & up to the successful completion of RRT.
4	Raw Water	9900000	Cu.m	Testing, commissioning & up to the successful completion of RRT.
5	Startup Power (from grid)	126000000	kWh	Testing, commissioning & up to the successful completion of RRT.

. For any excess consumption beyond the above guaranteed value, these shall be charged to the Supplier at the rates mentioned below:

- Coal at the rate of Rs. 900/MT at Track hopper
- LDO/HFO at the rate of Rs. 40000/kl at Fuel oil tanks
- Raw Water at the rate of Rs. 2.0/Cu.m at Raw Water reservoir
- Start up power at the rate of Rs. 10.0/ kWh at 400 kV Bus of power plant switchyard."

. All other consumables required for power project shall be in Supplier scope.

4.14.7 It shall be the responsibility of the Supplier to maintain adequate items in sufficient number, as Erection & Commissioning Spares to ensure that erection, commissioning works and operation up to end of Warranty Period do not hamper for requirement of the Spares. All the left over unused Erection and Commissioning Spares shall be the Supplier's property after the Warranty Period is over and after due reconciliation of spares at site.

4.15 Long Term Availability of Spares

4.15.1 The Supplier shall ensure the long-term availability of all the Spares mentioned in this Article to the Purchaser through out the term of the Contract. The Supplier shall also ensure that

before going out of production of the Spares of the Plant and Equipment covered under the Contract, the Supplier shall give the Purchaser at least 12 (twelve) months advance notice. in writing, so that the Purchaser has sufficient time to order for the Spares in bulk, if the Purchaser so desires. The same provision shall also be applicable to all the Sub-Suppliers and it shall be the responsibility of the Supplier to ensure that the respective Sub-Contract provides for the same.

4.15.2 In case of discontinuance of manufacture of any of the Spares by the Supplier or any of the Sub- Suppliers, the Supplier shall provide the Purchaser, 1 (one) year in advance of such discontinuance, all the manufacturing drawings, material specification and technical information required by the Purchaser for the purpose of manufacture of such Spares.

4.15.3 Further, in case of discontinuance of supply of the Spares by the Supplier or any of the Sub-Suppliers, the Supplier shall provide the Purchaser with full information for replacement of such Spares with other equivalent make, if so required by the Purchaser.

4.15.4 The Supplier shall provide the Purchaser with a "directory" of all the Sub-Suppliers giving the addresses and other particulars of such Sub-Suppliers. The Purchaser, if he so desires, shall have the right to procure the Spares directly from such Sub-Suppliers.

4.16 Access

Upon reasonable notice, the Supplier shall provide or arrange for the Purchaser access during normal business hours to the Supplier's Works, and all Sub-Suppliers' Works in order to witness the tests, to inspect and examine the Plant and Equipment, and to monitor compliance by the Supplier with the terms hereof; provided that such access shall not unreasonably interfere with the timely completion of the scope under the Contract. Notwithstanding any terms of this Sub-Article to the contrary, the Supplier (and, if applicable, any Sub-Supplier) may provide, and the Purchaser shall accept, an escort or any safety measures that the Supplier (and, if applicable, any Sub Supplier), in its sole discretion, deems necessary or advisable. The Purchaser shall be solely responsible for the cost and expense of lodging, transportation, meals and any and all other expenses incurred as a result of these inspection activities.

4.17 Compliance with Requirements, Codes and Standards of Care

4.17.1 Compliance with Applicable Law

4.17.1.1 The Supplier shall in its performance of the Contract ascertain and comply with the Applicable Laws and the Supplier shall be responsible and liable for any wrong assumptions, misunderstandings of any Applicable Laws and /or any other rules, regulations and laws prevailing in India.

4.17.1.2 All the Supplies shall be delivered by the Supplier in accordance with Applicable Laws in effect from time to time. If and to the extent that any Change in Law gives rise to the requirement to make a modification to the Plant and Equipment, such Change in Law shall be treated as if it were a Variation instructed by the Purchaser, upon which Article 19 of the Contract shall apply.

4.17.1.3 Either Party shall indemnify the other Party or any third parties against losses, claims and liabilities, including any governmental penalties and sanctions payable to a Competent Authority, together with any legal expenses incurred in connection therewith, to the extent arising out of any failure of the other Party, to comply with this assurance on compliance with the Applicable Laws.

4.17.2 Divergences from Statutory Requirements

If and to the extent that any Change in Law gives rise to the requirement to make a modification to the Equipment, such Change in Law shall be treated as if it were a Variation instructed by the Purchaser upon which the Article 19 of the Contract shall apply.

If either Party discovers any discrepancy or inconsistency between the Contract and any Requirement, Directive, such Party shall immediately provide written notice thereof to the other Party in accordance with the provisions in the Contract.

If either Party finds any divergence between the Applicable Law and the Performance

Guaranteed Values or the Technical Specifications (other than resulting directly from any Change in Law) it shall immediately give to the other Party written notice specifying the divergence. The Supplier shall promptly upon becoming aware of the same, inform the Purchaser in writing of its proposed amendment for removing the divergence, and with the Purchaser's consent and subject to agreement on any variation in the Contract Price, the Supplier shall deliver the Plant and Equipment and each Item thereof in accordance with such amendment. The cost and expenses (if any) involved in the above divergence shall be mutually discussed and agreed upon.

4.17.3 Codes

4.17.3.1 The Supplier shall at all times comply with the applicable Codes as relevant for the execution of the Contract and ensure that the Works are carried out in accordance with such Codes.

4.17.3.2 If any new Codes are introduced subsequent to Feb 21, 2009, which are recommended or which would result in better performance of the Project, the Supplier shall comply with the same. However, if such compliance calls for any modification of the design of the Plant and Equipment or any Item thereof with financial implication, the same shall be discussed and mutually agreed to between the Supplier and the Purchaser.

4.17.3.3 At all times, the Supplier shall execute and complete the Works in a safe, prudent and reliable manner strictly in accordance with the Contract and with Good Industry Practices and shall exercise the same degree of care, skill and diligence in execution of the Works that is generally accepted internationally and commonly used in the international electric utility industry for the power station of the same size and characteristics similar to that of the Project.

4.18 Program of Works

The Supplier shall so organize its resources and perform its obligations as to meet the Delivery Schedule as per the Project Schedule of each Unit of the Plant and Equipment to achieve the relevant completion of Reliability Run Test or Taking Over of such Unit after the

Commercial Operation Date of such Unit, applicable thereto, and to permit successful completion of Performance Guarantee Tests

4.19 Project Schedule

4.19.1 The complete design, engineering, approval of drawings, procurement, manufacture, testing, dispatch, seaworthy packing for the shipment of Plant and Equipment covered under the Contract are to be programmed (hereinafter "Delivery Schedule") in such a way that the erection, testing, Commissioning of the Plant and Equipment is completed by respective contractors within the Guaranteed Completion Date as specified below.

4.19.2 Successful completion of Reliability Run Test of each Unit with relevant auxiliaries duly commissioned and handing over of the Unit to the Purchaser within the following period from Zero Date..

Unit No.	Reliability Run Test completion (months) from Zero Date (best effort basis)	Reliability Run Test completion (months) from Zero Date (Guaranteed Completion Date)
1 X 600 MW	36	38
2 X 600 MW	40	42
3 X 600 MW	44	46
4 X 600 MW	48	50
5 X 600 MW	52	54
6 X 600 MW	56	58

4.19.3 Zero Date or Effective Date shall mean the date of the LoA issued, subject to following:

- Purchaser shall pay 4.95 million USD within 48 hours (two clear foreign exchange dealer Business days) from the date of LoA issued so as to determine the Effective Date. Any delay in the remittance of such payment shall entitle Supplier the corresponding extension of time in the Guaranteed Completion Date.

- Supplier shall submit ABG within 30 days from the date of LoA issued for 8% of the Contract Price and at the end of sixth month from the date of LoA issued for 3.5% of the Contract Price and at the end of twelfth month from the date of LoA issued for 3.5 % of the Contract Price.

- Purchaser shall pay any advance within 7 business days from receipt of swift message and a scanned image of the ABG to the bankers of the Purchaser to be notified by Purchaser, confirming that the ABG has been issued on behalf of Supplier. Purchaser shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of Purchaser. In case, of delay of payment of advance beyond 7 business days from receipt of swift message and a scanned image of the ABG, Guaranteed Completion Date will be extended by corresponding period of such delay.

    - For first advance payment if such delay continued for 30 days from due date, then the Contract Price and Guaranteed Completion Date shall be renegotiated.

    - For all other advance payments if such delay continued for 90 days from due date, then the Contract Price and Guaranteed Completion Date shall be renegotiated.

- All the area within the boundary wall shall be handed over to Supplier within 6 months from Zero Date with the formal confirmation letter from Purchaser. Failing to do so by Purchaser, the Guaranteed Completion Date shall be extended by the corresponding period of such delay.

- Purchaser will furnish the letter signed by their banker within 5 months from 'Effective Date' that debt finance has been tied up. Failing to do so by Purchaser, the Guaranteed Completion Date shall be extended by the same period of the delay of such furnishing.

4.19.4 The micro detailed Delivery Schedule so as to match with the above completion of the Works shall be submitted by the Supplier for Purchaser's approval, after award of the Contract.

4.19.5 The Supplier shall for approval of the Purchaser, submit, within 4 (four) weeks from Zero Date, the Delivery Schedule on the basis of Project Schedule in the form of PERT/Bar Chart indicating the list of activities and activity duration to be followed in respect of:

i) Manufacture and Testing of the Plant and Equipment at Supplier's Works;

ii) Shipment and Delivery to the Delivery Point.

4.19.6 The program submitted to the Purchaser, shall be reviewed by the Purchaser and on approval shall form part of the Contract and subject to up-datation, without change in Guaranteed Completion Date, based on Purchaser approval, shall be strictly adhered to by the Supplier during the execution of the Contract. The Supplier shall also submit the schedule of inputs required from the Purchaser in order to execute the project as per Project Schedule.

4.19.7 Grounds for Extension of Guaranteed Completion Date

Without prejudice to any other Article of time extension, the Supplier shall be entitled to an extension of time if, by the following reasons of:

(a) any Variation/Change Order issued in accordance with Article 19 hereof;

(b) events or circumstances of Force Majeure as defined in Article 26 hereof;

(c) Purchaser's failure to fulfil any of its obligations under the Contract;

(d) an instruction of the Purchaser to suspend the whole or any part of the Works for reasons not attributable to the Supplier.

4.19.8 Grant of Extension of Time

As soon as reasonably practicable following the occurrence of any of the circumstances described in Article 4.19.7 hereof, but subject to the provision thereto, the Purchaser shall

grant the Supplier from time to time in writing either prospectively or retrospectively such extension to the relevant Guaranteed Completion Date as shall be fair and reasonable.

4.19.9 Delivery Schedule

Supplier shall arrange supply of the Equipment sequentially as per agreed Project Schedule.

The Plant and Equipment and each Item thereof shall be supplied by the Supplier in accordance with the Delivery Schedule and the Delivery Schedule may, subject to the prior approval of the Purchaser, be amended from time to time. The Delivery Schedule and sequence of all the Items of the Plant and Equipment shall be so as to ensure that the schedule of the Supplies by the Supplier is met to enable the Commissioning of each Unit and/or the Plant and Equipment to occur within the period as specified under and enable the Taking Over of each Unit and/or the Plant and Equipment, as the case may be. by the Purchaser, after successful completion of Reliability Run Test and the completion of Performance Guarantee Test

4.19.10 Manufacturing Programme

The Supplier shall make available to the Purchaser a detailed Manufacturing Programme for the Plant and Equipment in line with the Project Schedule within 30 (thirty) Days from the date of Purchaser's final acceptance of the Project Schedule. During the execution of the Contract, such programmes shall be reviewed, updated, submitted to the Purchaser as and when needed by it or periodically as specified by it. If in the reasonable opinion of the Purchaser, proper progress is not maintained for reasons solely attributable to the Supplier. the Purchaser shall have the right to instruct the Supplier to accelerate the progress of the Works and suitable changes shall be made in the Supplier's operation to ensure proper progress.

4.19.11 Quality Assurance Programme

4.19.11.1 The Supplier undertakes to implement throughout the period of the Contract the Quality

Assurance Programme (**"QAP"**) as described in the Technical Specifications reference and as agreed with the Purchaser.

4.19.11.2 The QAP is a document, which presents in a tabular form the Quality Control checks to be exercised by the Supplier during the various stages of manufacture and dispatch in order to meet the requirements of the Contract. The QAP shall detail the components manufactured, characteristics being controlled and acceptance norms for this characteristic and the agency responsible for performance and witnessing the checks.

4.19.11.3 Purchaser has furnished & explained the sample Quality Plans (QP) for Equipment of Water Treatment Plants, Coal Handling Plant & Ash Handling Plant with minimum quality requirements for guidance of Supplier. Supplier shall follow the same & prepare similar QPs of other equipment of BOP. Supplier shall submit the same for Purchaser's approval within 45 days from Zero Date. Supplier shall float enquiries to Sub-vendors only with approved QPs.

Purchaser already furnished & explained it's Quality Plans (QP) for Boilers, Turbines & Generators and their auxiliaries. Supplier agreed to follow the same with minor changes, which shall be discussed & agreed after Zero Date.

4.19.11.4 The approved Quality Assurance Programme shall be the basis of inspection and certification by the Purchaser of respective Supplies of the Supplier. The necessary hold points shall be identified in the QAP where the clearance by the Purchaser shall be required before proceeding further unless a waiver is given by the Purchaser. At such stages, the Supplier shall give at least 10 (ten) Days' notice in advance for the Purchaser to attend such inspection and the Purchaser at its discretion may either attend the test or give waiver. The Supplier shall be responsible to furnish copies of tests certificates, IBR approved third party certificates and inspection reports to the Purchaser as per QAP before release of payment for such supply.

4.19.11.5 The details of the quality assurance / quality checks envisaged by the Supplier during manufacturing of the item/s supplied by the Supplier or procured through the sub-vendors/ Sub-Suppliers of the Supplier shall be detailed out in the quality plans to be submitted by the

Supplier. The Supplier may also furnish any additional information regarding quality assurance / quality checks in the additional sheets, if required. The QAP plans for other major Item/s manufactured by the Supplier or procured through his sub-vendors / sub-Suppliers shall be submitted during engineering. After approval of the Purchaser is accorded various quality plans shall be bound as a booklet and shall be submitted to the Purchaser as soon as possible. The Supplier shall ensure that the approved quality plans are followed scrupulously by the Supplier and the sub-vendors, sub-suppliers and manufacturing of the Item/s covered under the QAP shall be taken up only after Purchaser has approved the QAP.

4.19.12Progress Reports

The Supplier shall constantly monitor the progress of all activities in connection with delivery of the Supplies in accordance with the Delivery Schedule and the Project Schedule and shall submit a detailed Progress Report, in 6 (six) copies in print and soft copy in CD. to the Purchaser every Month. The Progress Report shall contain such information, as the Parties shall mutually agree. The Progress Report shall detail the actual status of procurement of raw materials and sub-contracted equipment, manufacture, assembly, inspection, testing and delivery of the Plant and Equipment and each Item of such Plant and Equipment as against the Project Schedule and if any activities are behind the Delivery Schedule and/or Project Schedule, shall set out the explanation therefore, consequences thereof, and the action being taken to remedy the delay.

4.19.13Test Reports

On completion of tests of the Items at the Supplier's Works, the Supplier shall furnish 4 (four) copies of test certificates and IBR approved third party certificates to the Purchaser for approval and subsequent dispatch clearance. The test report shall invariably indicate identification data, including model no., sr. no. and the other like necessary details of the Items of the Plant and Equipment, method of application and duration of test along with test results. Only on approval of these test results by the Purchaser or Purchaser's Third Party Inspection Agency, the material shall be dispatched to the Delivery Point.

4.20 Patent Rights, Royalties and License Fees

4.20.1 The Supplier shall hold the Purchaser indemnified and harmless from and against all claims and proceedings for or on account of infringement of any patent right, design, trade mark or name or other protected rights in respect of any plant or materials incorporated in the works from and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever in respect thereof and in relation thereto.

4.20.2 Royalties and fees for patents covering materials, apparatus, devices, equipment or process used in the Works shall be deemed to have been included in the Contract Price. The Supplier shall satisfy all demands that may be made at any time for such royalties or fees and he alone shall be liable for payments of the same.

4.20.3 In the event of any claim being made or action brought against the Purchaser arising out of the matters referred to in this Article, the Supplier shall be promptly notified thereof and may at the Supplier's own expenses conduct all negotiations for the settlement of the same and any litigation that may arise therefrom. The Purchaser shall not, unless and until the Supplier shall have failed to take over the conduct of the negotiations or litigation, make any admission, which might be prejudicial thereto. The conduct by the Supplier of such negotiations or litigation shall be conditional upon the Supplier having first given to the Purchaser such reasonable security as shall from time to time be required by the Purchaser to cover the amount ascertained or agreed or estimated as the case may be of any compensation, damages, expenses and costs for which the Purchaser may be liable in respect of such infringement as aforesaid. The Purchaser shall, at the request of the Supplier, afford all available assistance for the purpose of contesting any such claim or action and shall be repaid any expenses incurred in so doing.

4.20.4 Final payment to the Supplier by the Purchaser shall not be made while any suit or claim regarding infringement of patent or other intellectual property right and royalties remains unsettled. In the event any apparatus Plant or Equipment or any part there-of furnished by the Supplier in such suit or proceedings is held to constitute infringement and its use is not permitted, the Supplier shall, at his option, and at his own expenses, either procure for the Purchaser the right to continue use of said apparatus, Plant or Equipment or part thereof.

replace with non- infringing apparatus, Plant or Equipment or modify it so that it becomes non-infringing Equipment.

4.21 Supply Completion

The Supplier shall notify the Purchaser within 24 (twenty four) hours after the Supplier has supplied the last Item of the Plant and Equipment relating to Scope of Supply.

4.22 Financing Matters

4.22.1 The Supplier hereby consents to assignment of the Contract to the Lenders of the Project for their security purposes.

4.22.2 The Supplier shall cooperate with the Purchaser and the Lenders and shall execute, deliver, and perform under such documents as may be reasonably required by the Lenders.

4.22.3 Supplier shall provide complete support on documentation with respect to Purchaser Usance / Buyers Credit facility with its bankers.

4.23 Transfer of Ownership and Risk

4.23.1 The title to the Plant and Equipment shall pass to the Purchaser when the Plant and Equipment are delivered over ship's rail at dispatch port/airport as per CFR (INCOTERMS 2000) subject to furnishing clean Bill of Lading evidencing proof of Plant and Equipment having being received on board. Provided however, such passing of title of ownership to the Purchaser shall not in any way absolve, diminish or dilute the responsibilities and obligations of the Supplier under the Contract or otherwise affect the provisions respecting care, custody and control and loss.

4.23.2 The transfer of ownership and risk specified as above shall not be affected by any activity by the Supplier arising on account of Warranties under Article 18 hereof.

4.23.3 In performing the Scope of Supplies the Supplier shall not incorporate into the Plant and

Equipment any components, materials, tools and supplies that are not free and clear of any and all Liens, or other encumbrances. Should Purchaser be encumbered from using any Item of the Unit and/or portion of the Plant and Equipment or otherwise become the subject of legal action due to the Supplier's failure to comply with this Sub-Article, the Supplier shall promptly bring the Plant and Equipment into full compliance with this Sub-Article and perform all actions necessary to have the injunction lifted and/or the legal action dismissed with prejudice.

4.23.4 The Supplier shall, at its sole expense, promptly and duly execute, obtain from third parties and deliver to Purchaser such documents (including financing statements, short form memorandums of the Contract and Lien waivers for filing and recording purposes) and assurances, and take such further action as Purchaser may from time to time reasonably request in order to establish, perfect and maintain Purchaser's right, title and interest in and to the Plant and Equipment and the Project.

4.24 Interconnection.

Purchaser and Supplier acknowledge and agree that the design and engineering of the Electrical Equipment within Supplier's scope within the Battery Limits of Power Plant will require coordination among Purchaser, Supplier and the State Transmission Utility (STU) in Chhattisgarh or its successors and Power Grid Corporation of India Limited (PGCIL). Supplier shall be responsible for Supply of such Electrical Equipment within Supplier's scope and Interconnection Equipment to enable timely interface with the Grid. Transmission Line and equipment beyond Supplier Battery limits are not within the Scope of Supplier. The Purchaser shall be responsible for providing all necessary information from STU/PGCIL. and providing interconnection conditions outside the power plant boundary necessary for on-time interconnection to the Supplier.

4.25 Punch List.

Supplier shall co-operate with the Purchaser for preparation and submit a list of items of uncompleted Scope of Supplies, the lack of which or the failure of which to complete (considered individually or in the aggregate) does not or will not adversely affect the

performance of the Power Plant or the ability of Purchaser to safely and efficiently operate and maintain the Power Plant in the ordinary course of business (the "Punch List"). At any time prior to the Take Over Date, Purchaser shall have the right to add Punch List Items to the Punch List which prove, or are discovered to be, deficient and the same shall be liquidated by the Supplier before PG test completion date. All items which Purchaser believe to be deficient after the Take Over Date but within Warranty Period, as applicable, shall be submitted to Supplier as warranty work pursuant to Article 18 and the Supplier shall re-supply or rectify the defects of such Supplies.

4.26 Care custody

Notwithstanding which Party has title, care custody and control of the Equipment and loss or damage thereto shall remain with Supplier until passed to the Purchaser at the time of final handing over of each Unit.

5. PURCHASER'S OBLIGATIONS

The Purchaser's obligations under the Contract, in addition to those set forth in the further provisions of the Contract, are as follows:

5.1 Make Payments

The Purchaser shall be liable to make Payments to the Supplier in the manner as set forth in Article 12 of the Contract.

5.2 Purchaser's Representative

5.2.1 The Purchaser shall depute appoint an English-speaking employee or representative to act on its behalf as its authorized representative ("**Purchaser's Representative**") who will act as an in-charge for all the Works under the Contract. The Supplier's resident engineer shall report to the Purchaser's Representative for all the day-to-day Works.

5.2.2 The Purchaser shall provide the Supplier written notice of the name, current address, telephone and facsimile numbers of Purchaser's Representative. The Supplier shall comply

with instructions given by the Purchaser's Representative in connection with the Contract. .

5.2.3 The Purchaser shall cause the Purchaser's Representative to perform every act required under the Contract to be performed by the Purchaser's Representative and any obligation stated under the Contract to be an obligation of the Purchaser's Representative shall be deemed to be an obligation of the Purchaser. The Purchaser shall be responsible for any act, neglect or omission of the Purchaser's Representative as if it were an act, neglect or omission of the Purchaser.

5.2.4 The Supplier shall proceed with the supply of the Plant and Equipment in accordance with decisions, instructions and orders given by the Purchaser's Representative subject to and in accordance with the Contract, including provisions for Variations as set out in Article 19 hereof.

5.2.5 The Purchaser's Representative may issue written and/or oral instructions in case of emergencies with which the Supplier shall immediately comply. The Purchaser's Representative shall confirm any oral instruction in writing within 36 (thirty six) hours of its issuance.

5.3 Purchaser's Staff / Representative not personally liable

Neither any member of the Purchaser's staff / Representative nor the Engineer nor any of the staff of the Engineer, nor the Engineer's Representative shall in any way be personally liable for the acts or obligations under the Contract or answerable for any default or omission on the part of the Purchaser in the observance or performance of any of the acts, matters or things which are concerning the Contract.

5.4 Approvals / Consents

The Purchaser shall obtain and maintain all statutory approvals / consents for the purchase of the Plant and Equipment and timely execution of the Contract. The Purchaser shall be responsible for the approvals and consent required for implementing the Project and excludes those approvals that are to be obtained and maintained by the Supplier. The

Purchaser shall obtain registration with Sales Tax authorities.

5.5 Document Review.

The Supplier may send to the Purchaser for review any data, documentation, or specifications, drawings ("Documents"). The Purchaser's reviewer will verify the accuracy of the information and data that Supplier has supplied. All Documents submitted by Supplier to Purchaser for approval must be either approved or rejected by Purchaser with comments within 14 (fourteen) days from the date the Documents are delivered to Purchaser, where after they shall be deemed approved. In the event they are rejected by the Purchaser. the Supplier shall resubmit the same, and the Purchaser shall comments within 10 (ten) days from the date they are delivered to Purchaser, where after they shall be deemed approved.

However, if the submission of documents is not as per the Document Submission Schedule resulting in Bunching Effect then the approval of documents within 14 (fourteen) days by the Purchaser shall not be applicable In such case the time period for drawings approval shall be mutually discussed and agreed.

6. EFFECTIVENESS OF CONTRACT

The term of the Contract shall commence and it shall be in full force and effect from the Date of Contract Signing. Unless otherwise terminated the Term of the Contract shall be deemed to continue until the completion of the Warranty Period and till the completion of all the contractual obligations by the Supplier.

7. PROGRESSIVE AND FINAL CERTIFICATES

7.1 The Supplier may, at the times and in the manner explained hereunder, apply to the Engineer for Progressive and Final Certificates for the Works executed in terms of the Contract with complete supporting documentation.

The Supplier shall submit applications for Progressive Certificate upon the completion of progress events and each application shall be accompanied by such evidence as the

Engineer may reasonably require.

7.2 The Engineer shall issue to the Supplier progressive certificate certifying completion of works up to a said date, within 7 days after receiving of an application, therefore, made in accordance with this Article.

7.3 Every progressive certificate shall certify the Contract Price of the Plant and Equipment supplied or value of the Works duly executed pursuant to the Contract, up to the date named in the application for the certificate. If any Item/s supplied does not comply with the Contract and for which a progressive certificate has been issued earlier by the Engineer, the value of such Item/s shall be subtracted from the next progressive certificate.

7.4 No progressive certificate shall be relied on as conclusive evidence of any matter stated therein, nor affect or prejudice any right of the Purchaser or the Supplier against each other. The Engineer may, in any certificate, give effect to any corrections or modifications that should properly be made in respect of any previous certificate.

7.5 Application for the final certificate may be made by the Supplier to the Engineer at the end of the Warranty Period, provided the Supplier has fulfilled the necessary obligations under the Contract in totality.

7.6 The Engineer shall issue the Supplier a final certificate 15 days after receiving an application thereof with complete documentation. The final certificate shall certify the total or all amounts comprised in progressive certificates previously issued in respect of the Works or the portion thereof to which the final certificate relates subject to such additions thereof or reductions therefrom, as may be authorized in the Contract.

7.7 A final certificate shall, save in the case of fraud or dishonesty relating or affecting any matter dealt with in the certificate, be conclusive evidence as to the sufficiency of the Works and of the value thereof.

7.8 The Purchaser shall not be liable to the Supplier for any matter or thing arising out of or in connection with the performance of the Scope of Supplies under the Contract unless the

Supplier shall have made a claim in writing in respect thereof within 90 (ninety) days from the cause thereof.

8. INSPECTION, TESTING AND INSPECTION CERTIFICATE

8.1 The Engineer or Engineer's duly authorised representative and / or an outside inspection agency acting on behalf of the Purchaser, shall have at all reasonable times, access to the Supplier's premises or works and shall have the power at all reasonable times to inspect and examine the materials, workmanship and progress of the Works during its manufacture or erection and if any Item of the Plant and Equipment is being manufactured or assembled at other premises or the Supplier's Works, the Supplier shall obtain for the Engineer and for his duly authorised representative, permission to inspect as if the Works were manufactured or assembled on the Supplier's Works.

8.2 The Supplier shall give the Engineer / Inspector 15 (fifteen) days written notice of any material being ready for testing. Such tests shall be to the Supplier's account except for the expenses of the Purchaser's Inspector. The Engineer / Inspector, unless witnessing of the tests is waived, will attend such tests within 15 (fifteen) days of the date on which the Item/s is notified as being ready for test / inspection, failing which the Supplier may proceed with the test, which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

8.3 The Engineer or Inspector shall, within 7 (seven) days from the date of inspection as defined herein, give notice in writing to the Supplier of any objection to any drawings and / or any Item of the Plant and Equipment and workmanship which in his opinion is not in accordance with the Contract. The Supplier shall give due considerations to such objections and shall either make the modifications that may be necessary to meet the said objection or shall confirm in writing to the Engineer / Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

8.4 When the Shop Tests have been completed at Supplier's Works, the Engineer / Inspector shall issue a certificate to this effect 7 days after completion of tests but if the tests are not witnessed by the Engineer / Inspector, the certificate shall be issued within 7 days of receipt

of Supplier's test certificate by the Engineer / Inspector. Failure of the Engineer / Inspector to issue such a certificate shall not prevent the Supplier from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the Plant and Equipment should it, on further tests after erection, be found not to comply with the Contract.

8.5 In all cases where the Contract provides for tests whether at the premises or works of the Supplier or of any sub-Supplier , the Supplier, except here otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Engineer / Inspector or his authorized representative to carry out effectively such tests of the Items in accordance with the contract and shall give facilities to the Engineer / Inspector or to any authorized representative to accomplish testing.

8.6 The inspection and/or acceptance by the Engineer and issue of Inspection Certificate thereon shall in no way absolve or limit the liabilities and responsibilities of the Supplier towards quality of the Plant and Equipment to be supplied under the Contract and shall not prevent subsequent rejection, if such Item if found to be defective and not in conformity with the requirements of the Contract.

8.7 The Engineer shall have the right to re-inspect any Item of the Plant and Equipment though previously inspected and approved by him at Supplier's works before and after the same are erected at Site. If, by the above inspection, the Engineer rejects any Item/s, the Supplier shall make good such rejections either by replacement or modifications/ repairs as may be necessary to the satisfaction of the Engineer. Such replacements will also include the replacements or re-execution of all such Works of other contractors and / or agencies which might have got damaged or affected by the replacements or rework done to the Supplier's Works.

8.8 It is agreed and acknowledged by the Parties that no Item of the Plant and Equipment shall be shipped before all tests and inspections have been carried out according to the approved Quality Assurance Programme unless otherwise instructed by the Purchaser.

9. THIRD PARTY INSPECTION

The Plant and Equipment to be supplied under the Contract shall be inspected during manufacturing as per the QAP to be finalized. Material verification and stage inspection at all important stages as well as final testing and inspection shall fall within this scope. The inspection shall be carried out by the Purchaser or a third party inspection agency to be appointed by the Purchaser for supplies. The cost towards this inspection shall be borne by the Purchaser.

10. CONTRACT PRICE

10.1 In consideration of the Supplier supplying the Supplies, the Purchaser hereby covenants to pay to the Supplier the Contract Price amounting to USD 1,831,644,000 (Say US Dollars one billion eight hundred and thirty-one million six hundred and forty-four thousand only) at the time and in the manner set forth in the Contract subject to such deductions/adjustments as may be allowable in the Contract. The Contract Price shall mean the price for the Supplies supplied on CFR (INCOTERMS 2000) basis. Insurance will be arranged by or on behalf of Purchaser.

10.2 The following provisions shall apply in respect of Contract Price:

i) The invoice will be raised in US $ as per the original Contract Price with reference rate of RMB to USD (1USD equivalent to 6.82RMB) and payment will be released for this invoice as detailed above.

ii) Any exchange rate variation with respect to the reference rate of RMB to USD (1USD equivalent to 6.82RMB), based on the USD buying rate published by Bank of China on the date of payment release shall be to the account of the Purchaser and the contract price varies accordingly, the Supplier shall raise a debit/credit invoice on the Purchaser, which shall be duly supported by the relevant back up documents of exchange rates and the variations thereof.

iii) The Purchaser shall, in the event of unfavourable exchange rate variation, settle on

quarterly basis, such Exchange Rate Variation for payments made in preceding quarter based on the formulae explained below, within 2 business days of receipt of approval of such payment by RBI (Reserve Bank of India) which is expected to be not more than 1 month for first payment and 21 days for subsequent payments. Similarly the Purchaser shall be entitled to recover/adjust any favourable exchange rate variation from the succeeding invoices proposed/due for payment to the Supplier.

iv) Exchange rate variation for the quarter = ∑ each payment during the respective quarter × (6.82 – the exchange rate between RMB and USD at the date when the Purchaser made the payment) ÷ the exchange rate between RMB and USD at the date when the Purchaser made the payment.

v) The above principle will be followed for all payments to be made under the Contract including payments against Bank Guarantees. However the adjustment in value for exchange rate variation of Advance Bank Guarantee will be made on each subsequent Advance Bank Guarantee submission.

vi) The Exchange rate variation payments shall be made in US $.

11. PAYMENTS

The Purchaser, as per guidelines and conditions specified herein, shall arrange the payment to Supplier only for the performance of the Works under the Contract. All Payments during the currency of the Contract shall be "on account" payments only. The payments for the off-shore supply shall be made in US $.

11.1 It shall be the responsibility of the Supplier to effect the Payments to the Supplier's collaborator/associate, principal, sub- vendor, sub-supplier etc. The Supplier shall hold the Purchaser harmless and indemnified from and against all such claims. The Supplier acknowledges that this aspect has been taken into consideration in the Contract Price.

11.2 Due dates for payment

The Purchaser shall make progressive payment as and when the Payment is due as per the terms of payment set forth. The Payment shall become due and payable by the Purchaser within 21 days from the date of receipt of the Supplier's bill/invoice/debit note by the Purchaser provided the documents submitted are clear and complete in all respects.

On receipt of complete set of required documents, Purchaser shall process the documents within 7 days. Any delay in approval / comments from Purchaser within 7 days, same shall be treated as approval for payment. On approval from Purchaser, Purchaser shall release the payment within 14 days.

The Purchaser shall make timely payments to the Supplier of all amounts due to the Supplier under the Contract in accordance with the terms and provisions of the Contract. Any undisputed amount owed to either Party hereunder that is not paid by the owing Party after the date such amount is due under the Contract shall accrue interest each day such amount is not paid at an interest rate of 7% (seven percent) per annum. Such interest will be paid in USD upto US LIBOR (for the period of such delay) plus 200 basis points subject to 7% and the balance in Indian Rupees.

11.3 Payment Schedule (Billing Break-Up)

The Supplier shall prepare and submit to the Engineer, for approval, a break down of the Contract Price (Billing Break-Up). Any payment under the Contract except initial advance payment, if any, shall be made only after the Billing Break-Up is approved by the Engineer.

11.4 Application for Payments

11.4.1 Each such application shall state the amount claimed and shall set forth in detail, in the order of the Payment Schedule, particulars of the Works and of the item/s shipped/received at the Site pursuant to the Contract or erection at Site completed up to the date mentioned in the application and for the period covered since the last preceding application, if any.

No sum shall be included in any payment application in respect of the Works that, according to the decision of the Engineer, does not comply with the Contract, or has been performed,

at the date of certificate, prematurely.

11.5 Bank Guarantee

11.5.1 The Supplier shall furnish Advance Payment Bank Guarantees (ABGs) and Performance Bank Guarantees (PBGs). All Bank Guarantees furnished by the Supplier shall be on demand, unconditional, irrevocable and from a bank of international repute and in a form acceptable to the Purchaser's banker.

11.5.2 All Bank Guarantees shall have a claim period of 60 (sixty) days from the scheduled expiry date.

11.5.3 If any extension of the validity of the Bank Guarantees is required as a result of a delay in the Reliability Run Test (expiry date for ABG), or as a result of an extension in the Warranty Period of the Project , for reason of the Supplier, the Supplier shall, within 7 days prior to their expiry, arrange such extension. If the Supplier fails to arrange such extension or fails to arrange substitute the Bank Guarantees (in form and substance satisfactory to the Purchaser), the Purchaser shall be entitled to call the entire amount available under the Bank Guarantees. In case such extension is due to reasons that have nothing to do with the Supplier, the Supplier shall not have any obligation for extension of the validity of the Bank Guarantees.

11.5.4 Advance Payment Bank Guarantee ("ABG") shall be furnished by the Supplier to the Purchaser in a form as set forth in Annexure 2 as security towards:

(a) the initial advance payment;

(b) due performance of the Contract until the Reliability Run Test.

11.5.5 The ABGs shall be furnished within 30 days from the Zero Date for 8% of the Contract Price, for 3.5% of the Contract Price at the end of sixth month from the Zero Date and for 3.5 % of the Contract Price at the end of twelfth month from the Zero Date.

The ABGs shall be valid upto the completion of Reliability Run Test of the last Unit. The

amount of the Guarantee shall be progressively reduced on quarterly basis in proportion to the value of progress payments received.

11.5.6 Performance Bank Guarantees ("PBG") shall be furnished by the Supplier to the Purchaser, in a form as set forth in Annexure 3 as security towards:

(a) Successful completion of the Performance Guarantee Tests; and
(b) Due performance of the Supplier's Warranty Period obligations;
(c) Recover any Taxes applicable and payable by the Supplier which is paid by the Purchaser.

11.5.7 The Supplier shall furnish first PBG equivalent to 6% of Contract Price 30 days before scheduled date of completion of Reliability Run Test of first Unit, valid upto Warranty Period completion of the third Unit. The amount of this Performance Bank Guarantee shall be reduced prorated Unit wise on completion of the respective Unit Warranty Period. No further payments under the Contract shall be released to Supplier if the Performance Bank Guarantee is not submitted 30 days before the scheduled date of completion of Reliability Run Test of first Unit.

The Supplier shall furnish second PBG equivalent to 4% of Contract Price 30 days before completion of Reliability Run Test of fourth Unit, valid upto Warranty Period completion of the sixth Unit. The amount of this Performance Bank Guarantee shall be reduced prorata Unit wise on Scheduled Date of completion of the respective Unit Warranty Period. No further payments under the Contract shall be released to Supplier if the Performance Bank Guarantee is not submitted 30 days before the scheduled date of completion of Reliability Run Test of fourth Unit.

11.5.8 The Bank Guarantees shall be submitted by the tested swift message in favour of an Indian bank nominated by the Purchaser. If the Bank Guarantee confirmation is required, it shall be arranged by the Purchaser. All bank confirmation charges applicable in this regard shall be to the Purchaser's account.

12. TERMS OF PAYMENT

12.1 The Purchaser shall make progressive payment as and when they are due as per the agreed Payment Schedule. The charges for payment remittances in India shall be borne by Purchaser and that applicable in China shall be borne by Supplier. Further the Charges of respective correspondent banks/intermediary bank in USA shall be borne by each party.

12.2 Advance Payment

12.2.1 Payment of USD 4.95 Million within 48 hours of issue of LoA.

12.2.2 8% (Eight percent) advance payment of the Contract Price for supply of Items forming the Plant and Equipment, reduced by 4.95 Million USD advance paid pursuant to Article 12 2.1. will be paid by telegraphic transfer within 7 Business days from receipt of swift message and a scanned image of the ABG to the bankers of Supplier to be notified by Purchaser, confirming that the ABG has been issued on behalf of Supplier. Purchaser shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of Purchaser. In case of delay of payment of advance beyond 7 Business days from receipt of swift message and a scanned image of the ABG, Guaranteed Completion Date will be extended by corresponding period of such delay.

12.2.3 3.5% advance payment of the Contract Price shall be paid against submission of ABG of equal amount on the sixth month from Zero Date.

12.2.4 3.5% advance payment of the Contract Price shall be paid against submission of ABG of equal amount on the twelfth month from Zero Date.

12.2.5 For all advance payment, the application and invoice shall be submitted to the Purchaser.

12.3 Payment for Supply of Plant and Equipment

12.3.1. Balance Payment shall be governed by the following Articles:

a) 65% of the Contract Price against despatch of Offshore Supplies FOB Chinese/Third country port on pro-rata basis as per shipping schedule. duly supported by evidence of shipment;

b) 5 % of the Contract Price against receipt of offshore supplies at site on pro-rata basis as per shipping schedule;

c) 5% of the Contract Price against first synchronization (prorated for each Unit);

d) 5% of the Contract Price against successful completion of Reliability Run Test (prorated for each Unit) and on submission of Performance Bank Guarantee (PBG) by Supplier;

e) 5% of the Contract Price against successful completion of PG Test (prorated for each Unit).

Such payments shall be made by telegraphic transfer/any other electronic mode within 21 days from receipt of complete & correct documents, on receipt of complete set of required documents. Purchaser shall process the documents within 7 days. Any delay in approval / comments from Purchaser within 7 days, same shall be treated as approval for payment. On approval from Purchaser, Purchaser shall release the payment within 14 days.

Marine Insurance Policy shall be arranged on behalf of Purchaser before the shipments and a copy of the Insurance Policy shall be faxed to Supplier.

12.3.2 The Supplier shall submit the following documents along with the invoice to the Purchaser to claim the payments.

12.3.2.1 Documentation list for 65% prorated offshore supplies payments

(a) Signed commercial invoices in two original and three copies), invoice format need to be mutually discussed & approved by Purchaser. Signed Commercial invoice shall among other things contain the following:

- Goods are as per 'Off shore Supply Contract' dated———-
- Total value of the invoices shall be in USD———-
- Name and complete postal address of the Consignor;
- Name and complete postal address of the Consignee;
- Name and complete postal address of the place where the equipment is proposed to be physically delivered;
- Mode of conveyance – sea / air / land;
- Mode of payment giving details of the beneficiary bank:
- Invoice number and date;
- Reference of the contract / purchase order. Pursuant to which the equipment is being invoiced;
- Port of origin;
- Port of destination;
- No. of Packages and Package Reference number(s);
- Consignee code (by Purchaser);
- Gross & net weight of the package / equipment;
- Dimensions of each package (in Packing List);
- Country & place of manufacture;
- Bill of Lading / Airway Bill number and date- as detailed at Point (h);
- Description of the equipment along with quantity/unit price/value (in numbers and words);
- Terms of payment - % of the Contract Price to be payable as per the contract;
- Reference to the foreign trade policy under which the goods are being imported (Purchaser);
- Reference to the insurance policy number covering the transit risks.

(b) Catalogue/ Literature/ Write-up of cargo - 1 Original (if required by Customs);

(c) Phytosanitary certificate / Fumigation certificate is required if consignment is packed in wooden boxes/ pallets i.e. packing material is Wood. (2 Copies);

(d) Inspection Certificate / Inspection Waiver Note issued by Owner as per QAP;

(e) IBR approved third party certificate for pressure parts as per approved QAP;

pvk

(f) Master Packing List. Packing list in 3 (three) copies identifying Master packing list will have only the main Equipment name, weight. volume

(g) Detailed packing list. in 3 (three) copies identifying Detailed packing list will have each component listed with its dimensions, quantity, volume, type of packing, etc.

(h) 'Bills of lading' / 'Airway Bill' showing that the goods have been shipped clean On-Board, carrying vessel consigned to Owner as marked "freight prepaid" (destination port, India) notifying the applicant,

(i) Certificate of Country of Origin in duplicate, issued by Chamber of Commerce or any independent recognized Agency:

(j) Certificate from shipping Company / Carrier / agent of the shipping company / agent of the carrier certifying that the shipment has been made by a Seaworthy Vessel registered with an approved classification society as per the institute classification clause and class maintained equivalent to Lloyd's 100 A1 and mentioning the age of the vessel not beyond 25 years;

(k) Sailing Confirmation Letter from agent of shipping company.

(l) Shipment details must be conveyed within seven days of the shipment to the applicant by fax/telex/email and copy of such fax/telex/email to accompany documents.

(m) Further, a common reference No. shall appear on Invoice & other documents for cross reference

(n) Marine Insurance Policy shall be arranged on beha f of Purchaser before the shipments and a copy of the Insurance Policy shall be faxed to Suppl er.

12.3.2.2 Documents required for processing the invoices relatec to 5% of the Contract Price prorata basis on receipt of offshore supplies at site:

a) Reference Number of Invoice and its attachments (as explained at Article 12.3.2.1), provided they have been cleared / approved by Purchaser Engineers;
b) Evidence of Customs Clearance;
c) Original LR copy for inland transportation (Purchaser provided waybill to Supplier);
d) Reference to the insurance policy number covering the transit risks;
e) Project site entry Gate Pass;
f) Manufacturer's Test report & Test certificates as per approved QAP;
g) Signed jointly (Representatives of Purchaser & Supplier at the site) Inward Goods

Inspection report as proof of complete and safe receipt of goods at site.

12.4 Cash Flow

The cumulative payment of cash flow based on Contract Price in any month shall not exceed such cumulative percentage based on Contract Price upto that month as set forth Schedule 1, Cash Flow Schedule under the Contract. In case Supplier wish to supply the goods in advance compared to the project schedule then Supplier shall be permitted to do so but the payment shall be limited to cumulative percentage for that month as per the agreed cash flow statement.

12.5 Certificate Not to Affect Right of Purchaser and Liability of Supplier

No interim payment certificate of the Engineer nor any sum paid on account by the Purchaser, nor any extension of time for execution of the Works granted by the Engineer shall affect or prejudice the rights of the Purchaser against the Supplier or relieve the Supplier of the obligations under the Contract or be interpreted as approval of the Works done and no certificate shall create liability for the Purchaser to pay for alterations, amendments, variations or additional works not ordered, in writing, by the Engineer nor shall discharge the liability of the Supplier for the payment of damages whether due, ascertained or certified or not, or any sum against the payment of which the Supplier is bound to indemnify the Purchaser, nor shall any such certificate nor the acceptance by the Supplier of any sum paid on account or otherwise affect or prejudice the rights of Purchaser against the Supplier.

13. TAXES AND DUTIES

13.1 All taxes and duties applicable in India shall be to the Purchaser's account.

13.2 All taxes and duties applicable outside India shall be to the Supplier's account.

13.3 The Supplier shall (i) assist Purchaser in the preparation, processing and submission of all tax documentation such that documentation shall be made available by the Purchaser prior

to filing of such documents (ii) provide all necessary explanations relating to the nature of the Equipment and the manner in which it will be used; and (iii) provide any other reasonable matter specified in such procedures required by any taxing Governmental Authority as a condition to the granting of or maintaining of any exemption from, or reduction of, any taxes and import duties. Supplier shall consult with the Purchaser before submission of any documentation or the provision of any explanation to taxing Governmental Authorities and the Purchaser shall give reasonable assistance to Supplier therewith provided that such assistance shall not relieve Supplier of its responsibilities referred to above

14. STATUTORY VARIATION FOR TAXES AND DUTIES

14.1 If any statutory variation in taxes/duties/levies and any new taxes/duties/levies are newly introduced by any Competent Authority applicable for the Works carried out under the Contract with effect from the next day to Feb 21, 2009 and onwards and if the Supplier is required to pay any amount towards this tax or duty, the Purchaser shall reimburse the Supplier such payments against documentary proof. Likewise, if the variation results in decrease in taxes/duties/levies the resultant benefit will be passed on to the Purchaser by the Supplier. This provision will be applicable only to the direct transactions between the Supplier and the Purchaser.

14.2 Any variation in the rates/input credit regulation of applicable taxes and duties with effect from the next day to Feb 21, 2009, shall also be settled between the Supplier and the Purchaser at actuals against documentary evidence as per statutes.

14.3 No claim for any increase towards the statutory variation shall be entertained by the Purchaser during the extended period of the Contract, if any, provided the extension of the Contract is required by causes attributable to the Supplier.

15. REPRESENTATIONS AND WARRANTIES

15.1 Representations and Warranties of the Supplier

On and as of the date of the Contract the Supplier represents and warrants to Purchaser that:

15.1.1 Organization and Standing

The Supplier is a corporation duly organized and validly existing under the laws of China and is in good standing under the laws of China / India, and has the requisite corporate power and authority to carry on its business as now conducted and as proposed to be conducted, to own or hold under lease its properties and to enter into and perform its obligations under the Contract. The Supplier is duly qualified or licensed to do business and is in good standing in each jurisdiction where the failure to be so qualified or licensed would have a material adverse effect on Supplier.

15.1.2 Authorization

The Supplier has all requisite legal and corporate power to enter into the Contract and to carry out and perform all of its obligations hereunder. All corporate action on the part of the Supplier and its officers, directors and shareholders that is necessary for the authorization, execution and delivery of the Contract and for the performance of the Supplier's obligations hereunder has been taken.

15.1.3 Compliance with Other Instruments

The execution, delivery and performance by the Supplier of the Contract and the consummation of the transactions contemplated hereunder will not result in any violation, be in conflict with or constitute, with or without the passage of time or the giving of notice, a default under, or require any consent or waiver under, any provision of the Supplier's Articles of Association, charter documents or bye-laws, any material instrument, mortgage, deed of trust, loan, agreement commitment or obligation to which the Supplier is a party or by which Supplier or any of its properties or assets are bound.

15.1.4 Binding Obligation

The Contract constitutes a legal, valid and binding obligation of the Supplier enforceable against the Supplier in accordance with the terms hereof, except as limited by bankruptcy, insolvency, reorganization, arrangement, moratorium and similar laws relating to and affecting the rights of creditors generally and by general principles of equity.

15.2 Representations and Warranties of the Purchaser

On and as of the date of the Contract, the Purchaser represents and warrants to the Supplier that:

15.2.1 Organization and Standing

The Purchaser is a limited liability company, duly organized, validly existing and in good standing under the laws of India, and has the requisite power and authority to carry on its business as now conducted and as proposed to be conducted, to own or hold under lease its properties and to enter into and perform its obligations under the Contract. The Purchaser is duly qualified or licensed to do business and is in good standing in each jurisdiction where the failure to be so qualified or licensed would have a material adverse effect on the Purchaser.

15.2.2 Authorization

The Purchaser has all requisite legal power to enter into the Contract and to carry out and perform all of its obligations under the terms hereof. All action on the part of Purchaser and its officers, managers and members that is necessary for the authorization, execution and delivery of the Contract and for the performance of Purchaser's obligations hereunder has been taken.

15.2.3 Compliance with other Instruments

The execution, delivery and performance by Purchaser of the Contract and the consummation of the transactions contemplated hereunder will not result in any violation, be in conflict with or constitute, with or without the passage of time or the giving of notice, a

default under, or require any consent or waiver under, any provision of Purchaser's Clauses of incorporation, charter documents or bylaws, any material instrument, mortgage, deed of trust, loan, agreement, commitment or obligation to which Purchaser is a party or by which Purchaser or any of its properties or assets are bound.

15.2.4 Binding Obligation

The Contract constitutes a legal, valid and binding obligation of Purchaser enforceable against Purchaser in accordance with the terms hereof, except as limited by bankruptcy, insolvency, reorganization, arrangement, moratorium and similar laws relating to and affecting the rights of creditors generally and by general principles of equity.

16. REPLACEMENT OF DEFECTIVE PLANT AND EQUIPMENT

If, during the progress of the Project, the Engineer shall decide and inform in writing to the Supplier that the Supplier has manufactured any item of the Plant and Equipment unsound or imperfect or has furnished any plant or equipment inferior to the quality specified, the Supplier, on receiving details of such defects or deficiencies, shall at his own expense within 15 (fifteen) days of receipt of the notice, or otherwise within such time as may be reasonably necessary for making it good, proceed to alter, re- construct or remove such work and furnish fresh Item(s) up to the standard of the specifications. In case the Supplier fails to do so, the Engineer may, on giving the Supplier 15 (fifteen) days notice in writing of it's intention to do so, proceed to remove the portion of the Works so complained of and at the cost of the Supplier perform all such work or furnish all such Items provided that nothing in this Article shall be deemed to deprive the Purchaser of or affect any rights under the Contract which the Purchaser may otherwise have in respect of such defects and deficiencies.

The Supplier's full and extreme liability under this Article shall be satisfied by the payments to the Purchaser of the extra cost of such replacement procured including erection, such extra cost being the ascertained difference between the price paid by the Purchaser for such replacement and the Contract Price portion for such defective Items. Should the Purchaser not replace the defective Item(s), the Supplier's extreme liability under this

Article shall be limited to repayment of all sums paid by the Purchaser under the Contract for such defective Item(s).

If any action in Court is brought against the Purchaser or Engineer or an officer or agent of the Purchaser for the failure or neglect on the part of the Supplier to perform any acts, matters, covenants or things under the contract, or for damage or injury caused by the alleged omission or negligence on the part of the Supplier, his agents, representatives or his Sub-Suppliers, or in connection with any claim based on lawful demands of Sub-Suppliers, workmen, suppliers or employees, the Supplier shall, in all such cases, indemnify and keep the Purchaser and the Engineer and / or the Purchaser' representative harmless from all losses, damages, expenses or decrees arising out of such action.

17. CO-ORDINATION MEETINGS

17.1 The Engineer and the Supplier' Representative shall at frequent intervals conduct Co-ordination Meetings to keep a close watch on the progress of Works, removal of any bottlenecks in the implementation, program for inspection of materials and witnessing of tests at Supplier's works or Site.

17.2 The Supplier's Representative will also be called upon to attend to design co-ordination meetings with the Engineer, other contractors and consultants of the Purchaser. The Supplier's Representative shall attend such meetings at the Supplier's own cost as and when required and fully co-operate with the Purchaser and other agencies involved.

17.3 In the event any of the Works or activity is not likely to be completed within the Delivery Schedule and for completion of such work/activity, the Purchaser and the Supplier may arrive at new date which may be beyond the Delivery schedule, this Contract shall not be construed to be extension in time limit approved by the Purchaser but shall be agreed without any prejudice to other terms and conditions of the Contract.

18. WARRANTY PERIOD

18.1 The Supplier warrants that the Plant and Equipment supplied shall be new and in accordance with the Contract Documents and be free from defects in design, material and workmanship for a period of 12 (twelve) calendar months commencing immediately upon successful completion of the Reliability Run Test:

(a) New Equipment. The Supplier warrants (the "New Equipment Warranty") that all Equipment and other materials and components of the Power Plant provided in connection with the Supplies shall be new when first installed in the Power Plant, shall conform to all Requirements.

(b) Materials and Workmanship. The Supplier warrants (the "Materials and Workmanship Warranty") that the Supplies shall be performed in accordance with all Requirements, and (i) the Supplies shall be free from defects in manufacturing, workmanship, and materials; and (ii) the remainder of the Equipment shall be free from defects in systems engineering, manufacturing, workmanship, and materials. For purposes of this Article 18.1(b) an item shall be considered defective if it (i) does not conform to the standards set forth in the Technical Specifications or the Requirements, including those under this The Contract relating to performance, or (ii) is not suitable for its intended use under the climatic and range of operating conditions as specified in Technical Specifications.

This warranty will cover Equipment only for claims for such defects made during the Warranty Period.

18.2 Remedy.

Except as provided in Articles 18.3 and 18.4, if any Equipment Warranty is breached during the Warranty Period, Purchaser's sole remedy and the Supplier's sole liability (subject to Article 18) shall be as set forth in this Article 18.2:

(a) Provide, at site, new, remanufactured, or the Supplier-approved repaired parts or assembled components needed to correct the defect. The items replaced under this warranty become the property of the Supplier.

(b) Replace consumables, filters, antifreeze and other service items made unusable by the defect.

(c) Provide reasonable or customary labor (including overtime labor) and technical direction needed to correct the defect, including labor to disconnect the product from and reconnect the product to its attached equipment, mounting, and support systems, if required. In the event that the Supplier desires to utilize the Purchaser's site maintenance personnel / O & M Contractor to effect a repair, at Purchaser's request the Supplier shall reimburse the Purchaser / O & M Contractor for the hourly rate of Purchaser's personnel / O & M Contractor. In this case Supplier shall provide necessary technical supervision of Purchaser's personnel / O & M Contractor.

(d) Provide reasonable travel expenses for authorized mechanics, including meals, mileage, and lodging, when the Supplier chooses to make the repair on-site.

(e) Any approval required for carrying the material outside India for the purpose of repair or rectification shall be arranged by the Supplier at its own cost and shall also be shipped at its own cost.

(f) Provide special tools for the removal, replacement, reconnection, mounting and calibration of the defective components. Special tools, as necessary, may be borrowed from the Purchaser's stock on site. Heavy lifting tools, except for those normally kept by Purchaser on Site, shall be provided by the Supplier.

Any repaired or replacement part furnished under this warranty shall carry warranties on the same terms as set forth above, except that the warranty period shall be for a period of twelve (12) months from the date of such repair or replacement or the remainder of the original Warranty Period, whichever is longer("Extended Warranty Period"). In any event the warranty period and the Supplier's responsibilities set forth herein for such re-performed service or repaired or replacement part shall terminate one (1) year after the end of the Warranty Period applicable to the item of Equipment in which such repaired or replacement part was installed or in which such Services was re-performed.

The Supplier acknowledges that failure to make repairs on a timely basis after Purchaser's notification of a warranty claim may cause significant financial loss to the Purchaser. Therefore, the Supplier shall make repairs in an expeditious manner. If, after notification of a breach of an Equipment Warranty, Supplier shall unreasonably delay in diligently commencing, continuing or completing the remedy required by this Article 18.2, then Purchaser may complete said remedial action, and the Supplier shall be liable for all reasonable and necessary costs, charges, and expenses incurred by Purchaser in connection with such remedial action, and shall pay such costs, charges, and expenses within fifteen (15) Days after receipt of verifiable invoices certified by Purchaser.

All replacement parts and repaired parts are warranted through, but not beyond, the Warranty Period. Supplier's sole liability and responsibility, and Purchaser's sole and exclusive remedy, with respect to this Warranty shall be limited to the remedies set forth above.

18.3 Limitation on Warranty

This warranty shall not apply to or include and the Supplier shall not be responsible for:

(a) failure to operate the equipment as per the operating manual provided by the Supplier;

(b) failures resulting from abuse, neglect, and/or improper repair outside of prudent engineering practice;

(c) failures resulting from unauthorized repair or adjustments;

(d) damage to parts, fixtures, housings, attachments, and accessory items which are not part of the Supplies under the Contract.

18.4 Purchaser's Responsibilities Under Warranty

Under this Warranty the Purchaser is responsible for:

(a) Giving timely notice of a warrantable failure and promptly making the product available for repair;

(b) Performance of the required maintenance and use of proper fuel, oil, lubricants, and coolant;

(c) Allow the Supplier access to all electronic data stored in the electronic control module at site to its personnel;

(d) Assist the Supplier to obtain any possible exemption from taxes, levies, fees, or other charges under the laws of India;

(e) The Supplier shall arrange for transportation of used parts, replaced under this warranty, at its own cost to the desired destination of the Supplier. The Purchaser shall enable the Supplier to permit such transportation, provided that the responsibility of obtaining necessary approvals, if any shall vest with the Supplier; and

(f) Provide the Supplier with reasonable access to the Power Plant to perform its obligations in connection with any Equipment Warranties, subject to Purchaser fulfilling the requirements of the consumers of power from the Power Plant.

18.5 Sub Supplier Warranties

Without in any way derogating the Supplier's own representations, warranties and guarantees with respect to the Scope of Supplies, the Supplier shall use its reasonable efforts to obtain for the benefit of Purchaser, long-term warranties similar to the Equipment Warranties that are obtainable from Sub Suppliers without additional compensation to such Sub Suppliers. To the extent legally possible, the Supplier shall assign to Purchaser at the end of the Warranty Period, all Sub Supplier warranties and/or guarantees relating to the Equipment, or material or component provided in connection with the Scope of Supplies

that extend beyond the Warranty Period. To the extent such Sub Supplier warranties are unassignable, upon request of the Purchaser; the Supplier shall enforce such warranties for the benefit of the Purchaser.

18.6 Compliance with Laws, Codes and Standards

The Supplier warrants that the Equipment will conform to all those International, Government, National, State or Local Laws, Ordinances, Regulations, Codes and Standards, as applicable under Technical Specifications.

18.7 Latent Defects.

The Purchaser and the Supplier hereby agree to mitigate and remedy the defects in the Supplies, if any, arising after the Warranty Period, in mutually agreed terms. The Supplier acknowledges that such latent defects, to the extent not covered under insurance, would cause significant financial loss to the Purchaser and undertakes to cooperate with the Purchaser / O & M Contractor to the extent possible for remedy of such latent defects. This commitment of the Supplier shall be valid till completion of two years from the expiry of Warranty Period. In case of any delay in remedying such latent defects, the procedure as prescribed under Article 16, hereinabove shall be followed.

19. VARIATION/CHANGE ORDERS

19.1 The Supplier realizes and acknowledges the nature, magnitude of the Project and the possibility of Variation/Change order that may arise from time to time and agrees and ensures that it shall accept all the possible reasonable Variations/ Change order as may be necessary for the Project to function as a whole.

19.2 If any changes required for completion of the Scope of Supplies as per Technical Specifications, the Supplier shall not be entitled to any addition in the Contract Price or to an extension of time.

19.3 No alterations, amendments, omissions, suspensions, or variations of the Works

("**Variation/Change**") under the Contract as detailed in the Contract Documents, shall be made by the Supplier except as directed in writing by the Engineer.

19.4 The Engineer shall have full powers, subject to the provisions hereinafter contained, from time to time during the execution of the Contract, by notice or order ("**Variation/Change order**") in writing, to instruct the Supplier to make such Variations, alterations without prejudice to the contract. Any deviations in the Works executed shall be rectified by the Supplier without any extra costs.

19.5 If any suggested Variation/Change would, in the opinion of the Supplier, if carried out, prevent him from fulfilling any of his obligations or guarantees under the Contract, or that the same is beyond the scope of the Contract, or involves a claim for additional payment, he shall notify the Engineer thereof in writing and shall mark a copy to the Purchaser and the Engineer in concurrence with the Purchaser shall decide whether or not the same shall be carried out and if the Engineer confirms his instructions, Supplier's obligations and guarantees shall be modified to such an extent as may be mutually agreed.

19.6 If any Variation in Works as per article 19.4 and/or 19.5 results in increase or reduction of Contract Price, the Parties shall agree, to the extent of any change in the Contract Price. Any agreed difference in cost occasioned by any such variation shall be added to or deducted from the Contract Price as the case may be.

19.7 All Change Orders shall be in writing and executed by an authorized representative of each of Purchaser and Supplier. Except as otherwise provided in Article 19.8 & 19.9, no Changes shall be made except in accordance with a duly issued and fully executed Change Order. Change in inflation or indexation, exchange rates subject to Article 10.2 will not construe a reason for change order.

19.8 Purchaser may submit a written request to Supplier to make a Change. Within fifteen (15) Days following receipt of such request, or such other period as shall be agreed upon by the Parties, Supplier and Purchaser shall agree upon adjustment to the Scope of Supplies, Performance Guaranteed Values, Guaranteed Completion Date, Contract Price, or other terms of this The Contract, if any necessitated by the proposed Change and Purchaser

shall issue a Change Order. The Supplier shall proceed and execute the Change Order. If Purchaser elects not to issue any Change Order, Supplier shall not be compensated any costs and the Contract Price stands unaltered.

19.9 Supplier shall provide Purchaser with written notice of any condition or event that Supplier becomes aware of that Supplier reasonably believes will require a Change Such notice must be issued within five (5) Business Days following actual knowledge of such condition by an officer of Supplier or by management personnel of Supplier responsible for the performance of the Scope of Supplies and such notice shall describe such condition or event in reasonable detail. Within fifteen (15) Business Days following delivery of such notice, Purchaser and the Supplier shall decide on the notified Change. If Purchaser elects to proceed, Purchaser shall issue a Change Order and Supplier shall proceed with the Change Order and the Supplier shall not be compensated for any additional cost incurred if any, so long as the change is within the scope of Supplies. If the Purchaser elects not to proceed with the Change, the Purchaser shall perform the obligations under the Contract as per the Scope of Supplies specified in the Contract. The foregoing notwithstanding, Supplier shall not propose or carry any Change Order which keeps the Purchaser indifferent / neutral on financial terms and causes any financial loss to the Purchaser due to changes in this order resulting in defaults in other Contractual obligations of the Purchaser.

19.10 In the event and to the extent that a Force Majeure affects Supplier's ability to meet the Project Schedule, an adjustment in Guaranteed Completion Date shall be made by agreement of Purchaser and Supplier based on the numbers of days on which the work of supplies is effected. Supplier shall not be compensated for any additional cost or expense incurred due to the Force Majeure, except to the extent Purchaser receives insurance proceeds based on such costs incurred by Supplier, in which event Supplier shall be reimbursed to the extent of such related proceeds. Any dispute relating to a Force Majeure caused Change Order may be submitted to dispute resolution pursuant to Article 28.

19.11 All claims by Supplier for adjustments to one or more of the Contract Price, Guaranteed Completion Date, and the Performance Guaranteed Value as a result of Changes under this Article 19 shall be supported by such documentation as is sufficient for the Purchaser to determine the accuracy thereof.

20. INDEMNIFICATION

20.1.A Supplier's Indemnity

The Supplier shall protect, defend, indemnify and hold harmless Purchaser, Lenders and the O & M Contractor , each of their respective Affiliates, and the agents, officers, directors, shareholders, employees, permitted successors and permitted assigns (each, a "Supplier Indemnified Party"), from and against any and all losses, costs, damages, injuries, liabilities, claims, demands, penalties, interest and causes of action, including reasonable attorneys' fees and court costs (collectively, the "Damages"), directly or indirectly arising out of, resulting from or related to claims for personal injury or death, or for damage to or loss of tangible property of persons resulting from, or in connection with, performance or non-performance of the Works or breach of any term of the Contract by the Supplier, its Sub-Suppliers , including claims regarding negligence, whether caused in whole or in part by the Supplier, its Sub-Suppliers ; provided, that the Supplier shall not be liable for, and shall not be obligated to indemnify any Supplier Indemnified Party against, any such claims to the extent such claims result from (a) the negligence or willful misconduct of any Supplier Indemnified Party or (b) any failure of Purchaser to perform under the Contract.

20.1.B Purchaser's Indemnity.

Purchaser shall protect, defend, indemnify and hold harmless Supplier, each of its Affiliates and the agents, officers, directors, shareholders, employees, permitted successors, and permitted assigns (each, an "Purchaser Indemnified Party") from and against Damages, directly or indirectly arising out of, resulting from, or related to claims for personal injury or death, or for damage to or loss of tangible property of persons resulting from, or in connection with, performance or non-performance of its obligations under the Contract or breach of any term of the Contract by Purchaser or its engineering of, construction of and commissioning of the Power Plant, including such claims regarding negligence, whether caused in whole or in part by Purchaser or any other Supplier Indemnified Party; provided, that Purchaser shall not be liable for, and shall not be obligated to indemnify any Purchaser Indemnified Party against, any such claims to the extent such claims result from (a) the

negligence or willful misconduct of any Purchaser Indemnified Party or (b) any failure of the Supplier to perform hereunder.

20.2 Patent and Copyright Indemnification

The Supplier shall protect, defend, indemnify, and hold harmless the Supplier Indemnified Parties from and against any and all Damages that the Supplier Indemnified Parties may hereafter incur or pay by reason of any claims or suits arising out of claims of infringement of any domestic or foreign patent rights, copyrights or other intellectual property, proprietary or confidential rights with respect to materials and information used by the Supplier or any Sub Supplier in performing the Supplies.

20.3 Notice and Legal Defense

In the event a Person indemnified pursuant to Articles 20.1or 20.2 above (an "Indemnified Party") receives notice of any claim or notice of the commencement of any action, administrative or legal proceeding, or investigation as to which the indemnity under which it is indemnified may apply, the Indemnified Party shall promptly notify the Indemnifying Party in writing of such fact. The Indemnifying Party shall assume on behalf of the Indemnified Party and conduct with due diligence and in good faith the defense thereof: provided, however, that the Indemnified Party shall have the right to be represented therein by advisory counsel of its own selection and at its own expense; and provided further, that if the defendants in any such action include both the Indemnifying Party and the Indemnified Party and the Parties have reasonably concluded that there may be legal defenses available to the Indemnified Party that are different from or additional to, or inconsistent with, those available to the Indemnifying Party, the indemnifying Party shall select separate counsel reasonably satisfactory to the Indemnified Party to participate in the defense of such action on the Indemnified Party's behalf and at the Indemnifying Party's expense.

20.4 Failure to Defend Action

If any claim, action, proceeding or investigation arises to which any indemnity provided for in apply, and the Indemnifying Party fails to assume the defense of such claim, action,

proceeding or investigation, then the Indemnified Party may, at the Indemnifying Party's expense, and without affecting the Indemnifying Party's obligation to Indemnify under contest such claim.

20.5 Survival

The provisions of this Article 20 shall survive the full performance or termination of the Contract, as applicable, until the later of (i) the date four (4) years after successful completion of Performance Guarantee Tests or (ii) the date 4 (four) years after the date the Contract is terminated.

21. PROPRIETARY INFORMATION

21.1 The Supplier's Proprietary Information at the time of furnishing confidential or proprietary information, the Supplier will expressly designate by label, stamp, or other written communication that the information or documentation furnished is confidential.

(a) The Purchaser agrees (i) to treat such information as confidential, (ii) to restrict the use of such information to matters relating to Supplier's performance of the Contract, and (iii) to restrict access to such information to employees of Purchaser and its agents whose access is necessary in the implementation of the Contract. Confidential Information will not be reproduced without Supplier's prior written consent, and all copies of written information will be returned to Supplier upon request except to the extent that such information is to be retained by Purchaser pursuant to the Contract.

(b) The foregoing restrictions do not apply to information which: (i) is contained in a printed publication which was released to the public by the Supplier prior to the date of the Contract; (ii) is, or becomes, publicly known otherwise than through a wrongful act of Purchaser, its employees, or agents; (iii) is in possession of Purchaser, its employees, or agents prior to receipt from the Supplier, provided that the person or persons providing the same have not had access to the information from the Supplier; (iv) is furnished to others by the Supplier without restrictions similar to those herein on the right of the receiving party to use or disclose.

21.2 The Purchaser is granted a limited license for any Software delivered by the Supplier, whether as Item of any Plant and Equipment or separately. Purchaser is not granted a license for any other Software. This license allows Purchaser to:

(a) Use the Software only on the Plant and Equipment on which it is installed at the time of delivery or, if Software is supplied separately, in connection with Plant and Equipment supplied by Supplier. The Purchaser must obtain a supplementary license from Supplier before using the Software in connection with any other equipment or for any other purpose.

(b) Make one copy of the Software in machine-readable form solely for backup purposes. Purchaser must reproduce on each copy the copyright notice and any other proprietary legends that were on the original copy.

(c) Transfer the Software and all rights under this license to another party as part of the sale of the Plant and Equipment with which it is used.

(d) The Purchaser may not distribute copies of the Software to others or electronically transfer the Software from one computer to another over a network. The Software contains trade secrets. In order to protect them Purchaser may not decompile, reverse engineer, disassemble, or otherwise reduce the Software to a human-perceivable form. The Purchaser may not modify, adapt, translate, rent, lease, loan, resell for profit, distribute, network, or create derivative works based upon the software or any part thereof.

(e) All Software is protected by the copyright laws of the India. No rights under copyrights are transferred to Purchaser, except as specifically provided above.

(f) "Software" means a computer program supplied with the Plant and Equipment or any Item/s thereof, for performance of Plant and Equipment or such Item/s including data recording, storage and retrieval.

22.0 COMMISSIONING AND ACCEPTANCE TESTS

22.1 The entire commissioning and taking over of the Power Plant is dependent on the quality, effectiveness and the successful Commissioning and Taking Over of the Plant and Equipment supplied by the Supplier. The Supplier shall ensure that the Plant and Equipment supplied shall be of such quality that it meets the Performance Guaranteed Values set out herein below.

22.2 The Liquidated Damages for not meeting the Performance Guaranteed Values during the Performance Guarantee Test shall be assessed and recovered from the Supplier. Such Liquidated Damages shall be levied, in accordance with the Contract and shall be without prejudice to all the other conditions of the Contract.

22.3 If the Rejection Criteria specified below are not achieved due to reasons attributable to supplier, within 120 days after successful completion of Reliability Run Test, the Purchaser at their discretion may reject the Unit/s or accept it after levying and recovering Liquidated Damages.

22.4 Any recoveries by the Purchaser from the Supplier due to shortfall in guaranteed performance shall be independent of provisions of Article 23 herein below.

22.5 The Acceptance Tests for the successful Commissioning and Taking Over of the Power Plant shall comprise of the following:

22.5.1 Trial Run

On completion of erection of the Plant and Equipment, each Item of the Plant and Equipment shall be thoroughly cleaned and inspected jointly for correctness and completeness of installation and fitness for acceptability for the Trial Run of the Plant and Equipment. The list of tests to be performed prior to the Trial Run shall be determined by the Purchaser based on the Manuals furnished by the Supplier. The purpose of this Trial Run is to ensure integrity of each individual Item for its operation in the system for Initial Operation.

22.5.2 Initial Operation

After successful Trial Run of all the individual Item/s all the Item/s shall be operated together as a Unit. The purpose of this Initial Operation is to ensure integrity of all the Units which comprise the Plant and Equipment. Based on the observations made during Initial Operation, necessary corrections shall be effected in the Items to ensure proper integrated operation of the Unit and/or the Plant and Equipment as the case may be. After satisfactory completion of Initial Operation for each Item, the Unit, the Plant and Equipment shall be considered ready for Reliability Run Test. During Initial Operation, any adjustments /calibrations to the instruments fitted in the Unit/Plant and Equipment shall be done in the presence of testing staff of the Purchaser so as to enable them to familiarize themselves with its adjustments and maintenance except that the testing staffs of the Purchaser are not timely present after the notice of the Supplier.

22.5.3 Reliability Run Test

After satisfactory Initial Operation, the Plant and Equipment shall be put on Reliability Run Test (RRT) as mentioned in Technical Specifications and as follows:

(a) RRT of first Unit shall start not later than 37.5 months from Zero Date. RRT of subsequent Units shall start at 4 months gap (like 41.5 months for second Unit, 45.5 months for third Unit, etc.).

(b) Each Unit RRT shall be conducted within 14 days of operation. Each RRT shall consist of 72 hours of continuous operation at full load (or any other load at Purchaser's discretion) and further demonstrate operation at various other loads like 80%, 60%, 40% or any other load mutually agreed. Any minor failure of auxiliary equipment (which shall be set right immediately), which does not force the Unit shut down, will not be treated as failure of RRT.

(c) Each RRT may have maximum two shut downs of Unit with total hours of interruption not exceeding 8 hours.

(d) In case total number of hours of interruption of operation exceeds 8 hours, such RRT shall be treated as unsuccessful.

(e) If RRT of any Unit is not successful based on above criteria, the Supplier shall repeat the RRT. In case the Supplier could not conduct RRT successfully within 38 months, the Supplier shall be liable for Liquidated Damages (LD) on account of delay.

(f) However, in case the Supplier could not conduct RRT successfully within 38 months, the Purchaser would permit one additional RRT without levying LD. In case of major shut down due to 'Boiler tube leakage' in any Unit, the repeat RRT shall start immediately after repair but not later than 36 hours from the time of Unit shut down.

(g) In the event such repeat RRT is also not successful, the Purchaser may permit one more additional RRT without levying LD. In case of major shut down due to 'Boiler tube leakage' in any Unit, provided the repeat RRT starts immediately after repair but not later than 36 hours from the time of Unit shut down. But, in any Unit not more than two additional RRTs are permitted.

(h) In any case, all the additional RRTs for the total six Units shall not exceed 8 tests. The cost of consumables in such additional tests shall be borne by the Purchaser.

22.5.4 Performance Guarantee Test

22.5.4.1 The Supplier shall carry out Performance Guarantee Tests as per Annexure A Clause No. 6.00.00 of the Technical Specification.

The Supplier shall ensure the following Performance Guaranteed Values for the Power Plant:

Sr. No.	Parameter description	Performance Guaranteed Values
1	Unit GROSS HEAT RATE:- Unit gross heat rate in kcal / kWh at rated steam parameters & 0.1 ata as exhaust pressure. with zero percent make up, at TMCR condition and at reference ambient parameters as per Technical Specifications	2239.77
2.	Total auxiliary power consumption of all auxiliaries at TMCR condition (%)	7.017
3.	SPM – mg/Nm^3 (with one field in each gas path out of service)	50
4.	Gross electrical power output at Generator terminals (MW)	600
5.	Boiler steaming capacity at BMCR condition (tph)	2068
6.	Unburnt Carbon in fly ash by weight (%) (Max)	1

The Supplier guaranteed Turbine cycle Heat Rate as 1950 kcal/kWh. The Supplier agreed to guarantee Unit Gross Heat Rate as 2239.77 kcal/kWh, considering (minimum) 99.5% piping efficiency. However improved piping efficiency shall be considered later based on the actual Main steam parameters measured during PG Test. Formula to be used for calculating piping efficiency shall be { $(1 - (i_B - i_T)/i_B) \times 100$ }, where i_B, i_T are values of enthalpy of main steam at Boiler outlet & Turbine inlet respectively. Supplier indicated that piping loss is not considered on BE calculation. The Unit gross heat rate shall be calculated by the formula, UHR=THR/BE/PE.

22.5.4.2 After satisfactory completion of the Reliability Run Test, the Performance Guarantee Test shall be conducted on the Plant and Equipment. The duration of the Performance Guarantee Test of the Plant and Equipment at the rated capacity shall be decided by the Purchaser on the basis of the Manuals provided by the Supplier. However, a stability period of 2 (two) hours before commencement of Performance Guarantee Test and 2 (two) hours

test period followed by another 2 (two) hours stable period shall be maintained. Performance Guarantee Test shall be conducted within 30 (thirty) days of intimation from the Supplier about the readiness for conducting Performance Guarantee Test and within 90 (ninety) days of successful completion of Reliability Run Test.

22.5.4.3 All the tests shall be binding on both the Purchaser and the Supplier to determine the Plant and Equipment with the Performance Guaranteed Values.

22.5.4.4 The tests shall be conducted at the specified load conditions or as near the specified conditions as practicable. The suitable correction curves mutually agreed by the Purchaser and the Supplier shall be used.

22.5.4.5 Any special equipment, tools and tackles required for the successful completion of the Performance Guarantee Tests shall be provided by the Supplier free of cost.

22.5.4.6 Should the results of these tests show any decrease from Performance Guaranteed Values, the Purchaser shall intimate the Supplier and the Supplier shall replace or repair such Item of the Plant and Equipment as required to bring it to meet the guarantees. In such cases, the Performance Guarantee Tests shall be repeated within 1 (one) month from the date on which the Unit/s is made ready again for tests.

22.5.4.7 The provisions outlined in the ASME performance test codes or other International and Indian approved equivalents shall generally be used as a guide for all the above test procedures unless specified otherwise in the Technical Specification.

22.5.4.8 In the event each of the Unit is capable of conducting the Reliability Run or Performance Guarantee Test, but the Supplier is unable to perform the test due to the reasons not attributable to the Supplier, the portion of the Contract Price due upon Reliability Run Test or Performance Guarantee Test of the Unit shall be paid to the Supplier not later than 2 (two) months after the date upon which it was otherwise available for a Reliability Run Test or a Performance Guarantee Test.

23.0 LIQUIDATED DAMAGES

23.1 Liquidated Damages for Delay (Delay Liquidated Damages)

23.1.1 All the Supplies shall be started and completed in accordance with the Project Schedule as per Article 4.19.

23.1.2 Subject to Article 4.19.8, no necessity for an extension of time is anticipated, but if untoward or extraordinary circumstances arise beyond the control of the Supplier, Purchaser should entitle the Supplier to a reasonable extension of time, such extension may be granted but shall not operate to relieve the Supplier of any of the Supplier's obligations under the Contract.

23.1.3 The Supplier shall promptly notify the Purchaser any event of conditions which might delay the completion of supplies in accordance with the Delivery Schedule and the steps being taken to remedy such situation.

23.1.4 The time stipulated in the Project Schedule for the completion of the Reliability Run Test shall be deemed to be the essence of the Contract. In the event, the Supplier fails to complete the Reliability Run Test of the Unit and/or the Plant and Equipment, as the case may be, within the time period specified in it, it shall be viewed seriously and the Supplier shall be bound to pay the Purchaser Liquidated Damages as stated herein. The Purchaser may, without prejudice to any method of recovery, deduct the amount for such damages from any amounts due or which may become due to the Supplier. In the event any extension of time is granted by the Purchaser, in writing, for the Reliability Run Test according to the provision of 22.5.3 above, the Liquidated Damages shall be applicable for any further delay beyond such extended period.

23.1.5 If the Supplier fails to achieve Reliability Run Test of the Unit/s within the time period specified within Guaranteed Completion Date due to reasons attributable to the Supplier, the Purchaser shall levy Liquidated Damages and not as a penalty, equivalent to 0.5% (Zero point five percent) of Unit Price of the Plant and Equipment (excluding taxes and duties) per

week (7 days) of delay or part thereof of each Unit subject to the maximum 10% of the Unit Price for supply of the Plant and Equipment (excluding taxes and duties) .

23.1.6 The provision of Liquidated Damages as stipulated above or wherever stipulated is to be viewed in strict sense as any delay in executing the Works as stipulated will result in considerable cost overrun for the Purchaser, and as such these Clauses will be a deterrent to the Supplier from delays being caused. Accordingly, the Liquidated Damages would be levied by the Purchaser and become applicable once the delay on the part of Supplier has been established.

23.1.7 The payment or deduction of any sums under the provisions of this Article shall not relieve the Supplier from the obligations to complete the Works or from the other obligations the Supplier has to complete the Works or from the other obligations the Supplier has under the Contract of providing supervision during erection, testing and commissioning.

23.1.8 For the purpose of deciding the amount of the Liquidated Damages on the Contract, the Contract Price shall be considered. Further, Liquidated Damages for each Unit shall be levied separately.

23.2 Liquidated Damages for Poor Performance (Performance Liquidated Damages)

23.2.1 The Supplier shall furnish Performance Guaranteed Values in accordance with Sub-article 22.5.4.1. These guarantees shall be met by the Supplier.

23.2.2 The Liquidated Damages for not meeting the Performance Guaranteed Values during the Performance Guarantee Tests shall be assessed and recovered from the Supplier as under.

Liquidated damages towards shortfall in Performance Parameters:

Sr. No.	Variation Factor	Liquidated Damages for shortfall in performance

Sr. No.	Variation Factor	Liquidated Damages for shortfall in performance
1.	Unit Gross Heat Rate:- Unit gross heat rate in kcal / kWh at rated steam parameters & 0.1 ata as exhaust pressure, with zero percent make up, at TMCR condition and at reference ambient parameters as per tender specs.	Unit Gross Heat rate – USD 270494.36 per kcal / kWh or part thereof of increase in heat rate from Performance Guaranteed Value.
2.	Total auxiliary power consumption of all auxiliaries at TMCR condition (%)	USD 1408.82 per kW (or part thereof) of increase in Performance Guaranteed Value.
3.	Unit Gross electrical power output at Generator terminals (MW)	USD 1408.82 for every kW or part thereof by which output determined during the tests falls short of guaranteed rated output
4.	Each Boiler steaming capacity at BMCR condition (tph)	USD 40574.15 for each one tonne/hr. or part thereof decrease in steam generating capacity.
5.	Unburnt Carbon in fly ash by weight (%)	USD 281764.96 for every 1% (or part thereof) increase of unburnt Carbon in fly ash beyond the Performance Guaranteed Value. For Ex. Performance Guaranteed Value is 1.5%. Actual value is 1.9%. LD value shall be = (1.9-1.5) X USD 281764.96 = USD 112705.98

The Performance Guarantee test shall be conducted separately for each Unit and also for the first three Units together and the subsequent three Units together for measuring the Gross Guaranteed electrical power output at Generator terminals for the respective three Units (MW) and corresponding guaranteed auxiliary power consumption.

23.2.3 The aggregate liability under Performance Liquidated Damages shall not exceed 10% of the Contract Price (excluding taxes and duties).

23.2.4 The PG tests shall be witnessed & the results shall be approved by Purchaser's engineers.

23.2.5 Noise Level Guarantees

The Supplier shall guarantee the noise level of any equipment in the Power Plant not to exceed the limits specified below, unless otherwise indicated elsewhere in the tender specifications.

Criterion	Performance Guaranteed Value
Noise Pressure Level	Average 85 dB(A) at 1m distance measured at 1.5m above ground in a free field condition

No Liquidated damages/Rejection shall be applied on the increase in the Noise level beyond Performance Guaranteed Values. Supplier shall take necessary measures and to attenuate the noise levels within the limits specified.

23.2.6 The Liquidated Damages indicated above are in addition to the Liquidated Damages as stipulated in Article 23.1. The Liquidated Damages indicated above shall be levied for each Unit separately.

The overall cap for Performance Liquidated Damages shall be 10% of basic contract price (excluding taxes and duties).

The overall aggregate liability under the Contract for Delay Liquidated Damages and Performance Liquidated Damages shall not exceed 17.5% of the Contract Price (excluding taxes and duties).

23.2.7. If the performance shortfall is such that the shortfall exceeds Rejection Criteria as below in Article 24.2 given, then the Purchaser will be entitled at the Purchaser's own discretion to reject the Item, Unit and/or the entire Plant and Equipment as the case may be, terminate the Contract and recover from the Supplier any loss the Purchaser has suffered.

23.3 Set-off; Payment of Liquidated Damages

Purchaser, whether original or assignee, shall at Purchaser's discretion, (a) subject to set-off against any undisputed amount that is due and owing by Purchaser to Supplier, though running bills and/or (b) liquidate the Performance Bank Guarantee. The Supplier shall replace the Performance Bank Guarantee for the required quantum under Article 11.5.1 for maintaining the Bank Guarantee during the Warranty period.

24. REJECTION OF EQUIPMENTS

24.1 If the Supplier fails to demonstrate to the Purchaser, the Performance Guaranteed Values, subject to the tolerance(s)/limits agreed hereinbelow, and as is recorded during the first PG test carried out as per Annexure A Clause No. 6.00.00 of the Technical Specification/specifications, the Supplier shall be given a further period of 30 days subsequent to the first PG test to make corrections and conduct any retest. In the event of failure of the Supplier to demonstrate the performance parameters even during such re-tests, the particular equipment(s) under the Scope of Supply will stand rejected. In case the said equipments could not be rectified, the said equipment will have to be replaced at site, within reasonable time, at no extra cost basis to the Purchaser.

24.2 Rejection Criteria of Off-shore Supplies of the Power Plant:

The Purchaser may reject complete or any part of the Off-shore Supplies under any of the following circumstances:

a) **Output:** Shortfall in excess of 5% in guaranteed output (of all major equipments and complete Power Plant).

b) **Auxiliary power Consumption:** In excess of 5% over the guaranteed auxiliary power consumption value.

c) **Unit Gross Heat Rate**: In excess of 5% over the Performance Guaranteed Value.

d) **Emission Level**: In excess of guaranteed Emission level value.

e) **Unburnt Carbon in fly ash % by weight**: in excess of 2%.

24.3 Payment after Rejection

If the Purchaser exercises the option to reject the equipment on the basis of the rejection criteria as stated above then the Purchaser shall be entitled to all the payments made by Purchaser to Supplier in reference to the Contract and other allied payments related to the Contract.

25 FINAL ACCEPTANCE

25.1 On successful completion of the Acceptance Tests as specified in Sub-article 22.5 herein above the Purchaser shall give the Supplier a Final Acceptance Certificate indicating the date from which the Plant and Equipment or Unit/s thereof has been successfully Commissioned.

25.2 On conducting the Performance Guarantee Test, if it is established by the Purchaser as per contract guarantees that each Item, Unit and the Complete Plant is performing as specified in the Technical Specifications, the Purchaser shall issue to the Supplier a Final Acceptance Certificate.

25.3 Such a Final Acceptance Certificate shall be given within 30 (thirty) days after satisfactory completion of the Performance Guarantee Test and shall not be unreasonably withheld nor will the Purchaser delay the issuance thereof on account of minor omissions or defects which do not affect the safe and reliable operation and/or cause any risk to the Plant and Equipment. The Final Acceptance Certificate shall, however, not relieve the Supplier of any of his obligations which otherwise survive by the terms and conditions of the Contract.

26. FORCE MAJEURE

26.1 Definition of "Force Majeure"

(A) "Force Majeure" shall mean any event or circumstance or combination of events or circumstances beyond the reasonable control of Supplier and Purchaser which, or the effects of which, materially and adversely affects the performance by that Party of its obligations under or pursuant to the Contract.

(B) Without limiting the generality of the foregoing, "Force Majeure" hereunder shall include each of the following events and circumstances, including but not limited to, but only to the extent that each satisfies the above requirements:

(i) certain political events:

(a) any act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, revolution, riot, insurrection, civil commotion, act of terrorism, or sabotage;

(b) radioactive contamination or ionizing radiation; and

(c) strikes, lockouts or other generalized labor action occurring in India (excluding such events which are site specific and attributable to the Supplier and or sub Supplier) or works to rule or go-slows that are widespread or nationwide or that are of a political nature, such as, labor actions associated with or directed against a political party, or those that are directed against Purchaser or Supplier as a part of a broader pattern of labor actions against companies or facilities in India or in China;

(d) non availability of Fuel, raw water or start-up Power provisioning of which is under Purchaser Obligation, due to force majeure events.

(ii) any legislation, law, directive, regulation, rule, decree, order, restraint or other action (including expropriation or compulsory acquisition of the Power Station) by the Govt. of India , Govt. of Chhattisgarh or any Competent Authority;

(iii) the following uncontrollable events: (A) lightening, fire, earthquake, flood, cyclone, typhoon, or tornado or similar cataclysmic event; (B) explosion or chemical contamination; and (C) epidemic or plague;

(iv) marine and land transportation accident;

(v) fire or explosion, except as may be attributable to Supplier;

(vi) air crash or ship wreck.

(C) Notwithstanding the foregoing, Force Majeure shall expressly not include conditions caused by the negligence or wrongful acts of the Party claiming Force Majeure. Force Majeure shall also expressly not include the following conditions, except and to the extent that the following conditions result directly from Force Majeure:

(i) late delivery to Purchaser of machinery, Equipment, materials, spare parts or consumables;

(ii) a delay in the performance of Supplier to comply with, and complete, the obligations specified in the Contract in a timely manner;

(iii) normal wear and tear or random flaws in materials and Equipment or breakdowns in Equipment; and

(iv) the ability of a Party to pay any monies due pursuant to the Contract.

26.2 Procedure for Force Majeure

(a) If by reason of Force Majeure a Party is wholly or partially unable to carry out its obligations under the Contract, the affected Party shall (a) give the other Party notice of such Force Majeure as soon as reasonably practicable, and (b) give the

other Party a second notice, describing the Force Majeure in reasonable detail and, to the extent that can be reasonably determined at the time of the second notice, providing an evaluation of the obligations affected (including the anticipated effect on critical activities (if the Force Majeure is ongoing) or actual effect (if the Force Majeure has ended)), a preliminary estimate of the period of time that the affected Party will be unable to perform the obligations, and other relevant matters as soon as practicable, but in any event, not later than the later of (i) seven (7) Business Days after the initial notice of the occurrence of the Force Majeure is given by the affected Party, or (ii) twenty-four (24) hours after the resumption of any means of providing such notice between the Supplier and the Purchaser. When appropriate or when reasonably requested to do so by the other Party, the affected Party shall provide further notices to the other Party more fully describing the Force Majeure and its cause(s) and providing or updating information relating to the efforts of the affected Party to avoid and/or to mitigate the effect(s) thereof and estimate, to the extent practicable, the time that the affected Party reasonably expects it will be unable to carry out any of its affected obligations due to the Force Majeure. The affected Party shall also provide notice to the other Party of (A) the cessation of the Force Majeure and (B) the affected Party's ability to recommence performance of its obligations under the Contract by reason of the cessation of the Force Majeure as soon as possible, but in no event later than seven (7) Business Days after the occurrence of each of (A) and (B) above.

(b) The affected Party shall use all commercially reasonable efforts to mitigate the effects of Force Majeure, including (A) minimizing Delivery Schedule delays, (B) limiting/reducing property damage to the Power Plant, and (C) minimizing the Parties' cost of compliance with the terms and conditions set forth in the Contract.

26.3 Failure to Provide Notice

Failure by the affected Party to give written notice of a Force Majeure to the other Party within the period required by Article 26.2 shall not prevent the affected Party from giving such notice at a later time; provided, however, that in such case the affected Party shall not be excused pursuant to Article 26.4 for any failure or delay in complying with its obligations

under or pursuant to the Contract until such notice has been given. If said notice is given within the period required by Article 26.2(a), the affected Party shall be excused for such failure or delay pursuant to Article 26.4 from the date of commencement of the relevant Force Majeure.

26.4 Excused Performance

So long as the affected Party has at all times since the occurrence of Force Majeure complied with the obligations of Article 26.2(b) and continues to so comply, then the affected Party shall not be liable for any failure or delay in performing its obligations under or pursuant to the Contract, and any performance deadline that the affected Party is obligated to meet under the Contract, including the Guaranteed Completion Date shall be extended, one (1) day for a disruption / delay of one (1) day; provided that:

(a) The period of non-performance or Guaranteed Completion Date extension shall be of no greater scope and of no longer duration than is required due to the Force Majeure, including time for demobilization, remobilization.

(b) Unless otherwise agreed to by Purchaser in writing, in cases where Supplier is the affected Party, Supplier shall continue to perform the Supplies in good faith and with due diligence and use all reasonable efforts to (i) limit and remedy its inability to perform during and after the Force Majeure, and (ii) to complete the Scope of Supplies in accordance with the Delivery Schedule, as revised.

(c) It is the duty of the claiming Party to demonstrate through reasonable documentation all the elements of Force Majeure including but not limited to (i) specific action taken to work around or mitigate the impact, (ii) data in support of its claim, including as necessary specific event dates, directions, logic and schedule float to support the claim and (iii) specific cause for the claim of Force Majeure and to provide written documentation of such proof to the other Party as soon as reasonably possible. In the case of fire or explosion, the Party claiming Force Majeure must also provide, upon request of the other Party, documentation as to the cause of the fire or explosion and a statement as to the basis for believing such fire

or explosion was not caused by the intentional or negligent acts of the Party claiming Force Majeure. A Party is not required to grant a request for Force Majeure until such documentation has been supplied.

26.5 Termination for Force Majeure.

Notwithstanding anything contained in this Article 26 to the contrary, if either Party is rendered unable to perform its obligations hereunder, in whole or in substantial part, because of a Force Majeure lasting for a period of one hundred and twenty (120) consecutive Days or more, either Party shall have the option of terminating the Contract, exercisable by giving thirty (30) Days' written notice to the other Party, at any time after such Force Majeure has continued for a period of one hundred and twenty (120) consecutive Days and prior to the performance or resumption of performance by the Party claiming Force Majeure. Any termination under this Article 26.5 shall be handled in accordance with the procedures set forth in Article 27.6 for a termination of the Contract.

27 EVENTS OF DEFAULT, TERMINATION AND SUSPENSION

27.1 Supplier Event of Default

A "Supplier Event of Default" under the Contract shall be deemed to exist upon the occurrence of any one or more of the following events:

(a) Failure by Supplier to (i) make payment of any undisputed amounts due to Purchaser under the Contract, or (ii) timely submission of a Advance Bank Guarantee as required for Performance Security under the Contract;

(b) Supplier is in breach of any material provision of the Contract, other than a breach constituting a Supplier Event of Default under subsection (a) immediately above, including any violation of any Requirement, if (i) such breach continues for a period of thirty (30) Days after notice of such breach or (ii) if Supplier shall commence within such thirty (30) Days and shall thereafter proceed with all due diligence to cure such breach, such breach is not cured within such longer period as shall be

necessary for Supplier to cure the same with all due diligence, such longer period not to exceed forty five (45) Days after notice;

(c) Supplier files, or consent to the filing against it of, a petition for relief or reorganization or arrangement or any other petition in bankruptcy, for liquidation or to take advantage of any bankruptcy or insolvency law of any jurisdiction; or Supplier makes an assignment for the benefit of its creditors' or Supplier consents to the appointment of a custodian, receiver, trustee, or other officer with similar powers. for substantially all its property, or be adjudicated insolvent; or an order for relief shall be entered against Supplier in any case or proceeding for liquidation or reorganization or otherwise to take advantage of any bankruptcy or insolvency law of any jurisdiction, or ordering the dissolution, winding up or liquidation of all or any part of Supplier's property; or any petition for any such relief is filed against Supplier; or any reconstruction or amalgamation where by the resultant entity does not assume the obligations under the Contract;

(d) Failure tc achieve the dates for completion of successful Reliability Run Test and Performance Guarantee Tests and guarantee parameters within 150 days from respective stipulated completion date;

(e) Supplier abandons the Supply and such abandonment on an aggregate basis exceeds sixty (60) Days.

27.2 Purchaser Event of Default

A "Purchaser Event of Default" under the Contract shall be deemed to exist upon the occurrence of any one or more of the following events:

(a) Failure by Purchaser to (i) make payment of any undisputed amounts due to Supplier under the Contract, or failure continues for a period of thirty (30) Days after written notice of such nonpayment from Supplier to Purchaser provided, any amount disputed by Purchaser must be disputed in good faith;

(b) Purchaser is in breach of any material provision of the Contract, other than a breach constituting an Purchaser Event of Default under subsection (a) immediately above, (i) if such breach continues for a period of thirty (30) Days after notice of such breach to Purchaser and Lender or (ii) if Purchaser, or Lender shall commence within such thirty (30) Days and shall thereafter proceed with all due diligence to cure such breach, such breach is not cured within such longer period as shall be necessary for such Person to cure the same with all due diligence, such longer period not to exceed forty five (45) Days after notice; or

(c) Purchaser files, or consents to the filing against it of, a petition for relief or reorganization or arrangement or any other petition in bankruptcy, for liquidation or to take advantage of any bankruptcy or insolvency law of any jurisdiction; or Purchaser consents to the appointment of a custodian, receiver, trustee, or other officer with similar powers, for substantially all its property, or be adjudicated insolvent; or an order for relief shall be entered against Purchaser in any case or proceeding for liquidation or reorganization or otherwise to take advantage of any bankruptcy or insolvency law of any jurisdiction, or ordering the dissolution, winding up or liquidation of all or any part of Purchaser's property; or any petition for any such relief is filed against Purchaser or any reconstruction or amalgamation where by the resultant entity does not assume the obligations under the Contract.

27.3 Remedies for Breach

(a) Subject to Articles 27.1, upon the occurrence and during the continuation of any Supplier Event of Default, Purchaser may give written notice to Supplier specifying such Supplier Event of Default; and Purchaser shall have the right, at Purchaser's election, to terminate the Contract and/or, subject to Article 28, sue Supplier for damages and/or injunctive or other equitable relief arising in connection with such Supplier Event of Default or pursue any other remedy to which it is entitled under either law or equity.

(b) Upon the occurrence and during the continuation of any Purchaser Event of Default, Supplier may give written notice to Purchaser, specifying such Purchaser Event of

Default; and thereafter Supplier shall have the right, at Supplier's election, to terminate the Contract and/or, subject to Article 28, sue Purchaser for damages and/or injunctive or other equitable relief arising in connection with such Purchaser Event of Default or pursue any other remedy to which it is entitled under either law or equity. Notwithstanding the foregoing, Supplier shall pursue no remedy against Purchaser without first (i) giving Lender a second notice (in addition to that set forth in Article 27.2) specifying the nature of the Purchaser Event of Default, and (ii) allowing Lender sixty (60) Days after the receipt of said second notice in which to either cure the Purchaser Event of Default or assume Purchaser's obligations under the Contract. If Lender assumes the Contract, Supplier shall treat the assumption as if it were a fresh notice to Purchaser under Article 27.2, shall give the assuming party all of Purchaser's rights to cure under such Article 27.2 and shall perform all obligations herein for the benefit of the assuming party as if for Purchaser. Without the prejudice to Article 27.7, despite the existence of a Purchaser Event of Default, Supplier shall expeditiously continue with its performance of the Scope of Supplies until such time as it is allowed to exercise its remedies under this paragraph.

(c) If Purchaser elects to terminate the Contract pursuant to a Supplier Event of Default, Supplier shall provide Purchaser and Lender, at Supplier's expense, with the right to continue to use any and all patented and/or proprietary information (subject to reasonable proprietary restrictions, including, without limitations, confidentiality agreements and agreements which limit the use of the information to the completion of the Power Plant) reasonably necessary to complete and/or operate the Power Plant; provided that such information (i) shall be used only for purposes of completing and/or operating the Power Plant and not for any other purpose, and (ii) shall not be distributed to any Persons other than those who need to know such information in order to complete and/or operate the Power Plant. Purchaser shall be required to mitigate reasonably the cost for completion of such Supplies but may make such expenditures as in Purchaser's reasonable judgment will best accomplish the timely completion of the Power Plant; provided, Purchaser shall not be required or expected to mitigate any such costs by breaching, terminating, repudiating or renegotiating any agreement entered into between Supplier and any Sub Supplier (including, without limitation, any Sub Supplier that is an Affiliate of

Purchaser). Supplier shall be entitled to receive any further payments under the Contract only as provided in Article 27.3(f).

(d) If Purchaser elects to terminate the Contract pursuant to a Supplier Event of Default, the Purchaser shall, without prejudice to any other right he may have under the Contract, shall be free to use the equipment of the Supplier for the purpose of completion of Supply (without being responsible for any wear and tear to the equipment), which the Suppler shall allow without any hindrance and (ii) if the termination be due to reason(s) mentioned in Article 27.1(d), be entitled to have the RRT and/or PGT performed by any reliable third party of its choice, recover the costs thereof from the Supplier, bind the Supplier by the results achieved thereby and consider the same for the purpose of levy of Delay Liquidated Damages and Performance Liquidated Damages, as applicable, pursuant to Article 23.2.6.

(e) If Purchaser elects to terminate the Contract upon a Supplier Event of Default, Supplier shall, at Purchaser's request and at Supplier's expense, perform the following services, in addition to those required under Article 27.3(c) and (d), relating to the Supplies so affected:

(i) deliver to Purchaser all information as may be requested by Purchaser that is reasonably necessary for the completion of the Supplies and/or, to the extent such information was to be provided as part of the Supplies, reasonably necessary to the operation of the Power Plant, and

(ii) supply any proprietary components recuested by Purchaser and reasonably necessary for the completion and operation of the Power Plant.

(iii) compensate the Purchaser for all financial losses suffered , other than consequential damages, limited to value of the contract, Subject to Article 27.3(g), if Purchaser terminates the Contract pursuant to a Supplier Event of Default, Purchaser shall pay to Supplier as a "Termination Payment under Supplier Default".

(iv) final payment an amount equal to the value of that portion of the Equipment delivered to the Delivery Point prior to termination to the extent not already paid for by Purchaser.

(v) all payments due towards material / Equipment which is ready but not delivered at the delivery point. The payment on such material/ Equipment will be released on delivery at delivery point.

(f) The amounts payable to the Supplier on the above items shall be upon Supplier providing adequate proof of documentation relating to delivery of the said items at delivery point. In any case of disagreement on the specific price and amount of completion / Fitness of use of such delivered items, the certification by Lenders Engineer shall be taken as conclusive subject to and in accordance with the contract. Such payment shall be the sole and exclusive liability of Purchaser, and Supplier's sole remaining compensation and reimbursement under the Contract. The Purchaser shall be entitled to retain payments to the Supplier and apply the balance which may otherwise be due to the Supplier for completion of the Supplies. The Purchaser shall be entitled to recover any excess amount expended, over and above the balance amount, on the execution of Supplies. Such excess amount shall be over and above the Liquidated Damages as per terms of the Contract. The Supplier shall make all the payments due to the Purchaser within thirty (30) days after Purchaser gives Supplier notice of the amounts due from the Supplier.

(g) If Purchaser terminates the Contract pursuant to a Supplier Event of Default, then as soon as practicable after Purchaser has received all substituted equipment and materials that were intended to be delivered under the Contract as part of the Supplies, Purchaser shall determine the total reasonable and necessary expense incurred and accrued in completing the Supplies, inclucing all amounts charged by any substitute provider of equipment and/or material to finish the Supplies and additional reasonable and necessary overhead incurred and accrued by Purchaser to effect such takeover and to complete the Scope of Supplies. If the total reasonable and necessary expenses incurred by Purchaser in completing the Supplies exceeds the balance of the Contract Price unpaid at the time of the

Supplier Event of Default, then Supplier shall be liable for and shall pay to Purchaser the amount of such excess within thirty (30) Days following receipt of Purchaser's demand for such payment; provided, that Supplier's liability shall be subject to (and limited by) Article 18.

(h) If Supplier terminates the Contract pursuant to a Purchaser Event of Default, Purchaser shall pay to Supplier as a final payment an amount equal to the sum of (i) amount payable for any Supply finished with price specified in the Contract and (ii) expenses incurred in relation to the production equipment and materials ordered for the Project, delivered to the Purchaser or the Purchaser has the obligation to receive. ; (iii) cost for the Supplier to demobilize from the site the temporary facilities and send them back home; (iv) cost for demobilization of personnel employed solely for the Project at the date of termination, provided however, that the title of the equipment and Supplies will be passed on to the Purchaser. The Supplier shall raise a substantiated invoice (subject to satisfaction of the Purchaser, who may choose to have the same certified by the Lenders Engineer and whose certification subject to and in accordance with the contract shall be final of any such Equipment, as "Termination Payment under Purchaser's Default".

(i) With respect to any Purchaser Event of Default or Supplier Event of Default arising out of a late payment, besides the due amount, the remedy for such Event of Default shall be the interest on the overdue amount accruing at the stipulated Rate from and after the day the payment became overdue until the day it is paid.

27.4 Termination by Supplier under Special Circumstances

(a) Rights. If, and only if, Purchaser abandons or suspends the Contract for a period more than 90 days as per Article 27.7, Supplier may terminate the Contract in whole or in part at any time by written notice thereof to Purchaser. Upon such notice, the Supplier shall, unless the notice mentions otherwise: (i) immediately discontinue the Supplies on the date and to the extent specified in such notice; (ii) place no further orders or subcontracts for Equipment or materials; (iii) promptly make every reasonable effort to procure cancellation upon terms reasonably satisfactory to

Purchaser of all orders, subcontracts and rental agreements to the extent they relate to the performance of the Scope of supplies that is discontinued; and (iv) thereafter execute only that portion of the Scope of Supplies as may be necessary to preserve and protect Scope of Supplies already in progress and to protect Equipment at the Site or in transit thereto.

(b) Payments for such termination under this Article 27.4 shall be made to Supplier within Forty Five (45) Days after Purchaser's receipt of a substantiated invoice (subject to satisfaction of the Purchaser, who may choose to have the same certified by the Lenders Engineer and whose certification subject to and in accordance with the contract shall be final of any such Equipment, as "Termination Payment under Special Circumstances". The substantiated invoice will be for an amount equal to the sum of (i) amount payable for any Supply finished with price specified in the Contract and (ii) expenses incurred in relation to the production equipment and materials ordered for the Project, or equipment and materials delivered to the Purchaser or the Purchaser has the obligation to receive. ; (iii) cost for the Supplier to demobilize from the site the temporary facilities and send them back home; (iv) cost for demobilization of personnel employed solely for the Project at the date of termination, provided however, that the title of the equipment and Supplies will be passed on to the Purchaser.

27.5 Termination for Purchaser's Convenience

(a) The Purchaser may for its own convenience terminate the Contract, in full or part any time upon 90 days notice to the Supplier specifying the details of such termination and effective date of termination. Upon such notice, Supplier shall, unless the notice mentions otherwise: (i) immediately discontinue such part of Supplies on the date and to the extent specified in such notice; (ii) place no further orders or subcontracts for part of Equipment or materials; (iii) promptly make every reasonable effort to procure cancellation upon terms reasonably satisfactory to Purchaser of such orders, subcontracts and rental agreements to the extent they relate to the performance of such Scope of Supplies that is terminated; and (iv) thereafter execute only that portion of the Scope of Supplies that is not terminated.

(b) Payments for such termination under this Article 27.5 shall be made to Supplier within Forty Five (45) Days after Purchaser's receipt of a substantiated invoice (subject to satisfaction of the Purchaser, who shall choose the Lenders Engineer for due certification) of any such Equipment. as "Termination Payment upon Purchaser Convenience". The substantiated invoice will be for an amount equal to the sum of (i) amount payable for any Supply finished with price specified in the Contract and (ii) expenses incurred in relation to the production equipment and materials ordered for the Project, or equipment and materials delivered to the Purchaser or the Purchaser has the obligation to receive; (iii) cost for the Supplier to demobilize from the site the temporary facilities and send them back home; (iv) cost for demobilization of personnel employed solely for the Project at the date of termination, provided however, that the title of the equipment and Supplies will be passed on to the Purchaser.

27.6 Termination upon Prolonged Force Majeure

(a) If, and only if, the Contract is terminated as per provisions of Article 26.5 Supplier shall be entitled as a final payment ("Termination Payment under Force Majeure") an amount equal to the sum of (i) amount payable for any Supply finished with price specified in the Contract and (ii) expenses incurred in relation to the production equipment and materials ordered for the Project, delivered to the Purchaser or the Purchaser has the obligation to receive; (iii) cost for the Supplier to demobilize from the site the temporary facilities and send them back home; (iv) cost for demobilization of personnel employed solely for the Project at the date of termination, provided however, that the title of the equipment and Supply will be passed on to the Purchaser. The Supplier shall raise a substantiated invoice subject to satisfaction of the Purchaser, who may choose to have the same certified by the Lenders Engineer and whose certification subject to and in accordance with the contract shall be final of any such Equipment, as "Termination Payment under Force Majeure".

(b) Upon such termination, the Supplier shal cease and cancel all activities related to

the scope.

27.7 Suspension of the Work

(a) General. The Purchaser may at any time or from time to time, and for any reason, suspend the Supplies or any portion thereof by giving ten (10) Business Days prior notice to Supplier (a "Suspension Notice"). Such suspension shall continue for the period (the "Suspension Period") specified in the Suspension Notice; provided, however, the aggregate duration of all Suspension Periods shall not exceed 90 Days. At any time after the effective date of the suspension, Purchaser may require the Supplier to resume the Supplies.

(b) Extension of Time. In the case of any suspersion under this Article 27.7, Guaranteed Completion Date for performance by Supplier shall be extended by one Day for each Day of the Suspension Period the Parties acknowledge that the time required for subsequent completion of the Supplies may exceed the number of days of suspension or delay due to Supplier's scheduling constraints and the time required for demobilization and remobilization of the Supplies effort.

(c) Compensation to the Supplier. In the event that suspension is solely attributable to the Purchaser, any necessary and demonstrable costs incurred by the Supplier as a result of such suspension of the Supplies shall be paid by the Purchaser, provided the costs are sustained to the satisfaction of the Purchaser Engineer subject to and in accordance with the contract.

(d) Suspension arising out of Supplier / Other Supplier defaults. The Purchaser shall not be liable and responsible for any suspension or celay arising out of default due to the Supplier, its Sub Suppliers and other Suppliers. No compensation shall be paid to the Supplier due to Suspension under this Article.

(e) Suspension arising out of Purchaser defaults. If the Purchaser fails to pay to the Supplier any undisputed payment and such failure continues for 60 (sixty) days after written notice thereof has been given to the Purchaser by the Supplier, then the

Supplier may suspend any Works or part thereof. After the payment is made, the Supplier shall resume the Works.

(f) Special Suspension Provisions. If a suspension is more than ninety (90) Days in duration, Purchaser will pay Supplier pro rata for the portion of the Supplies completed when the suspension was notified. In the event that production / fabrication has proceeded to the point that Supplier and Purchaser deems it cannot reasonably reschedule completion or the request for suspension is received less than ninety (90) Days prior to the date by which the Equipment is ready for delivery, the Supplies shall be completed, invoiced and the Equipment, or the portions thereof completed, placed in storage at Purchaser's expense. In the event Supplier is otherwise unable to deliver the Equipment when ready due to the action or inaction of Purchaser, Supplier shall so notify Purchaser and such inability to deliver shall also be subject to the above provisions.

(g) Termination. If the suspension continues for an aggregate period exceeding 120 Days, due to reasons solely attributable to Purchaser, the Contract shall be terminated. Any termination under this Article 27.7 shall be handled in accordance with the procedures set forth in Article 27.4 for a termination of the Contract.

28. DISPUTE RESOLUTION

28.1 General Provisions

Every dispute of any kind or nature between the Parties arising out of or in connection with the Contract (each a "Dispute") shall be resolved in accordance with this Article, to the extent permitted by the laws governing the interpretation and enforcement of the Contract. All dispute resolution proceedings provided hereunder shall be conducted in the English language.

28.2 Referral to Senior Management

Upon the occurrence of a Dispute, either Party may deliver a written notice to the other

Party requesting that the Dispute be referred to the senior management of the Parties. Any such notice shall include the names of the senior management of the Party nominated to attempt to resolve the Dispute, and a schedule of their availability during the twenty (20) Day period following the date of the notice. Any such notice shall be delivered within a reasonable time after the Dispute arises, but in no event shall it be delivered later than thirty (30) Days. Within seven (7) Business Days after receipt of a written notice pursuant to this Article 28.2, the other Party shall provide a written notice to the requesting Party indicating the names of the senior management of the Party nominated to attempt to resolve the Dispute, and a schedule of their availability during the remainder of the twenty (20) Days period following the date of the notice. During the remainder of the twenty (20) Days period following delivery of the notice, the nominated members of the senior management of the Parties shall meet as frequently as necessary, and shall attempt in good faith to resolve the Dispute.

28.3 Technical Disputes

(a) In the event of a Dispute between the Parties that both Parties mutually agree in writing is a dispute of a technical nature (a "Technical Dispute"), then the Parties shall appoint a technical expert (the "Technical Expert"), to resolve the Technical Dispute. If the Parties are unable to agree to the appointment of the Technical Expert, then each Party shall choose an expert and the two (2) experts shall choose the Technical Expert jointly. Once appointed the Technical Expert shall (i) render his decision in writing with full reasons within thirty (30) Days after the date of his appointment, (ii) promptly fix a reasonable time and place for receiving representations, submissions, or information from the Parties, and (iii) issue directions to the Parties for the proper conduct of his determination and any hearing.

The Parties shall provide the Technical Expert with all evidence and information within their respective possession or control (i) that the Technical Expert may consider necessary for determining the Technical Dispute or (ii) that is relevant to and bears upon the matter to be determined, regardless of whether the Technical Expert or the other Party is aware of such relevant evidence or information.

(b) Each Party may appoint such lawyers, consultants, and advisers as it feels appropriate to assist the Technical Expert in his determination and to present their respective cases, provided that the Parties shall cooperate and seek to narrow and limit the issues to be determined. If within thirty (30) Days of his appointment the Technical Expert shall not have rendered a decision in accordance with his appointment, a new Technical Expert may (at the request of either Party) be appointed and the appointment of the existing Technical Expert shall cease for the purpose of determining the Technical Dispute, provided, that if the existing Technical Expert renders his decision in writing with full reasons prior to the appointment of a new Technical Expert, then the decision shall have effect and the proposed appointment of the new Technical Expert shall be without effect. The determination of the Technical Expert shall, except in the event of fraud or material mistake or misreading of justice, be final and binding upon the Parties. The procedure for conduct of the proceedings by the Technical Expert/Panel shall in the same manner as prescribed in case of Arbitration in Article 28.4 below. Judgment upon such determination may be entered on behalf of the prevailing Party in any court having jurisdiction thereof, and application may be made by such Party to any such court for judicial acceptance of such determination and an order of enforcement.

(c) Each Party shall bear the costs and expenses of all lawyers, consultants, advisers, and witnesses retained by it in any Technical Dispute referred to a Technical Expert, and the costs and expenses of the Technical Expert shall be shared equally by the Parties.

28.4 Arbitration

(a) Any Dispute that has not been resolved within twenty (20) Days of the delivery of a notice in accordance with Article 28.2, or that is not subject to resolution pursuant to Article 28.3 shall be resolved by final and binding arbitration in Singapore in accordance with UNICITRAL (United Nations Commission on International Trade law) model law on International commercia arbitration in 1985 and the UNICITRAL conciliation rules in 1980. There shall be three arbitrators, each of whom shall be

neutral, independent and impartial. Either Party may make demand for arbitration in writing to the other Party, setting forth the nature of the Dispute, the amount involved, if any, the remedies sought, and the name of the arbitrator appointed by the Party demanding arbitration. The demand for arbitration shall be made within a reasonable time after the expiration of the twenty (20) Day period set forth in Article 28.2, and in no event shall it be made after forty five (45) days after the expiration of the twenty (20) Day period set forth in Article 28.2. Within twenty (20) Days after any demand for arbitration under this Article 28.4, the other Party shall name its arbitrator, or in default thereof, such arbitrator shall be named pursuant to the Arbitration Rules. The two (2) arbitrators so selected shall name a third arbitrator within seven (7) days after selection of the second arbitrator, or, in the absence of agreement on a third arbitrator by the two (2) arbitrators so appointed, a third arbitrator shall be appointed pursuant to the Arbitration Rules. The arbitration hearing shall commence not later than seventy five (75) days after the date of the original demand under this Article 28.4. The language of the arbitration shall be English.

(b) The award of the arbitrators shall be made not later than thirty (30) days after the date of closing of the hearing, or if oral hearings have been waived, after the date of transmitting the final statements and proof to the arbitrators; provided, however, that in no event shall any award be made later than one hundred and twenty (120) Days after the date of the original demand for arbitration under this Article 28.4. In the event the arbitrators find a breach of the terms and conditions of the Contract to have occurred and be continuing, the arbitrators shall have express authority to order the payment of damages in accordance with the provisions of the Contract.

(c) Any payment of damages ordered by the arbitrators shall bear interest at the Stipulated Rate, which interest shall accrue daily, from the date as of which such damages are calculated to the date on which the Party entitled thereto receives payment thereof in full. The award of the arbitrators shall be final, except as otherwise provided by Applicable Law.

(d) Judgment upon such award may be entered on behalf of the prevailing Party in any

court having jurisdiction thereof, and application may be made by such Party to any such court for judicial acceptance of such award and an order of enforcement. The expenses of the arbitration, including attorney's fees, shall be borne by the unsuccessful Party unless the arbitrators by their award shall otherwise provide.

(e) Supplier and Purchaser each hereby consents to the submission of any dispute for settlement by final and binding arbitration in accordance with this Article.

28.5 Continuance of Work

Notwithstanding any action, arbitration, Dispute, claim or other controversy (a "Claim") between Supplier and Purchaser or between Supplier and any Sub Supplier, Supplier and Purchaser shall each continue to perform their respective obligations under the Contract in the manner provided herein and shall have no right to suspend or delay performance thereof on account of such Claim.

28.6 Survival of Provisions / Limitation on Actions

The provisions of this Article shall survive the termination or expiration of the Contract. No Party shall institute any action or arbitration under this Article, unless filed within two (2) years after the event giving rise to the action or arbitration.

29. LIMITATION OF LIABILITY

29.1 No Consequential Damages

Except for Liquidated Damages, the proceeds of insurance, any interest paid on delayed payments, disputed amounts under Article 28 and all liabilities and amounts as provided in the Contract, in no event, whether as a result of breach of Contract, tort liability (including negligence or strict liability), strict liability, warranty, indemnity, or otherwise, and whether arising before or after completion of the Scope of Supplies, shall either (a) Supplier or the Sub Suppliers be liable to Purchaser or Lender or (b) Purchaser or Lender be liable to Supplier or Sub Suppliers, for special, indirect, or consequential damages of any nature

whatsoever, including losses or damages caused by reason of unavailability of the Power Plant, shutdowns or service interruptions, loss of use, loss of profits or revenue, loss due to variation in currency exchange rates, inventory or use charges, cost of purchased or replacement power, interest charges or cost of capital or claims of Purchaser's or Purchaser's customers.

29.2 Limitation on Liquidated Damages

The total liability of Supplier for the payment of Liquidated Damages shall be pursuant to Article 23.2.8 of the Contract.

This Article shall not be construed to limit Supplier's other liabilities and obligations arising under or in connection with the Contract (including without limitation (i) achieve minimum performance standards, (ii) the plant to meet the emission standards, iii) indemnification to the Purchaser under Article 20.

This Article shall survive the termination of the Contract.

29.3 Maximum Liability

Notwithstanding any other provisions contained in the Contract, the aggregate liability of Supplier to the Purchaser with respect to any and all claims arising out of the performance or non-performance of obligations in connection with the manufacture, sale, delivery, storage, or use of the Supplies (including the Equipment and the remaining portions of the Power Plant) or the rendition of other services in connection therewith, whether based on Contract, warranty, tort (including negligence), strict liability or otherwise, liability to third parties for property damage to property other than the Equipment and liability for personal injury, shall not exceed the total Contract Price.

This Article shall survive the termination of the Contract.

29.4 Releases Valid in All Events

Any releases, disclaimers and limitations on liability expressed herein shall apply even in the event of the negligence, strict liability, fault or breach of the Contract (including other legal bases of responsibility such as fundamental breach) of the Party whose liability is released, disclaimed or limited.

Except in the case of criminal neglect or willful misconduct:

(a) The Supplier shall not be liable to the Purchaser, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, provided that this exclusion shall not apply to any obligation of the Supplier to pay Performance Liquidated Damages to the Purchaser, and

b) The aggregate liability of the Supplier to the Purchaser under the Contract shall not exceed the Total Contract Price, provided that this limitation shall not apply to any obligation of the Supplier to repair or replace defective Equipment or to indemnify the Purchaser with respect to patent infringement.

30. SECRECY AND CONFIDENTIALITY

30.1 Confidential Information

The Purchaser and the Supplier shall treat the details of the Contract and any information made available in relation thereto as private and confidential and neither of them shall publish or disclose the same or any particulars thereof (save insofar as may be necessary for the purposes of the Contract including the appointment and use of Sub-Suppliers), without the previous written consent of the other Party, provided that nothing in this Article shall prevent the publication or disclosure of any information that has come within the public domain otherwise than by breach of this Article.

30.2 The technical information, drawings, specifications and other related documents forming part of the Contract are and shall always remain the property of the Purchaser and shall not be used by the Supplier or the Sub-Supplier or any other the employees, agents, Supplier, labourers of the Supplier or the Sub-Supplier for any other purpose, except for execution of

the Works under the Contract. All rights, including rights in the event of grant of a patent and registration of designs are reserved. The technical information, Drawings, specifications, re-cords and other Documents shall not be copied, transcribed, traced or reproduced in any other form or otherwise in whole and/or duplicated, modified, divulged and/or disclosed to a third party nor used in any other form whatsoever, without the Purchaser's previous consent in writing, except to the extent required for the execution of the Contract. All the technical information, Drawings, specifications and other related Documents shall be returned to the Purchaser with all approved copies and duplicates, if any, immediately after they have been used for the agreed purpose.

30.3 In the event of any breach of this provision, the Supplier/Purchaser shall indemnify the Purchaser/Supplier from any loss, cost or damage or any other claim whatsoever from any Parties claiming from or through them in respect of such breach.

30.4 Disclosure of Confidential Information

Either Party shall be entitled to disclose the terms and conditions of the Contract and any data or information acquired by it under or pursuant to the Contract without the prior written consent of the other Party:

30.4.1 to any Affiliate of such Party or, in the case of the Purchaser, to any Competent Authorities having jurisdiction over the implementation of the Facility;

30.4.2 to any outside consultants, Suppliers, suppliers or advisers engaged by or on behalf of such Party in connection with the Scope of Work or the implementation of the Facility and acting in that capacity;

30.4.3 to any Persons or Sub-Suppliers from whom the Supplier intends to invite tenders in respect of the sub-contracting of any element of the Scope of Work;

30.4.4 to any security trustee, any bank or other financial institution and its advisers from which such Party is seeking or obtaining finance;

30.4.5 to the extent required by the Applicable Law or pursuant to an order of any court of competent jurisdiction, provided that the original disclosing Party is given notice and adequate time to seek a protective order applicable to the information before it is disclosed;

30.4.6 to any insurer under a policy of insurance required to be taken out by either Party under the Contract; or

30.4.7 to the directors, employees and officers of such Party; provided that:

(i) the disclosing Party determines in good faith that the recipient has a legitimate need to see such data or information;

(ii) the recipient has been made aware of and has agreed to be bound by the requirements of this Article.

31. GENERAL PROVISIONS

31.1 Waiver

The failure of either Party to insist in any one or more instances upon strict performance of any provisions of the Contract or the waiver with respect to any default or any other matter hereunder, shall not be construed as a waiver with respect to any subsequent performance, default or matter. No waiver of any of the terms or conditions hereof shall be valid or binding unless made in writing and duly executed by both the parties.

31.2 Independent Supplier

The Parties are independent. The Supplier shall perform and execute the provisions of the Contract as an independent Supplier to Purchaser and shall not be an agent, representative or employee of Purchaser. Subject to the terms of the Contract, the Supplier shall be solely responsible for all methods, techniques, sequences, quality procedures, and safety programs applicable to the performance of the Scope of Supplies and the manufacture, procurement & supply of the Plant and Equipment.

Further, the Contract shall not be interpreted or construed to create an association, joint venture, or partnership between the Parties or to impose any partnership obligation or liability upon either Party. Neither Party shall have any right, or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party, unless expressly agreed otherwise.

31.3 Survival

All provisions of the Contract that are to come into or continue in force and effect after the expiration or other termination of the Contract and the consummation of the transactions contemplated hereby, shall remain in effect and be enforceable following such expiration, termination or consummation. All statements as to factual matters contained in any certification, Exhibit or instrument delivered by or on behalf of a Party hereto or in connection with the transactions contemplated hereby shall be deemed to be a statement of such Party as of the date of such certificate, Exhibit, or instrument.

31.4 Language

All notices, demands, requests, statements, instruments, certificates, drawings, documents or other communications given, delivered or made by, or on behalf of, either Party to the other under or in connection with the Contract shall be in English. The Supplier shall be responsible for the accuracy of the translation of any document submitted by it to the Purchaser.

31.5 Severability

Any provision hereof which is prohibited or unenforceable in any jurisdiction shall, as to such jurisdiction, be ineffective to the extent of such prohibition or unenforceability without invalidating the remaining provisions hereof and without affecting the validity or enforceability of any provision in any other jurisdiction.

31.6 Entire Contract

Entire Contract shall mean the Contract, now exist and may be hereafter modified by mutual written consent of the Parties.

31.7 Amendments

No amendments, supplements or modifications of the Contract shall be valid unless (a) evidenced in writing and signed by duly authorized representatives of both Parties or (b) when by way of a Variation Order by the Purchaser in terms of Article 19.

31.8 Third Parties

Except as expressly provided, the Contract and each and every provision hereof is for the exclusive benefit of the Purchaser, permitted assigns and the Supplier as applicable, and not for the benefit of any third party (including any sub-Suppliers)

31.9 Headings

All the headings or captions are merely for convenience and are not part of the Contract and shall not in any way modify or affect the provisions of the Contract.

31.10 Site

All the Items of the Plant and Equipment shall be consigned to:

Site-In-Charge
WPCPL
Nariyara Village
Janjgir-Champa District
Chhattisgarh State, India

31.11 Governing Law and Jurisdiction

The Contract shall be governed by and construed in accordance with, the Laws of India. Subject to the provisions of Article 28, the Purchaser and the Supplier each hereby submits to the jurisdiction of the relevant courts in India as per Law and for the purposes of all legal proceedings arising out of or relating to the Contract or the transactions contemplated hereby. Purchaser and Supplier each hereby irrevocably waives, to the fullest extent permitted by the laws governing the interpretation and enforcement of the Contract, any objection which it may now or hereafter have to the laying of the venue of any such proceeding brought in such a court and any claim that such proceeding brought in such a court has been brought in an inconvenient forum. The Purchaser and the Supplier each hereby irrevocably consents to the service of any and all process in any such action or proceeding by a mailing of copies of such process to it at its address specified in the Contract.

31.12 Counterparts

The Parties hereto may sign the Contract in any number of counterparts, all of which taken together shall constitute one and the same instrument

31.13 Attorneys' Fees

If the Parties resort to arbitration, or legal action for the enforcement or interpretation of the Contract or for damages on account of a breach hereof, the succeeding Party in any such arbitration or action shall be entitled to recover all costs and attorneys' fees incurred therein from the losing Party.

31.14 Binding Effect

The Contract shall be binding upon and inure to the benefit of the Parties hereto and their respective permitted successors and permitted assigns.

31.15 Specific Performance

Without first having to proceed to dispute resolution pursuant to Article 28 each Party shall not be entitled to seek a decree compelling specific performance with respect to, any actual or threatened breach of, any material covenant or obligation of the other Party under the Contract.

31.16 Notices

(a) Unless explicitly stated to the contrary elsewhere herein, notices, demands, approvals, disapprovals or requests required or which may be given hereunder to the respective Parties shall be in writing in the English language and either (i) delivered personally, (ii) sent by facsimile or telex with confirmed answerback, (iii) sent by registered or certified mail, return receipt requested, or (iv) sent by recognized overnight courier; addressed as follows:

Purchaser Contact Persons:

Company: Wardha Power Company Private Limited
Name: G.P.Rao
Position: Project Head
Phone: 0091 40 23559922
Fax:0091 40 23559930
Mobile: 0091 9959911039
E-mail: gprao@ksk.co.in

Supplier Contact Person:

Company: SEPCO Electric Power Cor struction Corporation
Name: Mr. Peng Lianyong
Position: Project Manager
Phone: 0086 531 88623175
Fax: 0086 531 88609977
Mobile : 0086 13964146717
E-mail: wpcplh-doc@sepco1.net

(b) Notices shall be deemed delivered when actually received by the Party to whom they are addressed. Each Party shall have the right to change the place to which notice shall be sent or delivered by notice to the other party in compliance with this Article.

31.17 Rights / Ownership on the accruing Intellectual Property Right

The whole right title and interest in and to any designs, copyrights, patents, trademarks, technology, know-how and other intellectual property developed by the Purchaser post receipt of the Supplies from the Supplier shall remain with the Purchaser only and the Supplier has no right to claim any interest/share therein.

IN WITNESS WHEREOF, the undersigned have each caused the Contract to be duly executed and delivered as of the date signed below:

WARDHA POWER COMPANY PRIVATE LIMITED	**SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION**
S. Kishore	Wang Yi'e
Director	President
duly authorised representative for and on behalf of WARDHA POWER COMPANY PRIVATE LIMITED	duly authorised representative for and on behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION
Witness:	**Witness:**
1)	1)

G.P. Rao

Project Head

2)

Anil Kumar Kutty

Director

Hou Zuoxin

Chairman (SEPCO I)

2)

Yin Shiji

Dy. General Manager

SCHEDULE 1

Cash Flow

(total 3 pages)

Month	Cumulative Percentages of the Contract Price
0	0.00%
1	8.00%
2	8.00%
3	8.00%
4	8.00%
5	8.00%
6	11.50%
7	11.50%
8	11.50%
9	11.50%
10	11.50%
11	11.51%
12	15.01%
13	15.48%
14	15.65%
15	16.00%
16	16.33%
17	16.85%
18	17.33%
19	18.30%
20	19.22%
21	20.67%
22	24.25%
23	26.58%
24	28.77%
25	35.83%
26	40.01%

Month	Cumulative Percentages of the Contract Price
27	41.50%
28	44.49%
29	47.83%
30	51.10%
31	52.41%
32	55.74%
33	58.20%
34	62.06%
35	64.31%
36	66.91%
37	69.69%
38	72.98%
39	75.66%
40	77.92%
41	80.53%
42	83.32%
43	85.63%
44	87.49%
45	89.88%
46	90.34%
47	92.86%
48	93.37%
49	94.13%
50	94.17%
51	95.63%
52	95.63%
53	96.36%
54	96.36%
55	97.81%
56	97.81%
57	98.54%

Month	Cumulative Percentages of the Contract Price
58	98.54%
59	100.00%

SCHEDULE 2

Technical Specification

(Total .....Pages)

Annexure 1

Letter of Award

(Total 11 pages)

KSK
Power from knowledge

Wardha Power Company Private Limited

Works
Near Nariyara Village,
Akaltara Tehsil,
Janjgir - Champa District,
Chhattisgarh

Registered Office
8-2-293/82/A/431/A,
Road No. 22, Jubilee Hills,
Hyderabad - 500033
Tel: +91-40-23559922-25
Fax: +91-40-23559930

Ref.No : SEPCO,CHINA/GPRAO/1160201/156

Letter of Award for Offshore supplies

THIS Letter of Award (the "LoA") is made and entered into on the 26th February 2009 by and between -

WARDHA POWER COMPANY PRIVATE LIMITED, a company incorporated and existing under the laws of India with its business address at 8-2-293/82/A/431/A, Road No.22, Jubilee Hills, Hyderabad-500033, India (hereinafter known as "**WPCPL**") on one part;

and

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION, a company incorporated and existing under the laws of China with its business address at No.150, Jinger Road, Jinan, Shandong 250001, China (hereinafter known as "**SEPCO**") on the other part.

RECITALS

A. WHEREAS WPCPL is setting up a 3600 MW Coal based Power Plant (**"Power Plant"**) on build, own and operate basis at Nariyara, Janjgir – Champa Dist, Chattisgarh State, India (**"Site"**) for the purpose of generating electrical energy.

B. AND WHEREAS SEPCO is a reputed business house engaged in, procurement and supply of various kinds of plant and equipments for large power plants.

C. AND WHEREAS WPCPL has proposed to and SEPCO has agreed to, procure, supply and deliver Plant and Equipment including commissioning spares and , Consumables required till successful completion of Reliability Run Test for the complete Power Plant ("Off-shore Supplies") in accordance with agreed Technical Specifications;

D. AND WHEREAS, pending finalisation and execution of a detailed Contract for the Off-shore Supplies, Parties desire to enter into this Letter of Award to confirm the aforesaid understanding;

NOW THE PARTIES HEREBY AGREE AS FOLLOWS:

1. SCOPE OF THIS AWARD :

This award covers the Off-shore Supplies on CFR (INCOTERMS2000) basis at designated Indian Port, to be agreed upon by the Parties, based on and read with the

tender specifications, mails exchanged and the resolutions reached through various meetings held till date ending with the meeting held upto and including 26.02.2009 in China and in India. as cited in the references enclosed herewith.
The scope of offshore supplies does not include CNC Lathe Machine, training simulator and CCTV.

2. CONTRACT PRICE

The price of Off-shore Supplies ("Contract Price") shall be USD 1,831,644,000, inclusive of all taxes, cesses, duties, etc. as applicable in China and enroute to the designated Indian Port. Taxes and duties applicable in India on these offshore supplies are excluded in the contract price.

3. PAYMENT TERMS

Subject to any deductions/adjustment from the Contract Price as per the Contract proposed to be executed, SEPCO shall be entitled to receive the Contract Price, progressively, in the following manner:

3.1.a · Payment of USD 4.95 Million within 48 hours of issue of LOA
3.1.b 8% as reduced by 4.95 Million USD Advance on submission of Advance Bank Guarantee (ABG) for 8% of the Contract Value
3.2 3.5% Advance against submission of ABG of equal amount at the end of sixth month from Zero date

3.3 3.5% Advance against submission of ABG of equal amount at the end of twelfth month from Zero date.

3.2 65% against despatch of Offshore Supplies FOB Chinese/Third country port on pro-rata basis as per shipping schedule, duly supported by evidence of shipment.

3.3 5 % against receipt of offshore supplies at site on pro-rata basis as per shipping schedule.

3.4 5% of the Contract Price against first synchronization (prorated for each Unit)

3.5 5% against successful completion of Reliability Run Test (prorated for each Unit) and on submission of Performance Bank Guarantee (PBG) by SEPCO,

3.6 5% against successful completion of PG Test (prorated for each Unit)

WPCPL shall release the advance payment against ABGs within 7 working days from receipt of ABGs by WPCPL. All the other payments under the Contract shall be made by telegraphic transfer/any other electronic mode within 21 days from the date the payment falling due and receipt of complete & correct documents, the charges for such remittances to be borne by WPCPL in India and that applicable in China shall be borne by SEPCO. Further the Charges of respective correspondent banks/intermediary bank in USA shall be borne by each party.

SEPCO shall furnish first PBG equivalent to 6% of contract value 30 days before completion of Reliability Run Test of first unit, valid upto Warranty period completion of the third unit. The amount of this performance guarantee shall be reduced prorata unit wise on completion of the respective warranty period. No further payments under this contract shall

be released to SEPCO if the Performance Bank Guarantee is not submitted 30 days before the scheduled date of completion of Reliability Run Test of first unit

SEPCO shall furnish second PBG equivalent to 4% of contract value 30 days before completion of Reliability Run Test of fourth unit, valid upto Warranty period completion of the sixth unit. The amount of this performance guarantee shall be reduced prorata unit wise on completion of the respective warranty period. No further payments under this contract shall be released to SEPCO if the Performance Bank Guarantee is not submitted 30 days before the scheduled date of completion of Reliability Run Test of fourth unit

The ABGs & PBG shall be submitted from any of the following banks.

1. Industrial & Commercial Bank of China
2. Bank of China
3. Agricultural Bank of China
4. Construction Bank of China

The invoice will be raised in US $ as per the original contract value with reference rate of RMB to USD (1USD equivalent to 6.82RMB) and payment will be released for this invoice as detailed above.

Any exchange rate variation with respect to the reference rate of RMB to USD (1USD equivalent to 6.82RMB), based on the USD buying rate published by Bank of China. on the date of payment release shall be to the account of WPCPL and the contract price varies accordingly..

The WPCPL/SEPCO shall, on quarterly basis, settle the Exchange Rate Variation for payments made in preceding quarter based on the formulae explained below , within 2 working days of receipt of approval of such payment by RBI (Reserve Bank of India) which is expected to be not more than 1 month for first payment and 21 days for subsequent payments :

Exchange rate variation for the quarter = $\sum$ each payment during the respective quarter × (6.82 – the exchange rate between RMB and USD at the date when the WPCPL made the payment) ÷ the exchange rate between RMB and USD at the date when the WPCPL made the payment.

The above principle will be followed for all payments to be made under this contract including payments against Bank Guarantees. However the adjustment in value for exchange rate variation of Advance Bank Guarantee will be made on each subsequent Advance Bank Guarantee submission.

The payments for the Off-shore Supplies shall be made in US $

SEPCO shall provide complete support on documentation with respect to WPCPL Usanace / Buyers Credit facility with its bankers.

4. SCHEDULE OF OFFSHORE SUPPLIES

The Off-shore Supplies shall be scheduled in such a manner as to ensure that the Power Plant shall be completed within the time schedule ("Project Schedule") as mentioned below.

Unit No.	Reliability Run Test completion (months) from NTP/Zero date (best effort basis)	Reliability Run Test completion (months) from NTP/Zero date (Guaranteed)
1 X 600 MW	36	38
2 X 600 MW	40	42
3 X 600 MW	44	46
4 X 600 MW	48	50
5 X 600 MW	52	54
6 X 600 MW	56	58

Notice To Proceed (NTP) or Zero Date or Effective date shall mean the date of this LoA, subject to following:

- WPCPL shall pay 4.95 million USD within 48 hours (two clear foreign exchange dealer working days) from the date of LOA so as to determine the Effective date. Any delay in the remittance of such payment shall entitle SEPCO the corresponding extension of time in the Completion Schedule.

- SEPCO shall submit ABG within 30 days from the date of LOA for 8% of the Contract Price and at the end of sixth month from the date of LOA for 3.5% of the Contract Price and at the end of twelfth month from the date of LOA for 3.5 % of the Contract Price.

- WPCPL shall pay any advance within 7 working days from receipt of swift message and a scanned image of the ABG to the bankers of WPCPL to be notified by WPCPL, confirming that the ABG has been issued on behalf of SEPCO. WPCPL shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of WPCPL. In case, of delay of payment of advance beyond 7 working days from receipt of swift message and a scanned image of the ABG, project schedule will be extended by corresponding period of such delay.

- *For Ist advance payment if such delay continued for 30 days, then the Contract Price and Completion Schedule shall be renegotiated.*

- *For all other payments if such delay continued for 90 days, then the Contract Price and Completion Schedule shall be renegotiated*

All the area within the boundary wall shall be handed over to SEPCO within 6 months from Zero Date with the formal confirmation letter from Owner. Failing to do so by WPCPL, the Completion Schedule for the project shall be extended by the corresponding period of such delay.

WPCPL will furnish the letter signed by their banker within 5 months from 'Effective date' that debt finance has been tied up. The completion schedule shall be extended by the same period of the delay of such furnishing.

5. POWER PLANT PERFORMANCE GUARANTEES

SEPCO shall ensure that the OffShore Supplies under this LOA and or the Contract shall be capable of the delivering the following performance guarantees for the Power Plant:

Sr. No.	Parameter description	Performance guarantee
1	Unit GROSS HEAT RATE:- Unit gross heat rate in kcal / kWh at rated steam parameters & 0.1 ata as exhaust pressure, with zero percent make up, at TMCR condition and at reference ambient parameters as per tender specifications	2239.77
2.	Total auxiliary power consumption of all auxiliaries at TMCR condition (%)	7.017
3.	SPM – mg/Nm^3 (with one field in each gas path out of service)	50
4.	Gross electrical power output at Generator terminals (MW)	600
5.	Boiler steaming capacity at BMCR condition (tph)	2068
6.	Unburnt Carbon in fly ash by weight (%) (Max)	1

SEPCO guaranteed Turbine cycle Heat Rate as 1950 kcal/kWh. SEPCO agreed to guarantee Unit Gross Heat Rate as 2239.77 kcal/kWh, considering (minimum) 99.5% piping efficiency. However improved piping efficiency shall be considered later based on the actual Main steam parameters measured during PG Test. Formula to be used for calculating piping efficiency shall be { $(1 - (i_B - i_T)/i_B) \times 100$ }, where i_B, i_T are values of enthalpy of main steam at Boiler outlet & Turbine inlet respectively. SEPCO indicated that piping loss is not considered on BE calculation. The unit gross heat rate shall be calculated by the formula, UHR=THR/BE/PE.

6. LIQUIDATED DAMAGES

Liquidated Damages shall be applicable as under:

Delay in successful completion of Reliability Run Test :

In the event of a delay in successful completion of Reliability Run Test ("RRT") beyond the Guaranteed completion Dates of such test, as per Schedule mentioned in clause 4, ,SEPCO shall pay as liquidated damages ("Liquidated Damages") and not as a penalty, a sum equal to 0.5 % (Zero point five percent) of the Unit Contract Price, for each week [7 days] of delay in completion of Reliability Run Test or part thereof of each unit, subject to an aggregate of ten percent (10%) of the Contract value.

Performance Liquidated Damages

The Liquidated Damages payable in relation to the performance of the Power Plant shall be reckoned as follows:

Sr. No.	Variation Factor	Liquidated Damages for shortfall in performance
1.	Unit GROSS HEAT RATE:- Unit gross heat rate in kcal / kWh at rated steam parameters & 0.1 ata as exhaust pressure, with zero percent make up, at TMCR condition and at reference ambient parameters as per tender specs.	Unit Gross Heat rate – USD 270494.36 per kcal / kWh or part thereof of increase in heat rate from guaranteed value.
2.	Total auxiliary power consumption of all auxiliaries at TMCR condition (%)	USD 1408.82 per kW (or part thereof) of increase in guaranteed value.
3.	Unit Gross electrical power output at Generator terminals (MW)	USD 1408.82 for every kW or part thereof by which output determined during the tests falls short of guaranteed rated output
4.	Each Boiler steaming capacity at BMCR condition (tph)	USD 40574.15 for each one tonne/hr. or part thereof decrease in steam generating capacity.
5.	Unburnt Carbon in fly ash by weight (%)	USD 281764.96 for every 1% (or part thereof) increase of unburnt Carbon in fly ash beyond the guaranteed value. For Ex. Guaranteed value is 1.5%. Actual value is 1.9%. LD value shall be = (1.9-1.5) X USD 281764.96 = USD 112705.98

The Performance Guarantee test shall be conducted separately for each unit and also for the first three units together and the subsequent three units together for measuring the Gross Guaranteed electrical power output at Generator terminals for the respective three units (MW) and corresponding Guaranteed auxiliary power consumption.

The aggregate liability under performance liquidated damages shall not exceed 10% of the Contract value

The PG tests shall be witnessed & the results shall be approved by Owner's Engineers.

All Off-shore Supplies shall carry a warranty period of 12 months from successful RRT for defects and deficiency, during which period SEPCO shall repair or replace the defective/deficient Off-shore Supplies, as may be desired by WPCPL, free of all costs.

Overall Aggregate liability

The overall aggregate liability under contract for delay in guaranteed schedule and shortfall in guaranteed performance shall not exceed 17.5% of the Contract value.

7. NOISE LEVEL GUARANTEES:

SEPCO shall guarantee the noise level of any equipment in the Power Plant not to exceed the limits specified below, unless otherwise indicated elsewhere in the tender specifications.

Criterion	Guaranteed Value
Noise Pressure Level	Average 85 dB(A) at 1m distance measured at 1.5m above ground in a free field condition

No Liquidated damages/Rejection shall be applied on the increase in the Noise level beyond guaranteed values. SEPCO to take necessary measures and to attenuate the noise levels within the limits specified.

8. REJECTION OF OFF-SHORE SUPPLIES

In the event of SEPCO fails to demonstrate to the satisfaction of WPCPL, the performance guarantees, subject to the tolerance(s) agreed herein below and as is recorded during the first PG test, then, SEPCO shall be given a further period of 30 days to make necessary corrections and conduct any retest. In the event of failure to demonstrate the performance parameters even during such re-test, the particular equipment(s) under the Off-shore Supplies will stand rejected. In case the said equipments is not capable of being rectified, such equipment will have to be replaced at site, within reasonable time, at no extra cost basis to WPCPL.

Rejection Criteria of Off-shore Supplies of the Power Plant :

WPCPL may reject the any part of the Off-shore Supplies under the following circumstances:

1.) Output: Shortfall in excess of 5% in guaranteed output (of all major equipments and complete Power Plant)

2.) Auxiliary power Consumption: In excess of 5% over the guaranteed auxiliary power consumption value.

3.) Unit Gross Heat Rate : In excess of 5% over the guaranteed value.

4) Emission Level : In excess of guaranteed Emission level value.

5) Unburnt Carbon in fly ash % by weight : in excess of 2%

9. NON-ASSIGNMENT

No Party shall assign the benefits of this LOA without the first party intending to assign, obtaining a written consent of the other Party except that WPCPL is permitted to assign the LOA to its Lender(s)

10. TIME

Time is the essence of this LOA

11. LEGAL COMPLIANCES

SEPCO shall be fully and absolutely responsible for complying with all applicable laws, rules, regulations and guidelines and obtaining all permits and clearances in relation to the Off-shore Supplies and their performance upto and including the Performance Guarantee Test of Power Plant except for those deviations already agreed

12. GOVERNING LAW, JURISDICTION & DISPUTES:

The Contract will be governed by relevant and applicable laws of India and subject to the exclusive jurisdiction of Courts in India.

All disputes whatsoever in relation to the Contract will be settled by arbitration under UNICITRAL (United Nations Commission on International Trade Law) Rules of Arbitration, through a arbitral panel of two arbitrators (one to be appointed by either Party) and an umpire to be nominated by the two arbitrators. The venue of arbitration shall be in Singapore.

13. CONFIDENTIALITY

No party shall disclose this LOA/Contract or any part thereof, without the written consent of the other party except that such consent is not required when such disclosure have to be made to a lender, Statutory Authority or in pursuance of any directive from a Regulatory Authority.

14. NON-DISCLOSURE

SEPCO shall not disclose the existence or the contents of this LoA/Contract or any part thereof, for 6 months from Zero date, without the written consent of WPCPL.

15 EXECUTION OF CONTRACT:

Parties agree and understand that this LoA is only a broad statement of intent of Parties on matters covered herein and that the Parties shall finalise and execute the Contract on or before 20.3.2009, capturing all the relevant terms and conditions agreed to between the Parties, based on the Bid Documents, Offer submitted by SEPCO, Minutes of the Meetings held on various dates between the Parties and the decisions agreed to thereunder as per enclosed references (copies of these are available with both parties). The Contract on execution, shall be read with the documents referred to in the Reference List

IN WITNESS WHEREOF, the Parties hereby have caused this LoA to be executed by their duly authorized signatories on the date set forth above.

WARDHA POWER COMPANY PRIVATE LIMITED

.....

.....

Authorised Signatory
Name: S. Kishore
Designation: Director
Date: 26.02.2009

In the presence of
Name:G.P.Rao
Designation: Project Head
Date: 26.02.2009

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

.....

.....

Authorised Signatory
Name: Yin Shiji
Designation: DGM - SEPCO
Date: 26.02.2009

In the presence of
Name: Sun Lianming
Designation: CEO – SEPCO I
Date:26.02.2009

Enclosed – Reference list

WARDHA POWER COMPANY PRIVATE LIMITED
6 x 600 MW THERMAL POWER PROJECT AT NARIYARA, CHHATTISGARH

LIST OF DOCUMENTS AND COMMUNICATIONS TO FORM PART OF LOA / CONTRACT DOCUMENT WITH SEPCO

1) Bid Specification for 3600 MW Coal based power project dated 27th March 2008 released via NIT in all major newspapers.

2) Bid specification sent on 28th March 2008 to SEPCO

3) Minutes of pre bid meeting dated 10.05.08 held at Novatel Hotel, Hyderabad.

4) DCPL E-mail No. K712/NRM-1/V7/72 dated 18.06.08 on Amendment-1 to Technical specification.

5) DCPL E-mail No. K712/NRM-1/V7/101 dated 27.06.08 on extension of Bid submission date to 30th July 2008.

6) DCPL E-mail No. K712/NRM-1/V7/128 dated 03.07.08 on Amendment-2 to Technical specification to the offer.

7) DCPL E-mail No. K712/NRM-1/V7/152 dated 17.07.08 regarding Change in design water analysis.

8) SEPCO offer for 6 x 600 MW Sub-critical coal based power project submitted on dated 21.07.08.

9) DCPL E-mail dated 29.07.08 on extension of Bid submission date to 30th August 2008.

10) DCPL E-mail No. K712/NRM-1/V7/192 dated 28.08.08 on extension of Bid submission date to 08th Sept 2008.

11) DCPL E-mail No. K712/NRM-1/V7/193 dated 30.08.08 on contract documents and Notes on taxes.

12) Comment/clarification issued vide DCPL-K7V12/NRM-1/V7/197 dated 09.09.08 Technical offer.

13) WPCPL E-mail No. SEPCO,CHINA/GPRA/1160201/359 dated 10.09.08 on Tendering process.

14) Minutes of meeting held between SEPCO, WPCPL and DCPL between 25.09.08 to 28.09.08 at DCPL, Vashi

15) DCPL E-mail No. K712/NRM-1/V7/211 dated 29.09.08 on amendment in contract documents.

16) DCPL E-mail No. K712/NRM-1/V7/216 dated 06.10.08 on degassed cation conductivity analyser.

17) DCPL E-mail No. K712/NRM-1/V7/223 dated 11.10.08 on Specification for CNC Lathe and Eutectic Metal Spray.

18) SEPCO E-mail dated 10.10.08 and 15.10.08 on clarification/reply to pending points of MOM dated 25-09-08 to 28-09-08.

19) SEPCO reply dated 17.10.08 to DCPL E-mail dated 16.10.08 on pending points of MOM dated 25-09-08 to 28-09-08.

20) WPCPL mail dated 26th December 2008 on Pending Points and on compliance with CEA guidelines "Standard Technical Specification for Main Plant Package of Sub-Critical Thermal Power Project, 2 x (500 MW and above)".

21) SEPCO Clarification on Pending Points vide e-mail dated 31st December 2008

22) WPCPL mail on 3rd January 2009 to SEPCO including comments to 31st December 2008 SEPCO clarification.

23) WPCPL mail on 5th January 2009 to SEPCO containing WPCPL standard Quality plan for Turbine, Generator, Boiler, Electrical and auxiliaries.

24) MOM of meeting at SEPCO, Jinan office on 08th January 2009, complied documents sent on 10th January 2009 by WPCPL.

25) Two mails sent on 13th January 2009 by SEPCO on commercial clarification.

26) SEPCO sent a mail having a clarification on their experience on 13th January 2009

27) Minutes of Meeting held at SEPCO, Jinan office on 21st and 22nd January 2009.

28) SEPCO clarifications vide e-mail dated 4th February 2009.

29) Minutes of Meeting held at WPCPL, Hyderabad on 4th to 6th February 2009.

30) Quality Control Plans on BOPs forwarded to SEPCO by WPCPL

31) SEPCO reply to pending points of 6th February 2009 MOM on 11th February 2009

32) Comments on HMBDs forwarded to SEPCO vide WPCPL mail dated 12th February 2009 and clarifications furnished by SEPCO vide e-mail dated 14th February 2009.

33) Minutes of Meeting held at SEPCO, Jinan office on 16th to 21st February 2009.

34) Minutes of Meeting held at WPCPL, Hyderabad on 26th February 2009.

Annexure 2

Format of Advance Payment Bank Guarantee
(Total 3 pages)

Date: _____

Guarantee No.:

Dear Sir,

To:
Wardha Power Company Private Limited
8-2-293/82/A/431/A,
Road No.22, Jubilee Hills,
Hyderabad – 500 033, India

WHEREAS, in consideration of your agreeing to pay to M/s. SEPCO Electric Power Construction Corporation(SEPCO), a company incorporated under the laws of People's Republic of China and having its registered / principal office at No.150,Jinger Road, Jinan, Shandong, P. R. China, (hereinafter referred to as "Party" (which expressions shall include its successors and assigns permitted by us) a sum of US Dollar _____,(say US Dollars _____ only) as and by way of Advance Payment in terms of your LOA reference No. _____ dated_____ and the Contract Agreement NO. _____ with the Party (SEPCO) dated _____ (hereinafter referred as the "Contract") for the fulfillment of obligations such as supply to be carried out by the Party under the said Contract on furnishing a Bank Guarantee of equivalent value in the manner hereinafter contained, we, _____, _____ do hereby covenant and agree with you as follows:

1. We hereby undertake and bind ourselves irrevocably and unconditionally to pay to you the sum in aggregate not exceeding US Dollar _____ (Say US_____ Dollars) representing the Advance Payment made by you to the "Party" as aforesaid, without delay or demur, merely on the first written demand signed by your duly Authorised Signatory stating that the amount claimed is due by way of loss or damage caused to or would be caused to you by reason of

default or defaults on the part of the "Party" in discharging any of its obligation under the said "Contract". Your written demand shall be accompanied by a certificate issued by the project consultant as appointed by you (Beneficiary, i.e. Wardha Power Company Private Limited) to prove that the Party is in breach of his obligation(s) under the contract and stating the respect in which the Party is in breach. Any such demand made on us shall be conclusive as regards the amount due and payable to you by us under this guarantee.

2. Notwithstanding anything to the contrary, your decision as to whether the "Party" has made any such default or defaults under the aforesaid Contract and the amount or amounts to which you are entitled by reason thereof, will be binding on us and we shall not be entitled to ask you to establish your claim or claims under this guarantee but will pay you the sum promptly on first written demand made by you without any protest or demur forthwith.

3. This guarantee shall come into force simultaneously with receipt of the corresponding advance payment by "Party" and shall remain in full force and effect up to and including _____ (herein called the expiry Date) at the counters of _____, _____. Should it be necessary to extend the validity of this guarantee beyond the said date, we undertake to extend the period of the guarantee on your request till such time as may be mutually agreed between you and the "Party".

4. The amount of this guarantee shall be upon the receipt of your approval on the Party's application, progressively reduced on quarterly basis in proportion to the value of progress payment received by the Party.

5. All Banking Charges occurred in India are to the account of Wardha Power Company Private Limited.

6. We further agree that you shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said "Contract" and/or to extend the time for performance by the "Party" from time to time.

7. We, _____, _____, also undertake not to revoke this guarantee during its currency and until the discharge Certificate is issued by you in writing through your Bank.

8. Notwithstanding anything contained hereinabove, our liability under this guarantee is restricted to US Dollar _____ (say US Dollar _____ only) This guarantee shall remain valid up to _____ at the counters of _____, _____. Unless a claim in writing is lodged with us within a period of 60 days (sixty days) from the date of expiry of the guarantee i.e. up to and including _____ (Date) at the counters of _____, _____, all your rights under this guarantee shall stand forfeited and we shall be released and discharged from all liabilities under this guarantee whether or not this document shall have been returned to us.

THIS GURANTEE SHALL BE SUBJECT TO THE UNIFORM RULES FOR DEMAND GURANTEES, ICC PUBLICATIONS NO.458.

SIGNED AND DELIVERED this - - - - - - - -

For and on behalf of

Bank: _____, _____

Address: _____, No.

(AUTHORISED SIGNATORY OF BANK)

Annexure 3

Format of Performance Bank Guarantee

(Total 3 pages)

Date:

Guarantee No.:

To: Wardha Power Company Private Limited
8-2-293/82A/431/A
Road No. 22, Jubilee Hills
HYDERABAD – 500 033, India

Dear Sirs,

WHEREAS, M/s. SEPCO Electric Power Construction Corporation, a company incorporated under the laws of People's Republic of China, having its registered office at No. 150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as the "Party" which expressions shall include its successors and permitted assigns) has in terms of Contract No..... entered between you and the said Party, contracted to perform the Works and services as stated in the Contract.

AND WHEREAS, as per provision of the said Contract, the Party is required to furnish to you a Bank Guarantee for USD..... (Say US Dollar ..... only) towards due and faithful performance of the Party's obligations under the Contract.

Now, we ..... (name of the bank) hereby irrevocably agree and undertake as follows:

1. We hereby irrevocably guarantee to pay to you the sum in aggregate not exceeding USD ..... (Say US Dollar .....only), merely on the first written demand signed by your duly authorised representative stating that the amount claimed is due by reasons of breach by the said Party of any of the terms or conditions contained in the said

Contract or by reasons of the Party's failure in performance of the Contract. Your written demand shall be accompanied by a certificate issued by the project consultant as appointed by you (Beneficiary, i.e. Wardha Power Company Private Limited) to prove that the Party is in breach of his obligation(s) under the contract and stating the respect in which the Party is in breach. Any such demand made on us shall be conclusive as regards the amount due and payable to you by us under this guarantee.

2. This guarantee shall come into force from date on the successful completion of Reliability Run Test of the _____ Unit and shall remain in full force and effect up to and including_____ (Date) at the counters of_____, _____Branch or the earlier date upon which we have received a written notice from you and the Party jointly stating that the Contract has been terminated and no claim against the Party is outstanding. Should it be necessary to extend the validity of this guarantee beyond the said date, we undertake to extend the period of the guarantee till such time as may be mutually agreed between you and the Party.

3. All banking charges occurred in India are to the account of Wardha Power Company Private Limited.

4. Notwithstanding anything contained hereinabove our liability under this guarantee is restricted to USD..... (Say US Dollar .....only). This guarantee shall remain valid up to..... (Date) at the counters of , Branch.. Unless a claim in writing is lodged with us within a period of 60(sixty) days from the date of expiry of the guarantee i.e up to and including..... (Date) at the counters of , Branch, all your rights under this guarantee shall stand forfeited and we shall be released and discharged from all liabilities under this guarantee whether or not this document shall have been returned to us.

5. The amount of Performance Bank Guarantee shall be reduced prorated Unit wise on completion of the Warranty Period of the respective Unit, upon receipt of the certificate to that extent from you.

PVK

6. We further agree that you shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said contract with the Party.

7. This Guarantee shall not be affected by any change in your constitution / management / or of Party / or the Bank by absorption with any other body, corporation or otherwise and this Guarantee will be available for enforcement by such body or corporation.

8 We,____, ___ Branch, also undertake not to revoke this guarantee during its currency and until the discharge Certificate is issued by you in writing through your Bank.

THIS GURANTEE SHALL BE SUBJECT TO THE UNIFORM RULES FOR DEMAND GURANTEES,ICC PUBLICATIONS NO.458.

(AUTHORISED SIGNATORY OF BANK)

DATED THE 16th DAY OF MAY 2009

FIRST AMENDMENT TO THE OFFSHORE SUPPLY CONTRACT

AMONG

WARDHA POWER COMPANY LIMITED

AND

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO)

आंध्रप्रदेश आन्ध्र प्रदेश ANDHRA PRADESH

R 466045

K. NAGARAJA MAN
S.L.L. No 46/96, R.No.02/200
Shop No 59/A, Kushal Towers
Khairatabad, Hyderabad.

No. 8550 Date 15/05/2009 Value 100/-
Purchaser K. Ravi Sankar
For Whom Wardha Power company Ltd

This FIRST **AMENDMENT AGREEMENT** (**"Amendment Agreement"**) is made as of this 16th day of May, 2009 by and amongst:

1. **Wardha Power Company Limited (formerly Wardha Power company private limited)** , a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as **"WPCPL" or "Purchaser"**, which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors in title and permitted assigns);

   And

2. **SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO),** a company duly incorporated and existing under and by virtue of the laws of China and having its registered office at No.150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as "SEPCO" or "Supplier", which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

WHEREAS:

(A) The Parties have, on April 1, 2009, executed Offshore Supply contract ("**OSC**"), for recording their mutual agreement and understanding in relation to the terms and conditions under which the Supplier will make the Supplies and the Purchaser purchasing the same

(B) Pursuant to SEPCO's representation to WPCPL that design criteria for certain systems and associated scope of works discussions have been undertaken between the parties Pursuant to such discussions in this regard, the Parties have agreed that while the basic contract would remain, as it is, in toto, as executed on April1, 2009, two modifications with respect to contract price and associated reflection in the associated ABG submission could be, as set out in these presents.

(C) Accordingly, in order to reflect this understanding between the Parties, the following two amendments to the OSC are necessary to be carried out.

(D) In pursuance of the above, the Parties have agreed to amend the OSC as more particularly set out hereunder.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Amendments

The Parties hereby agree that the following amendments to the OSC shall be effective immediately on and from the date of execution of this Amendment Agreement:

1.1 Increase in contract price to the extent of USD 5,000,000 (Five Million only). Hence, the existing clause 10.1 are hereby deleted and substituted with the following:

10.1 In consideration of the Supplier supplying the Supplies, the Purchaser hereby covenants to pay to the Supplier the Contract Price amounting to USD 1,836,644,000(Say US Dollars one billion eight hundred and thirty-six million six hundred and forty-four thousand only)at the time and in the manner set forth in the Contract subject to such deductions/adjustments as may be allowable in the Contract. The Contract Price shall mean the price for the Supplies supplied on CFR (INCOTERMS 2000) basis. Insurance will be arranged by or on behalf of Purchaser.

1.2 the existing clause 11.5.5 is hereby deleted and substituted with the following :

11.5.5 The ABGs shall be furnished within 30 days from the Zero Date for 8% of the Contract Price less USD 400,000, for 4% of the Contract Price plus USd 400,000 at the end of sixth month from the Zero Date and for 3 % of the Contract Price at the end of twelfth month from the Zero Date.

The ABGs shall be valid upto the completion of Reliability Run Test of the last Unit. The amount of the Guarantee shall be progressively reduced on quarterly basis in proportion to the value of progress payments received.

1.3 the existing clauses 12.2.2, 12.2.3 and 12.2.4 are hereby deleted and substituted with the following :

12.2.2 8% (Eight percent) advance on the Contract Price for supply of Items forming the Plant and Equipment, reduced by 400,000 USD and 4.95 Million USD Advance paid pursuant to Article 12.2.1, will be paid by telegraphic transfer within 7 Business days from receipt of swift message and a scanned image of the ABG to the bankers of Supplier to be notified by Purchaser, confirming that the ABG has been issued on behalf of Supplier. Purchaser shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of Purchaser. In case of delay of payment of advance beyond 7 Business days from receipt of swift message and a scanned image of the ABG, Guaranteed Completion Date will be extended by corresponding period of such delay.

12.2.3 4% Advance on the Contract Price plus USD 400,000 shall be paid against submission of Advance BG of equal amount on the sixth month from Zero Date.

12.2.4 3% advance payment of the Contract Price shall be paid against submission of ABG of equal amount on the twelfth month from Zero Date.

2. Miscellaneous

2.1 Save and to the extent amended by Clause 1 of this Amendment Agreement, the OSC shall continue to remain in full force and effect in accordance with its terms.

2.2 The Parties agree that all of the provisions of the OSC shall apply *mutatis mutandis* to this Amendment Agreement, as if set out specifically herein and incorporated into this Amendment Agreement:

[Rest of the page has been intentionally left blank]

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS AMENDMENT AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For WARDHA POWER COMPANY LIMITED

Mr. S.Kishore, Director
duly authorized representative for and On behalf of WARDHA POWER COMPANY LIMITED

Witness

Mr. B.N.Prakash

For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Mr. Wang Chengcai, Deputy project Manager and duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

Ms. Wang Lin

DATED THE 2nd DAY OF SEPTEMBER 2009

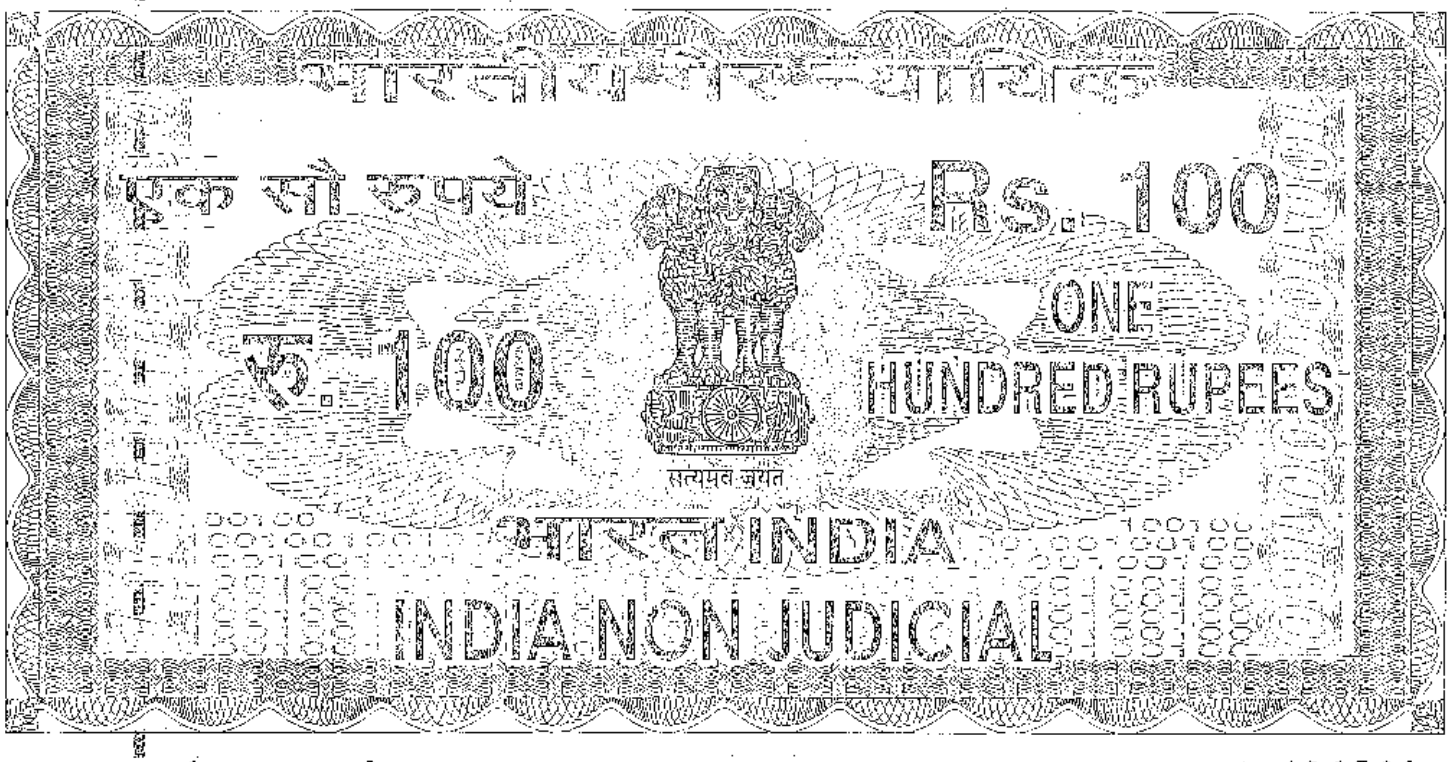
ADDENDUM TO THE OFF-SHORE SUPPLIES CONTRACT

BETWEEN

WARDHA POWER COMPANY LIMITED

AND

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO)



ఆంధ్రప్రదేశ్ आन्ध्र प्रदेश ANDHRA PRADESH

S 696591

Sl. No : 88 Date.:02/09/2009. Rs.: 100/-
Sold To : J. Krishna
S/o : Ramaiah R/o.Hyd
To Whom : Wardha Power Company Limited.

K. RAMA CHANDRAVATHI
STAMP VENDOR (L. No:27/99, RL.No. 16/2008),
6-3-387, Beside Banjara Durbar Hotel, Panjagutta
HYDERABAD - 500 082. Phone. No. 23351799

This ADDENDUM TO OFFSHORE SUPPLY AGREEMENT is made as of this 2nd day of September, 2009 by and amongst:

Wardha Power Company Limited (formerly Wardha Power Company Private Limited), a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as "WPCL" or **"Supplier"**, which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors in title and permitted assigns);

and

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO), a company duly incorporated and existing under and by virtue of the laws of China and having its registered office at No.150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as "SEPCO" or **"Purchaser"**, which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

WHEREAS:

(A) The Parties have, on April 1, 2009, executed Off-shore Supplies Contract ("Project Contract") for recording their mutual agreement and understanding in relation to the terms and conditions under which the Supplier will execute the Supplies thereunder in relation to the 3600 MW coal based power plant being set up at Nariyara, Janjgir – Champa District, Chattisgarh State, India (hereinafter referred to as the "Project" or the "Power Plant");

(B) The said Project Contract was followed by one Amendment thereto, viz. First Amendment Agreement dated 16th May, 2009

(C) At the time of execution of the Project Contract, as the list of mandatory spares which the Supplier agreed to procure, supply and deliver for the operation and maintenance of the Power Plant required detailed scrutiny, it was agreed that Mandatory Spares Supplies will be added subsequently by way of Addendum.

(D) Subsequent to signing of the Project Contract, SEPCO agreed to supply the Mandatory Spares (as hereinafter defined) to WPCL, required for the operation and maintenance of the Power Plant, and the terms were broadly outlined in the Letter of Award (LoA) dated 17th June, 2009 (Annexure-1 herein), under which it was agreed to execute a detailed addendum to the Project Contract, on or before August 2009, capturing all the relevant terms and conditions agreed to between the Parties in relation to the Mandatory Spares.

(E) Parties have agreed that the basic structure of the Project Contract would remain as it is, in toto, as executed on 1st April1, 2009, save the Amendment Agreements mentioned hereinabove as well as the addendum as set out in these presents.

(F) Accordingly, in order to reflect this understanding between the Parties, the following addendum to the Project Contract are necessary to be carried out.

(G) In pursuance of the above, the Parties have agreed to amend the Project Contract as more particularly set out hereunder.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Addendum

The Parties hereby agree that the following addendums to the Project Contract shall be effective immediately on and from the date of execution of this Addendum:

1.1. Under Article 1.1 – Definitions - the following will be added after the definition of the term "Lien(s)":

"Mandatory Spares" shall mean the Spares required for the operation and maintenance of the Power Plant as per the detailed list and specifications attached herewith and marked as Annexure – 2.

1.2 Following documents shall be added as Sl.Nos.6 & 7 of the Contract Documents as mentioned in Sub-Article 1.2.8 :

1.2.8 : Contract Documents

6. . Annexure- 1 to this addendum dated 2nd September, 2009, LoA – Letter of Award dated 17th June, 2009

7. Annexure- 2 to this addendum dated 2nd September, 2009 - List of Mandatory Spares

1.3 Following Sub-Clauses shall be added after Sub-Article 2.2.10 :

2.2.11 The Mandatory Spares shall be purchased from same main equipment/spares manufacturers except for standard items such as meters, valves, etc. In case of such standard items, the Supplier shall ensure the interchangeability of the Spares with any of the original equipment irrespective of the manufacturer of original equipments.

2.2.12 The supplier shall provide Purchaser with all the addresses, contact person,

e-mail, phone no and other details of his Sub-Supplier while placing the order on vendors for Spares. Supplier shall communicate and ensure with his sub-suppliers that the purchaser if desires have the right to place order for Mandatory Spares directly on them. However, the scope of this order shall remain unchanged without a scope change order issued with mutual consent.

1.4 Sub-Article 2.3.1, 2.3.2, 2.3.3 & 2.3.4 will be renumbered as 2.3.1 A, 2.3.2 A, 2.3.3 A & 2.3.4 A.

1.5 Following Sub-Articles shall be added as 2.3.1 B, 2.3.2 B, 2.3.3 B & 2.3.4 B :

Scope of Work / Scope of Supply for Mandatory Spares

2.3.1 B The Scope of Work to be carried out by the Supplier shall include but not be limited to design, engineering, manufacture, procurement, assembling, shop testing, seaworthy packing, forwarding and delivery of the Mandatory Spares as per annexure-2 on **CFR** basis up to the Delivery Point, for the Project, more specifically detailed in Annexure 2 ("Scope of Supply for Mandatory Spares").

2.3.2 B The Mandatory Spares supplied shall be complete in all respects with all mountings, fixtures and standard accessories (devices required for overseas transportation and long term storage at Purchaser's works) that are required to be supplied in accordance with Good Industry Practices, even if it is not specifically detailed in Annexure-2. The Supplier shall not be eligible for any extra payment in respect of such mountings, fixtures, fittings, and accessories as may be needed for safe and reliable operation of the Mandatory Spares as per applicable Codes though they may not have been included in the Addendum Contract. Various Items of the Mandatory Spares supplied shall be interchangeable with one another.

2.3.3 B The Supplier shall sequence his Supplies in accordance with the Delivery Schedule approved by the Purchaser to meet the requirements of the power plant by the respective Guaranteed supply Date .

2.3.4 B The obligations of the Supplier under the Contract shall include single point responsibility for all necessary co-ordination in respect of the independent supplies & allied activities to be performed to ensure that the Mandatory Spares supplies is completed in every respect as contemplated. Thus the Supplier needs to ensure that

the Scope of Supplies is completed in accordance with the Guaranteed Dates,

1.6 Sub-Article 3.1, 3.2 & 3.5 will be renumbered as 3.1 A, 3.2 A & 3.5 A.

1.7 Following Sub-Articles shall be added as 3.1 B, 3.2 B & 3.5 B :

3.1 B The Supplier is deemed to have carefully examined the Technical Specifications mentioned in Annexure 2 to his entire satisfaction before signing of the Contract. The Supplier is deemed to have made independent enquiries and satisfied himself for all the required information, inputs, conditions, circumstances and factors having effect on the Contract Price and on execution of the Works covered in the Contract.

3.2 B The Purchaser shall not permit any change in delivery Schedule or any financial adjustment arising due to lack of information on the part of the Supplier. Any information obtained by the Supplier from the Purchaser, which is not in writing, shall not in any way relieve the Supplier of the Supplier's responsibility to fulfill his obligation under the Contract.

3.5 B The Supplier shall not, except as expressly provided in the Contract and save to the extent of any misrepresentation or misinformation given to it by or on behalf of the Purchaser, be entitled to any extension of time for any of the Items listed in the annexure-2 or to any adjustment of the Contract Price on the grounds of misinterpretation or misunderstanding of any such matter. Any information obtained by the Supplier from the Purchaser, which is not in writing, shall not in any way relieve the Supplier of his responsibility to fulfill his obligation under the Contract.

The Supplier shall supply the Mandatory Spares required for Plant and Equipment in accordance with the Annexure-2 and perform all its other obligations as provided under the Contract.

1.8 Sub-Article 4.1 shall be renumbered as 4.1 A.

1.9 Following Sub-Article shall be added as 4.1 B:

4.1 B Scope of Work/ Scope of **Supply of Mandatory O&M Spares**

The Supplier shall supply the Mandatory Spares required for Plant and Equipment in accordance with the Annexure-2 and perform all its other obligations as provided under the Contract.

1.10 Sub-Article 4.3 shall be renumbered as 4.3 A

1.11 Following Sub-Article shall be added as 4.3 B:

4.3 B Completeness of Mandatory Spares

The Mandatory Spares supplied shall be complete in all respects with all mountings, fixtures and standard accessories (devices required for overseas transportation and long term storage at Purchaser's works) that are required to be supplied in accordance with Good Industry Practices, even if it is not specifically detailed in Annexure-2. The Supplier shall not be eligible for any extra payment in respect of such mountings, fixtures, fittings, and accessories as may be needed for safe and reliable operation of the Mandatory Spares as per applicable Codes though they may not have been included in the Addendum Contract. Various Items of the Mandatory Spares supplied shall be interchangeable with one another.

1.12 Sub-Articles 4.5.1 & 4.5.12 shall be renumbered as 4.5.1 A & 4.5.12 A

1.13 Following Sub-Article shall be added as 4.5.1 B & 4.5.12 B :

Drawings of the Mandatory Spares

4.5.1 A The Supplier shall provide Purchaser with catalogues, assembly drawings with complete dimentional and other information and other relevant documents so as to enable the Purchaser to identify and put to right use of the spares for operations and maintenence. Assembly drawing must include cross sectional drawing as required with overall dimensions and details required for assembly of the particular spares into main equipment.

4.5.12 B All the drawing and documents including work instructions, O&M manual, catalogues etc. shall be submitted to the Purchaser in 6 (Six) copies and one soft copy in CD for Purchaser's reference and records. If O&M manual is already supplied with all details with main equipments then it shall not be supplied again.

1.14 Sub-Article 4.6.1 will be renumbered as 4.6.1 A.

1.15 Following Sub-Article shall be added as 4.6.1 B :

4.6.1 B Operation and Maintenance Manuals Mandatory O&M Spares

For the Mandatory unit assemblies appearing in the list enclosed as Annexure-2 supplied by the Supplier, the Supplier shall submit to the Purchaser 2 (two) sets of the Operation and Maintenance (O&M) Manuals and one soft copy in CD. The Manuals shall contain the operational features of the Item/s trouble shooting, maintenance schedules for preventive maintenance, detail dimensional drawings, cross sectional drawings, method of assembly and the like to make the Purchaser's staff acquainted with the Item/s supplied as well as to enable them to operate and maintain the same in prescribed manner. The O&M Manuals shall contain all information for ordering of the spares, like part name, part no., address of the Supplier with phone number, fax number and other necessary details. The Supplier shall ensure that these O&M Manuals are made available to the Purchaser well before starting of Initial Operation of the Unit/s. If O&M manual is already supplied with all details with main equipments then it shall not be supplied again.

1.16 Sub-Articles 4.8.1, 4.8.2 & 4.8.3 shall be renumbered as 4.8.1 A, 4.8.2 A, 4.8.3 A:

1.17 Following Sub-Articles shall be added as 4.8.1 B, 4.8.2 B & 4.8.3 B:

4.8.1 B The Supplier, after proper surface treatment shall pack and crate all the Items of the Mandatory Spares for seaworthy packing (Phytosanitary /fumigation to be done in case of packing of goods in wooden boxes / pallets and shall furnish a certificate from the competent agency certifying that Phytosanitary /fumigation has been done) wherever applicable, in a manner suitable for export to a tropical humid climate region in accordance with the internationally accepted export practices, and in such manner so as to protect it from damage, corrosion and deterioration in transit and during it's transportation by sea, air and/or land, till the time of shipment reaching Delivery Point and reaching proper storing point and clear identification..

4.8.2 B Each Item of the Mandatory Spares shall be painted, greased and/or provided with a suitable protective coating as required to prevent rust or damage due to bad weather. Before packing the Items as required, the Mandatory Spares shall undergo the Supplier's standard preservation measures to protect it during shipment and long term storage (till utilization of spare) at delivery point.

Each spare part shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the content shall be shown on the outside of such case and a details list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposesw of identification. All cases, containers or other packages are to be opened for such examination as may be considered necessary by the purchaser.

4.8.3 B The Supplier shall give all information concerning the weight, size and content of each package, Service expectancy of period under normal operating condition before replacement including any other information the Purchaser may require. Each Mandatory Spares shall be clearly marked or labeled on the outside of the packing with its description and information as above When more than one spare parts are packed in a single case a general description of contain shall be shown on the outside of such case and detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

1.18 Sub-Article 4.9.2 will be renumbered as 4.9.2 A.

1.19 Following Sub-Article shall be added as 4.9.2 B :

4.9.2 B The Supplier shall use reasonable means to prevent at all times any damage or loss whatsoever to the Mandatory Spares . All the major Items of the Mandatory Spares shall be labeled with permanently affixed nameplates that will include the manufacturer's name, Item model number and serial number. Such identification system shall correspond to the information contained in warranties maintenance requirements and records, as well all related certificates, Drawings and documentation relating to the given Mandatory Spares that the Supplier delivers to Purchaser with the Mandatory Spares.

1.20 Sub-Articles 4.14.1 & 4.14.2 will be renumbered as 4.14.1 A & 4.14.2 A.

1.21 Following Sub-Article shall be added as 4.14.1 B & 4.14.2 B

4.14.1 B : The Spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items must be packed in sealed transparent plastic with desiccator packs as necessary. The

Supplier shall also recommend the storage conditions for he Spares and delivered by the Supplier in new and unused condition.

All the Mandatory Spares shall be manufactured along with the Plant Equipment components as a continuous operation as per same specification and quality plan

4.14.2 B The Mandatory Spares shall be capable of being inter-changed with the parts for which they are intended to be a replacement.

1.22 Sub-Article 4.15.1 shall be renumbered as 4.15.1 A.

1.23 Following Sub-Article shall be added as 4.15.1 B :

4.15.1 B The Supplier shall guarantee the long-term availability of all the Mandatory Spares to the Purchaser through out the life of the Power Plant . The Supplier shall also ensure that before going out of production of the Mandatory Spares of the Plant and Equipment covered under the Contract, the Supplier shall give the Purchaser at least 24 (Twenty Four months advance notice, in writing, so that the Purchaser has sufficient time to order for the Spares in bulk, if the Purchaser so desires. The same provision shall also be applicable to all the Sub-Suppliers. Further in case of discontinuance of manufacture of any spares by the Supplier and /or his sub-suppliers, Supplier will provide the Purchaser, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equipment makes required by the Purchaser for the purpose of manufacturing/procurement of such items.

1.24 Sub-Article 4.18 shall be renumbered as 4.18 A.

1.25 Following Sub-Article shall be added as 4.18 B :

4.18 B <u>Program of Supply Mandatory O&M Spares</u>

The Supplier shall so organize its resources and perform its obligations as to meet the Delivery Schedule for Mandatory Spares

1.26 Article 4.19.1 will be renumbered as 4.19.1 A.

1.27 The following Sub-Article shall be added as 14.9.1.B:

4.19.1.B - <u>The Delivery Schedule for Mandatory Spares</u>

The complete design, engineering, approval of drawings, procurement, manufacture, testing, dispatch, seaworthy packing for the shipment of Mandatory Spares covered under the Contract are to be programmed (hereinafter "Delivery Schedule") in such a way that the deliveries meet Guaranteed Completion Date as specified below :

For all Mandatory Spares, the delivery at site shall start from the 48th month from Zero Date or the date of successful completion of PG test of first unit which ever is later and will be completed latest by 15 days prior to PG test of 6th Unit. The Mandatory Spares shall be dispatched based on their readiness for dispatch meeting the above Schedule. However, Supplier shall put his best efforts to advance such Mandatory Spares which are requested by the Purchaser from time to time.

"Zero Date" for the supply of Mandatory Spares shall mean Zero Date of the offshore supply contract.

1.28 Sub-Article 4.19.9 shall be renumbered as 4.19.9 A.

1.29 Following Sub-Article shall be added as 4.19.9 B:

4.19.9 B **Delivery Schedule Mandatory O&M Spares**

Supplier shall arrange supply of the Mandatory Spares sequentially as per agreed Delivery Schedule.

1.30 Sub-Article 4.19.10 shall be renumbered as 4.19.10 A :

1.31 Following Sub-Article shall be added as 4.19.10 B :

4.19.10 B Manufacturing Programme Mandatory O&M Spares

The Supplier shall make available to the Purchaser a detailed Manufacturing Programme for the Mandatory Spares in line with the delivery Schedule within 60 (sixty) Days from the date of this addendum.

1.32 Deleted

1.33 Article 10.1 will be renumbered as 10.1.A.

1.34 The following Sub-Article shall be added as 10.1.B :

10.1.B: Contract Price for Mandatory Spares: In consideration of the Supplier supplying the Supplies, the Purchaser hereby covenants to pay to the Supplier the Contract Price amounting to USD 77449361 (Say US Dollars seventy seven million four hundred and forty nine thousand three hundred and sixty one only) at the time and in the manner set forth in the Contract Subject to such deductions/adjustments as may be allowable in the Contract. The Contract Price shall mean the price for the Supplies supplied on CFR (INCOTERMS 2000) basis. Insurance will be arranged by or on behalf of Purchaser.

1.35 Article 12.2 will be renumbered as 12.2.A

1.36 The following Sub-Article shall be added as 12.2.B:

12.2 B. <u>Advance Payment for Mandatory Spares :</u>

12.2.1. 9% Advance against Advance Bank Guarantee (ABG) of equivalent amount at the end of 1 month of release of Mandatory Spares LoA

12.2.2 6% Advance against ABG of equivalent amount at the end of 12th month from the Zero Date.

Purchaser shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of Purchaser.

The Advance payment will be paid by telegraphic transfer within 7 Business days from receipt of swift message and a scanned image of the ABG to the bankers of Supplier to be notified by Purchaser, confirming that the ABG has been issued on behalf of Supplier.

1.37 Article 12.3 will be renumbered as 12.3.A

1.38 The following Sub-Articles shall be added as 12.3.B:

12.3.B Balance Payment for Mandatory Spares

12.3.B.1. Balance Payment shall be governed by the following Articles:

1. 72.5% against dispatch proof from China sea/air port with complete and clear documentation as below

(a) Signed commercial invoices in two original and three copies), invoice format need to be mutually discussed & approved by Purchaser. Signed Commercial invoice shall among other things contain the following:

- Goods are as per 'addendum to Off shore Supply Contract' dated 2nd September, 2009.
- Total value of the invoices shall be in USD----------
- Name and complete postal address of the Consignor;
- Name and complete postal address of the Consignee;
- Name and complete postal address of the place where the equipment is proposed to be physically delivered;
- Mode of conveyance – sea / air / land;
- Mode of payment giving details of the beneficiary bank;
- Invoice number and date;

- Reference of the contract / purchase order. Pursuant to which the equipment is being invoiced;
- Port of origin;
- Port of destination;
- No. of Packages and Package Reference number(s);
- Consignee code (by Purchaser);
- Gross & net weight of the package / equipment;
- Dimensions of each package (in Packing List);
- Country & place of manufacture;
- Bill of Lading / Airway Bill number and date- as detailed at Point (h);
- Description of the equipment along with quantity/unit price/value (in numbers and words);
- Terms of payment - % of the Contract Price to be payable as per the contract;
- Reference to the foreign trade policy under which the goods are being imported (Purchaser);
- Reference to the insurance policy number covering the transit risks.

(b) Catalogue/ Literature/ Write-up of cargo - 1 Original (if required by Customs);

(c) Phytosanitary certificate / Fumigation certificate is required if consignment is packed in wooden boxes/ pallets i.e. packing material is Wood. (2 Copies);

(d) Inspection Certificate / Inspection Waiver Note issued by Owner as per QAP;

(e) IBR approved third party certificate for pressure parts as per approved QAP;

(f) Master Packing List. Packing list in 3 (three) copies identifying Master packing list will have only the main Equipment name, weight. volume;

(g) Detailed packing list. in 3 (three) copies identifying Detailed packing list will have each component listed with its dimensions, quantity, volume, type of packing, etc.

(h) 'Bills of lading' / 'Airway Bill' showing that the goods have been shipped clean On-Board, carrying vessel consigned to Owner as marked "freight prepaid" (destination port, India) notifying the applicant,

(i) Certificate of Country of Origin in duplicate, issued by Chamber of Commerce or any independent recognized Agency;

(j) Certificate from shipping Company / Carrier / agent of the shipping company / agent of the carrier certifying that the shipment has been made by a Seaworthy Vessel registered with an approved classification society as per the institute classification clause and class maintained equivalent to Lloyd's 100 A1 and mentioning the age of the vessel not beyond 25 years;

(k) Sailing Confirmation Letter from agent of shipping company.

(l) Shipment details must be conveyed within seven days of the shipment to the applicant by fax/telex/email and copy of such fax/telex/email to accompany documents.

(m) Further, a common reference No. shall appear on Invoice & other documents for cross reference

(n) Marine Insurance Policy shall be arranged on behalf of Purchaser before the shipments and a copy of the Insurance Policy shall be faxed to Supplier.

2. 12.5% shall be paid against delivery to site and joint inspection at site and Submission of Performance Bank Guarantee (PBG) for 10% of the value of Mandatory Spares valid till 12 months of mandatory spares receipt at site and against documentation listed below.

a) Reference Number of Invoice and its attachments provided they have been cleared / approved by Purchaser Engineers;

b) Evidence of Customs Clearance;

c) Original LR copy for inland transportation (Purchaser provided waybill to Supplier);

d) Reference to the insurance policy number covering the transit risks;

e) Project site entry Gate Pass;

f) Manufacturer's Test report & Test certificates as per approved QAP;

g) Signed jointly (Representatives of Purchaser & Supplier at the site) Inward Goods Inspection report as proof of complete and safe receipt of goods at site.

12.3.B.2. Purchaser shall release payments under the Contract by telegraphic transfer/any other electronic mode within 21 days from the date of receipt of complete & correct documents for the Mandatory Spares Supplies, the charges for such remittances to be borne by Purchaser in India and that applicable in China to be borne by the Supplier. Further the Charges of respective correspondent banks/intermediary bank in USA shall be borne by each party.

12.3.B.3. Marine Insurance Policy shall be arranged on behalf of Purchaser before the shipments and a copy of the Insurance Policy shall be faxed to Supplier.

1.39 Deleted

1.40 Article 18 will be renumbered as 18.A.

1.41 The following Sub-Article shall be added as 18.B :

18.B Warranty for Mandatory Spares:

The Supplier warrants that the Mandatory Spares supplied shall be new and in accordance with the Contract Documents and be free from defect in design, material and workmanship for a period of 12 months from the date of replacement of the Mandatory Spares or 24 months from the date of respective Mandatory Spares supply to Site which ever is earlier:

a) New Mandatory Spares. The Supplier warrants (the "New Mandatory Sparest Warranty") that all Mandatory Spares provided in connection with the Supplies shall be new, shall conform to all Requirements of corresponding equipment for which the spares are meant for.

(b) Materials and Workmanship. The Supplier warrants (the "Materials and Workmanship Warranty") that the Supplies shall be performed in accordance with all Requirements, and (i) the Supplies shall be free from defects in manufacturing, workmanship, and materials; and (ii) the remainder of the Mandatory Spares shall be free from defects in systems engineering, manufacturing, workmanship, and materials. For purposes of this Article 18.1(b) an item shall be considered defective if it (i) does not fit into the equipment for which it is meant for or the Requirements, including those under this The Contract relating to performance, or (ii) is not suitable for its intended use under the climatic and range of operating conditions as specified.

This warranty will cover Mandatory Spares only for claims for such defects made during the Warranty Period.

1.42 The following Sub-Article shall be added as 18.2 (g) :

18.2.(g): In respect of Mandatory Spares, in addition to the obligations stipulated in Sub-clauses 18.2 (a) to (f):

(g) If any of the Warranties is breached during the Warranty Period, the Supplier shall be liable to correct the defect or replace the defective spares within a mutually agreed reasonable time, free of all costs and with fresh Warranties. The Supplier acknowledges that failure to do so will cause significant financial loss to the Purchaser and therefore, if the Supplier unreasonably delays in diligently commencing, continuing or completing the said remedy, then the Purchaser may complete the said remedial action, and hold the Supplier liable for all reasonable and necessary costs, charges, and expenses incurred in connection with such remedial action the Supplier shall use its reasonable efforts to obtain for the benefit of the Purchaser, long-term warranties similar to the Warranties from the Sub-supplier(s), if any, without additional compensation therefor.

1.43 The following Sub-Article shall be added as 23.1.9

23.1.9 Delay Liquidated Damages for Mandatory Spares:

In the event of a delay in completion of Scope of Supplies under Contract beyond the time stipulated therein, SEPCO shall pay as liquidated damages and not as a penalty, a sum equal to 0.5 % (Zero point five percent) of the undelivered value of mandatory spares per week to a maximum of 10% of undelivered value , excluding taxes and duties, of the mandatory spares.

1.44 The following Sub-Article shall be added as 24.4

24.4 : Rejection Of Mandatory Spares Supplies:

The QAPs for mandatory spares shall be in line with the QAPs agreed for other relevant supplies for the project. In case any spares QAPs are not covered under relevant project supplies then QAPs will be submitted by SEPCO for approval and mutually discussed and agreed. The Purchaser shall be entitled to reject any of the Mandatory Spares Supplies which do not meet the Specifications and quality requirements and such spares will have to

be replaced at Site, within reasonable time, at no extra cost basis to the Purchaser.

1.45 The following Sub-Articles shall apply also for the supply of Mandatory Spares. 2.3.2, 3.4, 4.2, 4.8.4,4.8.5,4.8.6, 4.8.7, 4.8.8, 4.8.9, 4.8.10, 4.9.1, 4.10.1, 4.12.1, 4.12.2, 4.12.3, 4.12.4, 4.12.5, 4.12.6, 4.12.7, 4.12.8, 4.12.9, 4.13, 4.14.3, 4.15.2, 4.15.4, 4.19.11, 4.19.13, 4.21, 4.23, 4.23.1, 4.23.2, 4.23.3, 4.26, 8.1, 8.3, 8.4, 8.6, 8.7, 8.8, 9, 16, 18.2, 18.3,18.5,18.7, 19.

1.46 The words 'Spares' as appearing in Sub-Articles 4.15.2 & 4.15.3 shall be equally applicable to 'Mandatory Spares' also.

2. Miscellaneous

2.1 Save and to the extent amended by Article 1 of this Addendum Agreement, all other terms of the Project Contract shall remain the same and continue to be in full force and effect in accordance with its terms

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS ADDENDUM AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For WARDHA POWER COMPANY LIMITED

Mr. S.Kishore, Director
duly authorized representative for and On behalf of WARDHA POWER COMPANY LIMITED

Witness

Mr. Pranav Komerwar

For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Mr. SunLianming , CEO
duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

Mr. Xue Li

DATED THE 19th DAY OF JANUARY 2010

SECOND AMENDMENT TO THE OFFSHORE SUPPLY CONTRACT

AMONG

WARDHA POWER COMPANY LIMITED

AND

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO)

आंध्रप्रदेश आन्ध्र प्रदेश ANDHRA PRADESH

AE 084255

Sl. No. 2060 Date: 19/01/10 Rs: 100/-
Sold To J. Krishna S/o J. Ramaiah R/o Hyd,
For Whom WARDHA POWER COMPANY LIMITED, Hyd,

K. RAMADEVI,
Stamp Vendor, Ph No:040-23233509
Licence No:203, Lic. No:03/2010.
H. No:8-1-[illegible], Near Hly Gate,
Khairatabad, Hyderabad-Urb 004.

This SECOND **AMENDMENT AGREEMENT** (**"Amendment Agreement"**) is made as of this 19th day of January, 2010 by and amongst:

1. **Wardha Power Company Limited (formerly Wardha Power company private limited)** , a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as **"WPCPL" or "Purchaser"**, which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors in title and permitted assigns);

   And

2. **SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO),** a company duly incorporated and existing under and by virtue of the laws of China and having its registered office at No.150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as "SEPCO" or "Supplier", which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

WHEREAS:

(A) The Parties have executed Offshore Supply contract ("**OSC**") on April 1, 2009 and first amendment to Offshore Supply Contract on May 16,2009, for recording their mutual agreement and understanding in relation to the terms and conditions under which the Supplier will make the Supplies and the Purchaser purchasing the same

(B) Pursuant to SEPCO's representation to WPCPL that design criteria for certain systems and associated scope of works discussions have been undertaken between the parties Pursuant to such discussions in this regard, the Parties have agreed that while the basic contract would remain, as it is, in toto, as executed on April 1, 2009, two modifications with respect to contract price and associated reflection in the associated ABG submission could be, as set out in these presents.

(C) Accordingly, in order to reflect this understanding between the Parties, the following two amendments to the OSC are necessary to be carried out and would substitute Article 1 of the first amendment in entirety

(D) In pursuance of the above, the Parties have agreed to amend the OSC as more particularly set out hereunder.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Amendments

The Parties hereby agree that the following amendments to the OSC shall be effective immediately on and from the date of execution of this Amendment Agreement. The first amendment shall be substituted with this Amendment Agreement ("Second Amendment"):

1.1 Increase in contract price mentioned in the OSC signed on April 1,2009 to the extent of USD 20,000,000 (Twenty Million only) . Hence, the existing clause 10.1 are hereby deleted and substituted with the following:

10.1 In consideration of the Supplier supplying the Supplies, the Purchaser hereby covenants to pay to the Supplier the Contract Price amounting to USD 1,851,644,000(Say US Dollars one billion eight hundred and fifty-one million six hundred and forty-four thousand only)at the time and in the manner set forth in the Contract subject to such deductions/adjustments as may be allowable in the Contract. The Contract Price shall mean the price for the Supplies supplied on CFR (INCOTERMS 2000) basis. Insurance will be arranged by or on behalf of Purchaser.

1.2 the existing clause 11.5.5 is hereby deleted and substituted with the following :

11.5.5 The ABGs shall be furnished within 30 days from the Zero Date for USD146,531,520, additional USD 73,865,760 after sixth month from the Zero Date and USD 72,349,320 at the end of eleventh month from the Zero Date.

The ABGs shall be valid upto the completion of Reliability Run Test of the last Unit. The amount of the Guarantee shall be progressively reduced on quarterly basis in proportion to the value of progress payments received.

1.3 the existing clauses 12.2.2 and 12.2.3 are hereby deleted and substituted with the following :

12.2.2 8% (Eight percent) advance on the Contract Price for supply of Items forming the Plant and Equipment, reduced by 1,600,000 USD and 4.95 Million USD Advance paid pursuant to Article 12.2.1, will be paid by telegraphic transfer within 7 Business days from receipt of swift message and a scanned image of the ABG to the bankers of Supplier to be notified by Purchaser, confirming that the ABG has been issued on behalf of Supplier. Purchaser shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of Purchaser. In case of delay of payment of advance beyond 7 Business days from receipt of swift message and a scanned image of the ABG, Guaranteed Completion Date will be extended by corresponding period of such delay.

12.2.3 USD 73,865,760 Advance shall be paid after submission of Advance BG of equal amount on the sixth month from Zero Date.

12.2.4 USD 72,349,320 Advance shall be paid after submission of ABG of equal amount on the eleventh month from Zero Date.

1.4 the existing clauses 12.3.1 (c) is hereby deleted and substituted with the following :

4.2% of the Contract Price against first synchronization (prorated for each Unit);

2. Miscellaneous

2.1 Save and to the extent amended by Clause 1 of this Amendment Agreement, the OSC shall continue to remain in full force and effect in accordance with its terms.

2.2 The Parties agree that all of the provisions of the OSC shall apply *mutatis mutandis* to this Amendment Agreement, as if set out specifically herein and incorporated into this Amendment Agreement:

[*Rest of the page has been intentionally left blank*]

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS AMENDMENT AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For WARDHA POWER COMPANY LIMITED	For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION
S.Kishore, Director duly authorized representative for and On behalf of WARDHA POWER COMPANY LIMITED	Mr. Wang Chengcai, Deputy project Manager and duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

C Srinivas

C SRINIVAS
S/o Late Sri C. Bapi Raju,
8-2-293/82/A/431/A,
Road No. 22,
Jubilee Hills,
Hyderabad-500033

Witness

DATED THE 30th DAY OF DECEMBER 2011

THIRD AMENDMENT TO THE OFFSHORE SUPPLY CONTRACT

Between

KSK MAHANADI POWER COMPANY LIMITED

And

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

ఆంధ్రప్రదేశ్ आन्ध्र प्रदेश ANDHRA PRADESH

AS 476999

V. SRIKANTH
LICENCED STAMP VENDOR
LIC. No. 15-10-018/2000, REN. No. 15-10-009/2009
PLOT No. 49, SURVEY No. 10,
BESIDE SWATHI SCHOOL, MADHAPUR,
SERILINGAMPALLY, R.R. DIST.
PHONE No: 9493014949

Sl.No. 35539 Date: 01-12-2011
SOLD TO: B. Praveen S/o Late. B. Ashok R/o Hyd
FOR WHOM: M/s K S K Mahanadi Power Company Limited. Hyd.

This THIRD **AMENDMENT AGREEMENT** (**"Amendment Agreement"**) is made as of this 30th day of December, 2011 by and amongst:

1. **KSK MAHANADI POWER COMPANY LIMITED,** a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as "KMPCL" or "Purchaser", which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors-in-business and permitted assigns);

And

2. **SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO),** a company duly incorporated and existing under and by virtue of

the laws of China and having its registered office at No.150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as "SEPCO" or "Supplier", which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

WHEREAS:

(A) SEPCO executed an Offshore Supply Contract bearing no. SEPCO/China/SK/1160201/252 on April 1, 2009 with WARDHA POWER COMPANY PRIVATE LIMITED ("WPCPL" subsequently referred as WARDHA POWER COMPANY LIMITED "WPCL") (hereinafter referred as "OSC") , first amendment to Offshore Supply Contract on May 16, 2009 ("First Amendment") and second amendment to Offshore Supply Contract on January 19,2010 ("Second Amendment"), for recording their mutual agreement and understanding in relation to the terms and conditions under which the Supplier will make the Supplies and the Purchaser purchasing the same.

(B) Subsequent to the date of execution of the OSC and pursuant to the Scheme of Arrangement of Demerger approved by the Hon'ble High Court of Andhra Pradesh, India the Project referred to in the OSC was demerged from WPCL to KMPCL. Accordingly, the OSC together with all rights, obligations, liabilities, benefits and privileges thereunder of WPCL stood transferred to and vested in KMPCL.

(C) This transfer and vesting of rights under the OSC to KMPCL was acknowledged by WPCL, KMPCL and SEPCO vide a Tripartite Amendment to Off-shore Supply Contract dated May 14, 2010.

(D) Pursuant to discussions between the parties on the scope of works the parties have agreed that the basic terms of the contract would remain, however, the first two units of 600 MW each require expedited and timely commissioning and also procurement of certain additional items that were not originally envisaged in the Billing Breakup submitted to KMPCL.

(E) SEPCO has represented that it has taken necessary steps in the direction and has for this purpose enabled its sub vendors to focus on sourcing as well as expediting to deliver the equipment. In this regard, certain modifications to the contract are required to be carried out as under.

(F) In pursuance of the above, the Parties have agreed to amend the OSC as more particularly set out hereunder.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Amendments

The Parties hereby agree that the following amendments to the OSC shall be effective immediately on and from the date of execution of this Amendment Agreement. The First Amendment and Second Amendment shall be substituted with this Amendment Agreement:

1.1 Increase in contract price mentioned in the Second Amendment to Offshore Supply Contract on January 19, 2010 to the extent of USD 50,000,000 (Say US Dollars Fifty Million only). Hence, the existing clause 10.1 are hereby deleted and substituted with the following:

10.1 In consideration of the Supplier supplying the Supplies for all the six units but expedited supplies for the first two units, the Purchaser hereby covenants to pay to the Supplier the Contract Price amounting to USD 1,901,644,000 (Say US Dollars One thousand Nine hundred and one million six hundred and forty four thousand only) at the time and in the manner set forth in the Contract subject to such deductions/adjustments as may be allowable in the Contract. The Contract Price shall mean the price for the Supplies supplied on CFR (INCOTERMS 2000) basis. Insurance will be arranged by or on behalf of Purchaser.

1.2 the existing clause 11.5.5 is hereby deleted and substituted with the following :

11.5.5 The ABGs shall be furnished within 30 days from the Zero Date for USD146,531,520, additional USD 73,865,760 after sixth month from the Zero Date and USD 72,349,320 at the end of eleventh month from the Zero Date.

The ABGs shall be valid upto the completion of Reliability Run Test of the last Unit. The amount of the Guarantee shall be progressively reduced on quarterly basis in proportion to the value of progress payments received.

1.3 the existing clauses 12.2.2,12.2.3 and 12.2.4 are hereby deleted and substituted with the following :

12.2.2 USD 141,581,520 shall be paid by telegraphic transfer within 7 Business days from receipt of swift message and a scanned image of the ABG to the bankers of Supplier to be notified by Purchaser, confirming that the ABG has been issued on behalf of Supplier. Purchaser shall arrange for the confirmation of the ABG, if required, for which the necessary charges shall be to the account of Purchaser. In case of delay of payment of advance beyond 7 Business days from receipt of swift message and a scanned image of the ABG, Guaranteed Completion Date shall be extended by corresponding period of such delay.

12.2.3 USD 73,865,760 Advance shall be paid after submission of Advance BG of equal amount on the sixth month from Zero Date.

12.2.4 USD 72,349,320 Advance shall be paid after submission of ABG of equal amount on the eleventh month from Zero Date.

1.4 Without prejudice to any other terms, the terms of a, b, c, d, e in existing clauses 12.3.1 are hereby deleted and substituted with the following:

12.3.1.1 With respect to the first two units of supplies:

a) Total amount aggregating to USD 532,440,696 (67.21% of the contract price of US$ 792,216,455 with respect to the first two units) against dispatch of Offshore Supplies FOB Chinese/Third country port on pro-rata basis as per shipping schedule, duly supported by evidence of shipment. Such amount shall be paid in the following manner:

i) Applicable Payments shall be paid against invoices raised by the Supplier until 30 December, 2011 with respect to first two units of supplies and already processed.

ii) Amount USD 26,380,000 shall be paid against invoices with respect to supplies and invoices by the Supplier until 30 December, 2011 with respect to first two units of supplies.

iii) Balance amount USD 23,620,000 shall be paid against supplies or prorata invoices of equivalent amount raised after 30 December, 2011 with respect to first two units of supplies.

b) USD 28,359,756 against receipt of Offshore Supplies at site on pro-rata basis as per shipping schedule.

c) USD 32,320,400 against first synchronization (prorated for each Unit).

d) USD 38,569,334 against successful completion of Reliability Run Test (prorated for each Unit) and on submission of Performance Bank Guarantee (PBG) by Supplier (prorated for each Unit).

e) USD 38,569,334 against successful completion of PG Test (prorated for each Unit)

12.3.1.2 With respect to the last four units of supplies:

a) USD 721,128,104 (65% of the contract price of US$ 1,109,427,545 with respect to the last four units) against dispatch of Offshore Supplies FOB Chinese/Third country port on pro-rata basis as per shipping schedule, duly supported by evidence of shipment.

b) USD 64,222,444 against receipt of Offshore Supplies at site on pro-rata basis as per shipping schedule.

c) USD 45,261,800 against first synchronization (prorated for each Unit).

d) USD 54,012,866 against successful completion of Reliability Run Test (prorated for each Unit) and on submission of Performance Bank Guarantee (PBG) by Supplier (prorated for each Unit).

e) USD 54,012,866 against successful completion of PG Test(prorated for each Unit).

2. Miscellaneous

2.1 Save and to the extent amended by Clause 1 of this Amendment Agreement, as amended by the Tripartite Amendment Agreement, the OSC shall continue to remain in full force and effect in accordance with its terms.

2.2 The Parties agree that all of the provisions of the OSC, as amended by the Tripartite Amendment Agreement, shall apply *mutatis mutandis* to this Amendment Agreement, as if set out specifically herein and incorporated into this Amendment Agreement.

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS AMENDMENT AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For KSK MAHANADI POWER COMPANY LIMITED	For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION
Mr.S.Kishore, Director duly authorized representative for and On behalf of KSK MAHANADI POWER COMPANY LIMITED	Mr. Wang Lingfang, President duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

(P. SRINIVASA RAO)

Witness

Duqiwei

INDIA NON JUDICIAL

Government of National Capital Territory of Delhi

e-Stamp

सत्यमेव जयते

Certificate No.	:	IN-DL321154196272950
Certificate Issued Date	:	30-Mar-2016 12:40 PM
Account Reference	:	IMPACC (IV)/ dl815803/ DELHI/ DL-DLH
Unique Doc. Reference	:	SUBIN-DLDL815803630831544915980
Purchased by	:	KSK MAHANADI POWER COMPANY LIMITED
Description of Document	:	Article 5 General Agreement
Property Description	:	Not Applicable
Consideration Price (Rs.)	:	0 (Zero)
First Party	:	KSK MAHANADI POWER COMPANY LIMITED
Second Party	:	Not Applicable
Stamp Duty Paid By	:	KSK MAHANADI POWER COMPANY LIMITED
Stamp Duty Amount(Rs.)	:	100 (One Hundred only)

Please write or type below this line

This stamp paper forms an integral part of clarification - Agreement

For KSK Mahanadi Power Company Limited

Authorised Signatory

Statutory Alert:

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DATED THE 31st DAY OF MARCH 2016

AGREEMENT

Between

KSK MAHANADI POWER COMPANY LIMITED

and

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

This Agreement is made as of this 31st day of March 2016 by and amongst:

1. KSK MAHANADI POWER COMPANY LIMITED, a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as "KMPCL" or "Purchaser", which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors-in-business and permitted assigns);

and

2. SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO), a company duly incorporated and existing under and by virtue of the laws of China and having its registered office at No.10567, Jingshi Road, Jinan, Shandong Province, China (hereinafter referred to as "SEPCO" or "Supplier", which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

WHEREAS:

Both SEPCO & KMPCL (Parties) agree upon the following clarifications, to the contracts & their amendments in vogue.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. Contract price and payment

1.1 Payment schedule for Off-shore supply (attached as Annexure-1) includes the following:

- Payment schedule for Unit 3 &4
- Payment schedule for escalation amount of 45MUSD
- Payment schedule for deferred payments
- Payment schedule for Unit 2&5.
- Payment schedule for Unit 1 & 6

1.2 On shore contracts

a) The contract price for on shore contract also now stands revised upwards Extent of increase shall be known after discussions/negotiations by both Parties together with Indian sub-vendors/subcontractors/sub-suppliers/service-providers. However the escalation on contract price of onshore contract shall be shared in following proportion.

- Upto Rs. 60 Cr. – 50% KMPCL and 50% SEPCO
- Any additional amount over and above Rs. 60 Cr. – 40% KMPCL and 60% SEPCO

b) On account of the above an amount of Rs 50 Cr is already included in Construction contract and the same shall be adjusted in KMPCL's portion after negotiation with Indian sub-vendors/subcontractors/sub-suppliers/service-providers.

1.3 ABG deduction

The balance ABGs (which are beyond those indicated in the Contracts/Amendments signed till date) shall be released by the Purchaser to the Supplier by three times i.e. one third of balance amount in April 2016, one third in May 2016, and one third in June 2016.

1.4 Interest Payment

1.4.1 Interest for "deferred payment"

Both parties agreed the interest against deferment plan for the period from January 2016 to the payment date as per annexure-1 shall be paid by KMPCL at 5% per annum. SEPCO is entitled to demand for the full amount of deferment to be repaid if any default by KMPCL for payment from Jan. 2017 against the payment schedule Annexure-1. However the first USD 25 Million of deferment will be released before Apr, 20th, 2016.

1.4.2 Interest for other payment

Time period for interest amount calculation shall be reckoned based on qualifying payments as per attached Annexure 1 herewith and 1.2.1 above, difference between date of actual payment done and the due date as per payment schedule. Due date for payment is before 20th day of each month.

1.5 Foreign Exchange Variation (FEV)

The waiver of FEV against the deferred payment is based on the following conditions:

With regard to the deferred payment, if KMPCL cleared the deferred payment dues as per the payment schedule Annexure-1 herewith, SEPCO agreed to waive off only Foreign Exchange Variation losses against the deferred amount. If any default by KMPCL against making the deferred payment as per Annexure-1 herewith, the FEV clause in the original contract shall be applicable.

1.6 Contract schedule/Project Completion schedule:

a) The "First Commissioning " means "First Synchronization";
b) Both parties agreed that RRT within 3 months from First Synchronization because equipment and materials of Unit 2&5 lying idle for long which requires long period for commissioning and testing
c) The First Commissioning is subject to:

- SEPCO and KMPCL shall take responsibility to divert one of the generators under manufacturing at DFEM works to ensure generator for unit 2 to dispatch from the manufacturer works by 30th May, 2016 and reach site by 31st August, 2016.
- SEPCO and KMPCL shall take responsibility to ensure Coal Mills for unit 2 to dispatch from the manufacturer works by 30th June, 2016 and reach site by 30th September, 2016 and completion of erection by 15th November, 2016.
- SEPCO and KMPCL shall work together arrange sufficient numbers of visa for Chinese workers to meet site requirements.
- KMPCL and SEPCO should make their respective documents for custom clearance ready to ensure to deliver equipment and materials to site on time.

1.7 Liquidated Damages

Actual values of LDs shall be calculated as per contractual provisions at the time of application of the same.

However, a grace period agreed in Agreement dated 31st March 2016 shall be allowed for the applicability of Liquidated Damages due to delay in respective unit.

1.8 Waive off

Both Parties agreed to waive off claims (unless specified otherwise in this agreement) from each side including but not limited to any KMPCL's claims except back charge claims, any offshore claims on and before September 2015 from both sides, LD (for delay) against unit #3 and #4. However back charge claims shall be settled by both site in charges of KMPCL and SEPCO by end of April, 2016 as per market price at that time.

1.9 The maximum liability

The maximum liability of SEPCO in aggregate under this Contract shall not exceed USD 1,906,504,000 plus INR 38,850,671,589 provided however, such limit shall not apply to Liquidated Damages and loss and damages arising in respect of any indemnity and infringement of intellectual property rights.

1.10 Unit #2 and #5 shall be in continuous construction. As regards Unit #1 &#6, the EPC schedule of the same shall be finalized and agreed by both parties according to the status of project equity/finance. This may result in change in payment schedule of Unit #1 and #6.

2. This agreement shall become effective and enforceable upon signing by both Parties.

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For KSK MAHANADI POWER COMPANY LIMITED	For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION
Mr. C-SRINIVAS. duly authorized representative for and On behalf of KSK MAHANADI POWER COMPANY LIMITED	Mr. duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

Witness

For KSK Mahanadi Power Company Limited

Authorised Signatory

Annexure -1

Payments schedule for U3&4 Balance payment, Escalation amount, Deferred payment, Unit 2&5, Unit 1&6 payment;

In MUSD

Month	U3&4 payment	Escalation amount (Compensation)	Deferred Payment	Total for U2&5	Total for U1&6	Monthly Total
16-Mar				85.741		85.741
16-Apr	19.283	3.932	25.000	85.741	16.751	150.707
16-May		1.568		31.535		33.103
16-Jun	19.283	1.568		31.535	9.391	61.777
16-Jul		1.568		16.364	9.391	27.323
16-Aug	19.283	1.568		16.364	13.782	50.997
16-Sep		1.568		16.364	9.906	27.838
16-Oct		1.780			9.782	11.562
16-Nov		1.780			18.448	20.228
16-Dec		1.780			10.000	11.780
17-Jan		1.535	15.000	11.315	22.397	50.247
17-Feb		1.535	15.000	13.503	28.609	58.647
17-Mar		0.535	10.000		28.827	39.362
17-Apr		1.503	10.000	24.819	32.609	68.931
17-May		1.503	9.000	13.503	32.609	56.615
17-Jun		1.223	13.040		30.609	44.872
17-Jul		3.181	13.000	13.503	30.609	60.293
17-Aug		1.223	10.220		16.827	28.270
17-Sep		2.213			17.910	20.123
17-Oct		2.213			11.315	13.528
17-Nov		1.223			13.503	14.726
17-Dec		1.223			11.960	13.183
18-Jan		1.223			30.503	31.726
18-Feb		1.223			11.315	12.538
18-Mar		0.688			13.503	14.191
18-Apr		1.476				1.476
18-May		2.545			13.503	16.048
18-Jun		1.623				1.623
Total	57.849	45.000	120.260	360.287	444.059	1027.455

For KSK Mahanadi Power Company Limited

Authorised Signatory

INDIA NON JUDICIAL

Government of National Capital Territory of Delhi

e-Stamp

सत्यमेव जयते

Certificate No.	:	IN-DL32121128451245O
Certificate Issued Date	:	30-Mar-2016 12:44 PM
Account Reference	:	IMPACC (IV)/ dl815803/ DELHI/ DL-DLH
Unique Doc. Reference	:	SUBIN-DLDL81580363077421617987O
Purchased by	:	KSK MAHANADI POWER COMPANY LIMITED
Description of Document	:	Article 5 General Agreement
Property Description	:	Not Applicable
Consideration Price (Rs.)	:	0 (Zero)
First Party	:	KSK MAHANADI POWER COMPANY LIMITED
Second Party	:	Not Applicable
Stamp Duty Paid By	:	KSK MAHANADI POWER COMPANY LIMITED
Stamp Duty Amount(Rs.)	:	100 (One Hundred only)

Please write or type below this line

This Stamp Paper forms an integral part of Grace Period agreement

For KSK Mahanadi Power Company Limited

Authorised Signatory

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DATED THE 31st DAY OF MARCH 2016

AGREEMENT

Between

KSK MAHANADI POWER COMPANY LIMITED

and

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

This Agreement is made as of this 31st day of March 2016 by and between :

1. KSK MAHANADI POWER COMPANY LIMITED, a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as "KMPCL" or "Purchaser", which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors-in-business and permitted assigns);

and

2. SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO), a company duly incorporated and existing under and by virtue of the laws of China and having its registered office at No.10567, Jingshi Road, Jinan, Shandong Province, China (hereinafter referred to as "SEPCO" or "Supplier", which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

Both Parties agree upon the following clarifications, to the contracts & their amendments in vogue.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER :

As regards 'First Commissioning dates' mentioned in Clause 1.4 'Fourth amendment of Offshore Supply Contract'; Clause 1.2 of 'First amendment of Offshore Services contract'; Clause 1.3 of 'Fifth amendment of Construction contract'; Clause 1.2 of 'Second amendment of Onshore Supply Contract'; Clause 1.2 of First amendment of Onshore Services contract', Purchaser agrees with the grace period beyond those dates, as mentioned below.

Unit	First Commissioning	Grace period
Third Unit (Unit # 2)	31st December 2016	8 months
Fourth Unit (Unit # 5)	30th April 2017	8 months
Fifth Unit (Unit # 1)	31st October 2017	10 months
Sixth Unit (Unit # 6)	31st December 2017	10 months

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For KSK MAHANADI POWER COMPANY LIMITED	For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION
Mr. C-SRINIVAS. duly authorized representative for and On behalf of KSK MAHANADI POWER COMPANY LIMITED	Mr. duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

Witness

For KSK Mahanadi Power Company Limited

Authorised Signatory

INDIA NON JUDICIAL

Government of National Capital Territory of Delhi

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Certificate No.	:	IN-DL321227949980740
Certificate Issued Date	:	30-Mar-2016 12:46 PM
Account Reference	:	IMPACC (IV)/ dl815803/ DELHI/ DL-DLH
Unique Doc. Reference	:	SUBIN-DLDL815803630726475173200
Purchased by	:	KSK MAHANADI POWER COMPANY LIMITED
Description of Document	:	Article 5 General Agreement
Property Description	:	Not Applicable
Consideration Price (Rs.)	:	0 (Zero)
First Party	:	KSK MAHANADI POWER COMPANY LIMITED
Second Party	:	Not Applicable
Stamp Duty Paid By	:	KSK MAHANADI POWER COMPANY LIMITED
Stamp Duty Amount(Rs.)	:	100 (One Hundred only)

Please write or type below this line

This Stamp Paper forms an integral Part of fourth Amendment to the offshore supply contract

For KSK Mahanadi Power Company Limited

Authorised Signatory

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DATED THE 30th DAY OF MARCH 2016

FOURTH AMENDMENT TO THE OFFSHORE SUPPLY CONTRACT

Between

KSK MAHANADI POWER COMPANY LIMITED

And

SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

This FOURTH **AMENDMENT AGREEMENT** (**"Amendment Agreement"**) is made as of this 30th day of March 2016 by and amongst:

1. **KSK MAHANADI POWER COMPANY LIMITED,** a company incorporated under the Indian Companies Act, 1956 having its registered office at 8-2-293/82/A/431/A, Road No. 22, Jubilee Hills, Hyderabad - 500 033 (hereinafter referred to as "KMPCL" or "Purchaser", which expression shall, unless repugnant to the context or meaning thereof, be deemed to include its successors-in-business and permitted assigns);

And

2. **SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION (SEPCO),** a company duly incorporated and existing under and by virtue of the laws of China and having its registered office at No.10567, Jingshi Road, Jinan, Shandong Province, China (hereinafter referred to as "SEPCO" or "Supplier", which expression shall unless repugnant to the context otherwise, include its successors and permitted assigns);

The Purchaser and the Supplier are referred to herein individually as a "Party" and collectively as the "Parties".

WHEREAS:

(A) SEPCO executed an Offshore Supply Contract bearing no. SEPCO/China/SK/1160201/252 on April 1, 2009 with WARDHA

POWER COMPANY PRIVATE LIMITED ("WPCPL" subsequently referred as WARDHA POWER COMPANY LIMITED "WPCL") (hereinafter referred as "OSC") , first amendment to Offshore Supply Contract on May 16, 2009 ("First Amendment") and second amendment to Offshore Supply Contract on January 19,2010 ("Second Amendment"), third amendment to Offshore Contract on December 30,2011 ("Third Amendment"), for recording their mutual agreement and understanding in relation to the terms and conditions under which the Supplier will make the Supplies and the Purchaser purchasing the same.

(B) Subsequent to the date of execution of the OSC and pursuant to the Scheme of Arrangement of Demerger approved by the Hon'ble High Court of Andhra Pradesh, India the Project referred to in the OSC was demerged from WPCL to KMPCL. Accordingly, the OSC together with all rights, obligations, liabilities, benefits and privileges thereunder of WPCL stood transferred to and vested in KMPCL.

(C) This transfer and vesting of rights under the OSC to KMPCL was acknowledged by WPCL, KMPCL and SEPCO vide a Tripartite Amendment to Off-shore Supply Contract dated May 14, 2010.

(D) Pursuant to discussions between the parties on the scope of works the parties have agreed that the basic terms of the contract would remain, however, necessary amendments are required to be carried out to reflect the new developments.

(E) SEPCO has represented that it has taken necessary steps in the direction and has for this purpose enabled its sub vendors to focus on expediting to deliver the equipment. In this regard, certain modifications to the contract are required to be carried out as under.

(F) In pursuance of the above, the Parties have agreed to further amend the Offshore Supply Contract (OSC) as more particularly set out hereunder.

IT IS HEREBY AGREED BY AND BETWEEN THE PARTIES AS UNDER:

1. The Parties hereby agree that the following amendments to the OSC shall be effective immediately on and from the date of execution of this Amendment Agreement , and the First Amendment, Second Amendment, Third Amendment shall be substituted with respect to

clause as modified under this Amendment Agreement ("**Fourth Amendment**") :

1.1 The existing clause 10.1 of OSC is hereby deleted and substituted with the following:

> 10.1 In consideration of the Supplier supplying the contracted Supplies and also for expedited supplies for the next two units, the Purchaser hereby covenants to pay to the Supplier the Contract Price amounting to USD 1946,644,000 (US Dollars One Billion Nine hundred Forty Six million Six Hundred and Forty Four Thousand only) at the time and in the manner set forth in the Contract subject to such terms in the Contract. The Contract Price shall mean the price for the Supplies supplied on CFR (INCOTERMS 2000) basis.

1.2 The existing clause 11.5.5 is hereby deleted and substituted with the following:

> 11.5.5 The Purchaser shall retain Supplier furnished ABGs for an aggregate value of USD 72,663,902. The balance ABGs shall be released by the Purchaser to the Supplier in mutually agreed time frame.
>
> The ABGs so furnished by the Supplier shall be valid upto the completion of Reliability Run Test of the fourth Unit. The amount of the Guarantee shall be progressively reduced on quarterly basis in proportion to the value of supplies made hereinafter and invoices submitted thereto pursuant to 12.3.1.2 below.

1.3 Without prejudice to any other terms, the terms of a) , b), c) ,d), e) in existing clauses 12.3.1 are hereby deleted and substituted with the following :

> 12.3.1.1 With respect to the first two units of supplies, of the Total amount aggregating to USD 792,216,456 with respect to the first two units, the balance unadjusted advance stands at 4,304,268 with equivalent ABG by the Supplier and the same shall stand discharged upon completion of the balance supplies of equivalent value under the OSC with respect to the first two units and return of the ABG so furnished
>
> 12.3.1.2 With respect to the next two units of supplies, the aggregate contract value of USD 683,596,343 shall be as follows:

a) USD 68,359,634 with equivalent ABGs furnished by the supplier shall be retained, such ABG shall be progressively reduced on quarterly basis in proportion to the value of supplies made hereinafter and progress payments received thereto

b) USD 541,881,931 of the contract price with respect to the next two units against the Offshore Supplies FOB Chinese/Third country port on pro-rata basis as per shipping schedule.

c) USD 21,659,747 against first synchronization (prorated for each Unit).

d) USD 25,847,515 against successful completion of Reliability Run Test (prorated for each Unit) and on submission of Performance Bank Guarantee (PBG) by Supplier (prorated for each Unit).

e) USD 25,847,515 against successful completion of PG Test (prorated for each Unit).

The Purchaser commits to release monthly payment before the 20th day of each month as per the cash flow statement annexed as Annexures 1 herewith regardless of the amount of invoices submitted in that same month. Quarterly reconciled statement of account with invoices shall be duly signed by both parties within 30 days of the closure of quarter.

Without prejudice to other contractual terms, if any delay in monthly payment occurs consecutively for two times, the project schedule in 1.4 below shall be extended accordingly with a provision for catch up of the payment by The Purchaser before signing of the quarterly reconciliation statement.

12.3.1.3 With respect to the last two units of supplies, the aggregate contract value of USD 470,831,203 shall be as follows:

a USD 410,049,882 of the contract price with respect to the next two units against the Offshore Supplies FOB Chinese/Third country port on pro-rata basis as per shipping schedule.

b) USD 17,947,134 against first synchronization (prorated for each Unit).

c) USD 21,417,093 against successful completion of Reliability Run Test (prorated for each Unit) and on submission of Performance Bank Guarantee (PBG) by Supplier (prorated for each Unit).

d) USD 21,417,093 against successful completion of PG Test (prorated for each Unit).

The Purchaser commits to release monthly payment before the 20th day of each month as per the cash flow statement annexed as Annexures 2 herewith regardless of the amount of invoices submitted in that same month. Quarterly reconciled statement of account with invoices shall be duly signed by both parties within 30 days of the closure of quarter.

Without prejudice to other contractual terms, if any delay in monthly payment occurs consecutively for two times, the project schedule in 1.4 below shall be extended accordingly with a provision for catch up of the payment by The Purchaser before signing of the quarterly reconciliation statement.

Time period for interest amount calculation shall be reckoned based on qualifying payments as per monthly cash flow given under Annexure.

1.4 The existing clause 4.19.2 of OSC is hereby deleted and substituted with the following revised dates:

Units	First Commissioning
Third Unit (Unit # 2)	31st December 2016
Fourth Unit (Unit # 5)	30th April 2017
Fifth Unit (Unit # 1)	31st October 2017
Sixth Unit (Unit # 6)	31st December 2017

As regards application of Liquidated Damages against delays beyond the respective RRT dates, the Purchaser agrees to consider a grace period for each of the RRT dates in favour of the supplier with respect to application of LD clause for delay, after due deliberation ("LD Application Dates"). The Purchaser can schedule and supply power after such First Commissioning.

To facilitate timely commissioning of the third Unit (Unit #2 of the EPC String) the supplier and the Purchaser shall put efforts to coordinate and facilitate early supplies of one of the Generators under manufacturing at Dong Fang Equipment Manufacturing (DFEM) so as to enable dispatch of the same from DFEM works by 15th April 2016 and to reach site by 31st August 2016.

Similarly, the supplier and the Purchaser shall put efforts to ensure coal mills for the third Unit (Unit #2 of the EPC String) are dispatched from manufacturing works by 30th June 2016 and reach site by 30th September 2016.

1.5 The existing clause 23.1.5 of OSC is hereby deleted and substituted with the following:

If the supplier fails to achieve RRT (according to the conditions of RRT of Contract only)of the Unit#2, #5, #1 and #6 within the RRT dates due to reasons attributable to the supplier, The Purchaser shall levy Liquidated Damages and not as a penalty, equivalent to 0.5% (Zero point five percent) of Total Unit Value (excluding taxes and duties) per week (7 days) of delay or part thereof of each Unit, from LD Application Dates, subject to the maximum 10% of Total Unit Value as agreed above (excluding taxes and duties) .

1.6 The Parties hereby agree and confirm that the quantum and timeline for furnishing Performance Bank Guarantee provided for at 11.5.7 of OSC shall stand amended to the following

- For EPC Unit #2 & #5 - USD 34,179,817 per unit before expiry of 18 days from the completion date of Reliability Run Test of respective unit valid up to warranty period completion of the respective unit

- For EPC Unit #1 & #6 - USD 23,541,560 per unit before expiry of 18 days from the completion date of Reliability Run Test of respective unit valid up to warranty period completion of the respective unit

2. Miscellaneous

Save and to the extent amended by this Amendment Agreement, the OSC shall continue to remain in full force and effect in accordance with its terms.

The Parties agree that all of the provisions of the OSC, as amended by the Amendment Agreement, shall apply *mutatis mutandis* to this Amendment Agreement, as if set out specifically herein and incorporated into this Amendment Agreement.

Except for the above stated amendments, the terms and conditions settled under the OSC dated 01.04.2009 shall continue to subsist and bind both the parties.

[Rest of the page has been intentionally left blank]

IN WITNESS HEREOF THE PARTIES HAVE EXECUTED THIS AMENDMENT AGREEMENT ON THE DAY AND YEAR FIRST HEREINABOVE WRITTEN

For KSK MAHANADI POWER COMPANY LIMITED	For SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION
Mr. C-SRINIVAS. Duly authorized representative for and On behalf of KSK MAHANADI POWER COMPANY LIMITED	Mr. Wu Chuanrui Duly authorized representative for and On behalf of SEPCO ELECTRIC POWER CONSTRUCTION CORPORATION

Witness

Witness

For KSK Mahanadi Power Company Limited

Authorised Signatory

Annexure -1

Month	Unit 2&5 Total, MUSD	Cumulative Total, MUSD
Mar-16	50	50
Apr-16	75	125
May-16	75	200
Jun-16	75	275
Jul-16	35	310
Aug-16	25	335
Sep-16	25	360
Oct-16	20	380
Nov-16	20	400
Dec-16	20	420
Jan-17	25	445
Feb-17	25	470
Mar-17	25	495
Apr-17	20	515
May-17	15	530
Jun-17	10	540
Jul-17	10	550
Aug-17	10	560
Sep-17	10	570
Oct-17	9	579

For KSK Mahanadi Power Company Limited

Authorised Signatory

Annexure -2

Month	Unit 1&6 Total, MUSD	Cumulative Total, MUSD
Jan-17	40	40
Feb-17	30	70
Mar-17	30	100
Apr-17	50	150
May-17	50	200
Jun-17	40	240
Jul-17	40	280
Aug-17	20	300
Sep-17	20	320
Oct-17	15	335
Nov-17	15	350
Dec-17	15	365
Jan-18	25	390
Feb-18	20	410
Mar-18	15	425
Apr-18	15	440

For KSK Mahanadi Power Company Limited

Authorised Signatory

SCHEDULE II

TECHNICAL SPECIFICATION

VOLUME # 1

Project	**6 x 600 MW THERMAL POWER PLANT PROJECT AT NARIYARA, CHATTISGARH, INDIA**	
Owner	KSK Power from knowledge	**Wardha Power Company Private Limited, India**
Owner's Consultants		**DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI**
E P C Contractor	SEPCO	**SEPCO Electric Power Construction Corporation, China**

1/4/09
(XUE LI)

CONTENTS OF VOLUME # 1

SECTION-I	INTENT OF SPECIFICATION
SECTION-II	QUALIFYING CONDITIONS - NOT USED
SECTION-III	PROJECT DESCRIPTION AND SPECIFICATION
SECTION-IV	SCOPE OF WORK & TERMINAL POINTS
SECTION-V	PERFORMANCE REQUIREMENT AND BID EVALUATION CRITERIA
SECTION-VI	DESIGN REQUIREMENT
SECTION-VII	REDUNDANCY REQUIREMENT
SECTION-VIII	OPERATION, CONTROL & PROTECTION FEATURES
SECTION-IX	PLOT PLAN LAYOUT REQUIREMENTS
SECTION-X	BUILDING/EQUIPMENT LAYOUT REQUIREMENTS
SECTION-XI	TESTING AND COMMISSIONING
SECTION-XX	ENVIRONMENTAL CONSIDERATIONS
SECTION-XXI	CHEMICAL LABORATORY EQUIPMENT

ATTACHMENTS

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ANNEXURE-II	FUEL OIL CHARACTERISTICS
ANNEXURE-III	DESIGN RAW WATER ANALYSIS
ANNEXURE-IV	CLIMATOLOGICAL TABLE
ANNEXURE-V	VASTU REQUIREMENTS
ANNEXURE-VI	RECOMMENDED VELOCITIES FOR SIZING OF PIPING
ANNEXURE-VII	RECOMMENDED INSULATION THICKNESS
ANNEXURE-VIII	WORKSHOP EQUIPMENTS LIST
ANNEXURE-IX	LABORATORY EQUIPMENTS LIST
ANNEXURE-X	LIST OF MANDATORY SPARES - NOT USED
ANNEXURE-XI	LIST OF DRAWINGS ATTACHED.
ANNEXURE-XII	SCHEMATIC DWG OF CW, DM-ETP SYSTEM

薛利 1/4/09
(XUG LI)

SCHEDULE-II

TECHNICAL SPECIFICATION FOR EPC CONTRACT

WARDHA POWER COMPANY PRIVATE LIMITED

6 X 600 MW COAL POWER PLANT AT NARIYARA, JANJGIR-CHAMPA

CHATTISGARH (INDIA)

30.03.2009
(KIRAN PANDA)
WPCPL

(XUE LI)
2009.03.30

TECHNICAL SPECIFICATION

CONTENTS

SECTION-I	INTENT OF SPECIFICATION
SECTION-II	QUALIFYING CONDITIONS - NOT USED
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SECTION-I

INTENT OF SPECIFICATION

1.0 This specification is intended to obtain, on the basis of an Engineering, Procurement and Construction (EPC) Contract, a complete 3600 MW (6 X 600 MW) Power Plant using Pulverized Coal as the main fuel to work as a base load station. The Power Plant will be installed near Village Nariyara in Janjgir-Champa District of Chhatisgarh State, India.

The plant shall be of high reliability and availability, minimum availability of the plant 90% through out its life time.

2.0 The Contractor shall be responsible for providing all equipment, material and services including design and construction of all civil, structural and architectural works specified or otherwise which are required for a complete plant meeting the intent of this specification, ensuring high degree of reliability, availability, operability and maintainability. The equipment, system/sub systems and components shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner and shall also be in line with the current practices for reliable and efficient functioning of plants of similar size and rating.

3.0 The scope of supply and services shall be as specified and in accordance with the requirement and conditions stated in this specification. Omission of specific reference to an item in the specification shall not relieve the EPC Contractor from the responsibility of providing all items of supply and services required to provide complete plant meeting the overall performance requirements stated in the specification.

4.0 Following volumes form a part of this specification, the same as if, these have been included herein:

Schedule-II Technical specification

Above Technical specification is prepared on the base of following documents:

1) Bid Specification for 3600 MW Coal based power project dated 27th March 2008 released via NIT in all major newspapers.

2) **Bid specification sent on 28th March 2008 to SEPCO**

3) Minutes of pre bid meeting dated 10.05.08 held at Novatel Hotel, Hyderabad.

4) **DCPL E-mail No. K712/NRM-1/V7/72 dated 18.06.08 on Amendment-1 to Technical specification.**

5) DCPL E-mail No. K712/NRM-1/V7/101 dated 27.06.08 on extension of Bid submission date to 30th July 2008.

6) DCPL E-mail No. K712/NRM-1/V7/128 dated 03.07.08 on Amendment-2 to Technical specification to the offer.

7) DCPL E-mail No. K712/NRM-1/V7/152 dated 17.07.08 regarding Change in design water analysis.

8) SEPCO offer for 6 x 600 MW Sub-critical coal based power project submitted on dated 21.07.08.

9) DCPL E-mail dated 29.07.08 on extension of Bid submission date to 30th August 2008.

10) DCPL E-mail No. K712/NRM-1/V7/192 dated 28.08.08 on extension of Bid submission date to 08th Sept 2008.

11) DCPL E-mail No. K712/NRM-1/V7/193 dated 30.08.08 on contract documents and Notes on taxes.

12) Comment/clarification issued vide DCPL-K7V12/NRM-1/V7/197 dated 09.09.08 Technical offer.

13) WPCPL E-mail No. SEPCO,CHINA/GPRA/1160201/359 dated 10.09.08 on Tendering process.

14) Minutes of meeting held between SEPCO, WPCPL and DCPL between 25.09.08 to 28.09.08 at DCPL, Vashi

15) DCPL E-mail No. K712/NRM-1/V7/211 dated 29.09.08 on amendment in contract documents.

16) DCPL E-mail No. K712/NRM-1/V7/216 dated 06.10.08 on degassed cation conductivity analyser.

17) DCPL E-mail No. K712/NRM-1/V7/223 dated 11.10.08 on Specification for CNC Lathe and Eutectic Metal Spray.

18) SEPCO E-mail dated 10.10.08 and 15.10.08 on clarification/reply to pending points of MOM dated 25-09-08 to 28-09-08.

19) SEPCO reply dated 17.10.08 to DCPL E-mail dated 16.10.08 on pending points of MOM dated 25-09-08 to 28-09-08.

20) WPCPL mail dated 26th December 2008 on Pending Points and on compliance with CEA guidelines "Standard Technical Specification for Main Plant Package of Sub-Critical

Thermal Power Project, 2 x (500 MW and above)".

21) SEPCO Clarification on Pending Points vide e-mail dated 31st December 2008

22) WPCPL mail on 3rd January 2009 to SEPCO including comments to 31st December 2008 SEPCO clarification.

23) WPCPL mail on 5th January 2009 to SEPCO containing WPCPL standard Quality plan for Turbine, Generator, Boiler, Electrical and auxiliaries.

24) MOM of meeting at SEPCO, Jinan office on 08th January 2009, complied documents sent on 10th January 2009 by WPCPL.

25) Two mails sent on 13th January 2009 by SEPCO on commercial clarification.

26) SEPCO sent a mail having a clarification on their experience on 13th January 2009

27) Minutes of Meeting held at SEPCO, Jinan office on 21st and 22nd January 2009.

28) SEPCO clarifications vide e-mail dated 4th February 2009.

29) Minutes of Meeting held at WPCPL, Hyderabad on 4th to 6th February 2009.

30) Quality Control Plans on BOPs forwarded to SEPCO by WPCPL

31) SEPCO reply to pending points of 6th February 2009 MOM on 11th February 2009

32) Comments on HMBDs forwarded to SEPCO vide WPCPL mail dated 12th February 2009 and clarifications furnished by SEPCO vide e-mail dated 14th February 2009.

33) Minutes of Meeting held at SEPCO, Jinan office on 16th to 21st February 2009.

34) Minutes of Meeting held at WPCPL, Hyderabad on 26th February 2009.

35) LOA for Five(5) separate contracts issued on 26th February 2009.

i) The Contract signed jointly by the Purchaser and the Supplier based on and read with:
   - Bid Documents issued by the Purchaser containing Conditions of the Contract and Technical Specifications, including but not limited to any amendments.
   - Supplier's Bid proposal including the letters of clarification thereto exchanged between the Supplier and the Purchaser prior to the award of Contract and as contained in Letter of Intent / Letter of Acceptance (LOA)/ Letter of Award.

ii) All the materials, literature, drawings data, manuals, and information of any sort given by the Supplier and approved by the Purchaser as well as those given by Purchaser to the Supplier;

iii) Any other mutually agreed and written correspondences containing the terms, conditions and specification of the Contract.

iv) All the Schedules attached to the Contract.

5.0 The drawings enclosed with various volumes in the specification are indicative and only for reference of the Contractor. Any variation arising during detailed engineering stage shall be taken into account by the Contractor without any extra cost and/or time implication to the Owner.

6.0 Owner shall interpret the meaning of the specification, drawings, requirement of operation, maintenance, redundancy etc., and shall have a right to reject or accept any work or material which in his assessment is not technically complete to meet the requirements of this specification and/or applicable National and International standards mentioned elsewhere in this specification.

7.0 Contractor is required to carefully examine and understand the specifications and seek clarifications, if required, to ensure that he has understood the specifications as intended by the Owner. In the absence of any specific clarifications indicated by the Owner during bidding stage, the interpretation of Owner shall be final. The Contractor's offer should not carry any sections like clarifications, interpretations and/or assumptions. All such points are required to be clarified before submission of the bid.

8.0 In the event of conflict between requirements of any two clauses of this specification/documents or requirements of different codes/standards specified, the more stringent requirement as per the interpretation of the Owner shall apply.

9.0 It will be imperative on each Contractor to fully inform himself of all local conditions and factors, which may have any effect on the execution of the work covered under the tender documents. It is advised that the Contractor shall acquaint himself, in his own interests by visit to the site, with the conditions prevailing at site.

10.0 Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific items mentioned shall be understood as establishing type, function and quality desired. Other manufacturer's products may be considered provided sufficient information is furnished so as to enable the Owner to determine without the need for any additional clarification/data, that the products proposed are proven and equivalent or superior to those named.

VOLUME-II

SECTION-III

PROJECT DESCRIPTION AND SPECIFICATION

VOLUME-II
SECTION-III

PROJECT DESCRIPTION AND SPECIFICATION

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SECTION-III

PROJECT DESCRIPTION AND SPECIFICATION

General requirements and information about the project are outlined here; however, detailed project requirements are elaborated in the subsequent sections.

1.00.00 GENERAL DESCRIPTION OF WORKS

1.01.00 Wardha Power Company Pvt. Ltd. (WPCPL) is a KSK group company, which is a fast growing industrial house having its headquarter in Hyderabad. The group has envisaged installation of a 3600 MW power plant near Nariyara Village in Janjgir-Champa district of Chhattisgarh, India.

The intent of this EPC Specification covers the requirements of 3600 MW (6 X 600 MW)capacity coal based Power Plant.

The specification and features of the plant as brought out below and in other sections are based on sub-critical boiler and turbine.

1.02.00 WPCPL intends to build, own and operate a new coal fired power station near villages Nariyarain Janjgir Champa District of Chhatisgarh, India. The power station design life shall be minimum 30 years. The Contractor is expected to acquaint himself by visit to the site with the conditions prevailing at site before submission of the bid.

1.03.00 This specification covers the design, manufacture, supply, delivery, erection and commissioning of the power station on EPC basis, in accordance with this Enquiry Document & Specification.

1.04.00 It is essential that all necessary works are completed to ensure that the first unit be capable of full commercial operation upon the issue of the Taking-over Certificate and that such commercial operation of the first unit will not be affected or delayed in any way by the completion of the works associated with the second or subsequent units.

1.05.00 The plant shall be designed for base load operation and capable of full range of operating conditions with a high availability (minimum 90% availability and 89% PLF) and high overall thermal efficiency in a cost effective manner (i.e. including capital cost, through-life operation and maintenance costs).

2.00.00 DESCRIPTION OF SITE

The site is located at latitude 21 Degrees 57' North and longitude 82 Degrees 25' East near villages Nariyara in Janjgir Champa District of Chhatisgarh, India. Akaltara town is about 10 km North-East by road from the site. The state highway NH-200 runs at 0.5 km from this site. District HQ Janjgir- is situated at a distance

of about 40 km from this area. The Bilaspur-Janjgir Champa-Jharsuguda broad gauge railway line is passing within a distance of 5 km. This line is also connected to Titilagarh and Rayagada towns. The Morga-II mines is 125 km from this area from where the coal can be brought by railway to the site. The nearby water source is the Mahanadi river. Water requirement shall be made available from Mahanadi/Seonath river runs around 50 kms from site.

3.00.00 LAYOUT

About 2050 acres (830 Ha) of land is being acquired by the company .The land is adequate for the proposed power plant including the ash disposal area.

The land has general elevation of about 275 m above MSL. Plot plan drawing (based on 6 x 600 MW configuration) is attached with this tender specification as guide to the Contractor.

The Contractor shall propose his optimised site layout, taking into account the interface arrangements, meteorological data, site contours and ease and cost of plant operation. The Contractor shall accommodate equipment to be supplied under this specification judiciously utilising the allocated space providing enough free space around each plant and equipment for easy handling and maintenance. The Contractor shall keep space in his layout to accommodate in future a Flue Gas Desulphurisation (FGD) plant of required capacity.

4.00.00 SOURCE OF FUEL

4.01.00 Coal

Coal for the station will be made available from the Morga coalfields in Korba district, around 125 km from the site. Coal transportation is envisaged through bottom discharge rail wagons to be owned and operated by the Owner.

The plant shall be suitable for operation over the entire life for coal specified in Annexure-I enclosed.

4.02.00 Fuel Oil

Heavy Fuel Oil (HFO) and Light Diesel Oil (LDO) will be transported to the Power Station through Rail/Road tankers. A comprehensive system of unloading, storage and handling shall be provided by the Contractor. The fuel oil analysis is presented in Annexure-II.

5.00.00 SOURCE OF WATER

The make-up water requirement of the plant shall be drawn from the Mahanadi / riverine system, which is approximately 50 km from the project site. A closed cycle circulating water system with IDCTs shall be provided.

Water required for construction purpose shall be arranged by the CONTRACTOR through Borewells. Contractor shall make arrangement for storage and distribution of construction water as per requirement including treatment, if any.

Necessary permits for Borewells will be obtained by Owner. The requirement of construction water in phases will be indicated by Contractor.

The design raw water analysis is presented in Annexure-III.

6.00.00 ASH DISPOSAL

The fly ash from the station will be collected in dry form in silos and shall be collected by trucks or shall be disposed up to the Ash Disposal areas by High Concentration Slurry Disposal (HCSD) system. The ash disposal area for the station is located at approximately 2 km from the site of Power Station. The dry ash silos shall also be used for dry ash utilisation purpose and shall be provided near the plant boundary. Fly ash shall be collected from FA silo in Bulkers/ Capsule trucks/rail tanker by telescopic unloading spout and in open trucks by Ash conditioner. And conveying of fly ash from the silo to ash dyke is by HCSD system. Dry ash vendor shall collect ash in trucks from the silos. The bottom ash shall be conveyed to the Ash silo and there to ash dyke in dry form.

7.00.00 POWER EVACUATION

The power generated from this power station will be fed to the grid through 400 kV transmission system. Each generator shall be connected to the 400 kV Switchyard through its associated step-up Generator Transformer (GT). Necessary activities for evacuation of power upto the 400 kV switchyard shall be under taken. One and half breaker scheme is envisaged at the switchyard.

The single line diagram for the switchyard is attached for the Contractor's guidance.

The requirement of construction power for the project shall be met by the arrangement with state grid at 33 KV level. The peak demand for construction power shall be indicated by the Contractor. The Contractor shall provide Diesel Generator sets of adequate capacity as back up to the construction power tapped from state grid. Line shall be laid upto one point within the plant boundary. Further downstream arrangement including switchyard, if necessary shall be arranged by Contractor.

Owner does not undertake reliability/availability of construction power. Contractor to pay charges towards construction power as per CSEB tariff.

8.00.00 ENVIRONMENTAL CONDITIONS

The site is situated in Janjgir Champa district of Chhatisgarh. The nearest Climatological station is located at Champa for which the Climatological table is presented in Annexure-IV.

9.00.00 ENVIRONMENT PROTECTION

9.01.00 **Dust Control**

Dust particle to the air from the site, from coal stacking area, ash dump area, roadway, etc shall be controlled by means of a permanently mounted water sprinkler system. However, dust emitting from Boiler shall be controlled by Electro Static Precipitator and chimney of specified height.

9.02.00 **Liquid Effluents**

The Contractor shall be responsible for waste management on the site, and for the control of liquid effluents generated/produced during the period of the construction and operation of the plant. The collection of effluents and the associated treatment systems shall be so designed that when the plant is maintained and operated it can meet the Zero discharge requirements of the Pollution Control Board for prevention and Control of Water Pollution, at all times. **Complete waste water reuse philosophy i.e. ZERO DISCHARGE shall be adopted with Ultra Filtration and Reverse Osmosis system..**

The Contractor shall be responsible for obtaining, in agreement with the Owner's Site Engineer, all necessary consents, licenses and permissions (other than those which are the specific responsibility of the Owner). These shall be obtained providing sufficient time to ensure that the construction and commissioning programme can be achieved. Owner will arrange for necessary clearance and approval for the project from the State Pollution Control Board and Ministry of Environment and Forests, Government of India.

9.03.00 The Contractor shall ensure that he complies with those aspects of the consents, which fall within his scope of supply so that the Owner can meet his commitments.

10.00.00 **DESIGN CODES & STANDARDS**

10.01.00 The plant shall be designed, installed and tested in accordance with internationally recognised standards and national standards appropriate to the duty, operational requirements, statutory obligations and environmental conditions specified. The design shall cater for statutory and mandatory requirements appropriate to the project location and specification such as the Indian Boiler Regulations, Indian Electricity Rules, Indian Factory Act, LPA and Indian Explosive Rules etc. Design code requirement for civil and structural is covered elsewhere in the document.

10.02.00 Contractor shall acquaint himself with the statutory and mandatory requirements of the state & central government. It will be his sole responsibility to ensure that all plant, equipment and design fully meet these requirements.

10.03.00 Where the Contractor's preferred design and installation procedure standards differ from the standards designated in the specific technical sections of this specification, then the adopted design basis should be at least equivalent to the standards required by the designated standard.

10.04.00 The Contractor shall be consistent in his application of standards over the whole plant and shall state in his Bid which standards he proposes to use and shall provide a schedule of the standards to be used for the major plant items.

10.05.00 The standards and design mentioned under 10.03.00 and 10.04.00 are other than statutory requirements of state and central governments.

11.00.00 RELIABILITY, AVAILABILITY AND MAINTAINABILITY (RAM)

11.01.00 Availability Data

The Contractor shall provide reliability data consistent with his availability analysis. The data is required to enable assessment of corrective maintenance and to support an independent availability analysis.

The data shall be consistent through different hierarchical levels of plant detail. Thus, data for the boiler, turbine-generator and balance of plant shall provide a whole plant estimate in agreement with the whole-plant data.

For the boiler, turbine-generator and balance of plant, data shall be provided for the major subsystem/equipment. As a minimum, data shall be given for all critical items whose failure alone would stop power generation (these may include air heater, turbines, electrical generator, transformer etc.). The sub-system/equipment listing shall include all the major contributors to breakdown lost availability and shall together account for at least 90% of the plant area total loss.

Average Annual Availability (AAA) is defined as:

$$(1 - \frac{(F + P)}{(PH)}) \times 100\%$$

Where

F = Hours lost due to forced outage in a year.

P = Hours lost due to planned and scheduled/statutory Maintenance.

PH = Period Hours (8,760/year).

Design margins, redundancy and buffer storage shall be incorporated as necessary to achieve the required availability.

11.02.00 Reliability and Maintainability (RAM) Programme

The Contractor shall implement a Reliability and Maintainability programme (as described in BS 5760 - Reliability of Constructed or Manufactured Products, systems, Equipment and Components). The programme will provide the Owner the confidence that the availability targets will be achieved. The programme will ensure that adequate effort is brought to bear on RAM during all phases (conception and definition, design and development, manufacturing and installation, operation and maintenance) of the plant.

11.03.00 Availability Value

The Contractor shall state the expected (or design intent) value of availability for the Plant.

The Contractor shall provide evidence to support his design intent, on a historic and/or calculation basis.

During the Contract design phase the Contractor shall demonstrate how the specified availability will be achieved. This shall be done at system level by one of the following ways by providing evidence that the system-level plant has a design which has demonstrated successful service elsewhere;

Or, if the system-level plant is a new design with little or no service experience, by undertaking a reliability assessment from a knowledge of the failure mechanisms or failure data or both.

Similar approach (stating an expected availability and demonstrating how it will be achieved) shall be adopted by the Contractor for the individual plant items within each system.

11.04.00 **Availability Between Planned Outages**

The Contractor shall provide information on the expected (or design intent) annual forced outage rate (FORs) for the plant systems identified. An indication of the standard deviation of the annual FOR shall be given. The predicted annual FOR for the plant and how this figure is calculated from the individual FORs shall be indicated with substantiation for the quoted values from equivalent plant operating elsewhere. Where the expected FOR value (quoted) is less than the mean FOR quoted an explanation shall be provided. The cause of FOR for any plant system in excess of 5% shall be given.

12.00.00 **PLANT OPERATING PATTERNS**

Operational staff shift patterns will be 24 hours per day, 7 days per week for main plant operation such as boiler and turbine operation with the possibility of reduced shift cover for other plant areas dependent upon the plant systems offered. However, the plant offered shall be suitable for two-shift operation also.

12.01.00 **General Operational Requirements**

The plant shall be operated from a single centralised control room for each phase permitting safe and efficient operation to be achieved with minimum manpower requirements. Fully automatic control systems over the full load range shall be provided where practicable, incorporating high reliability with failsafe features and with facility of recording all the operations of the auto and operator in the Event recorders/ history data base.

The plant shall be designed such that all routine operations, e.g. start-up, shutdown and load changing can be initiated and controlled from a single central control room. The plant shall also be designed to minimise through life costs. Provision shall be made for automatic turbine run-up and automatic grid synchronisation and load control system.

Facilities adjacent to, but separate from the central control room, shall be provided for data amendment, design of software and formats, control, storage and printing of associated documentation, loading into the appropriate system and monitoring of the network and attached equipment. At least one engineering workstation per unit shall be provided for the station, connected as required to the permanently installed facilities.

13.00.00 SAFETY

All plant components shall be designed for 'fail safe' operation with appropriate audible and visual warning of any plant fault in the control room.

Unless unavoidable, materials which could be hazardous to health in normal or fault conditions, shall not be used in the construction of equipment or in components used therein. Where such use cannot be avoided, then the prior approval of the Engineer shall be obtained i.e. assessment will be required and the materials shall be clearly and unambiguously indicated on the equipment, together with any special instructions. Hazardous material shall be taken as meaning explosive, toxic, carcinogenic, mutagenic or biologically active in any way.

The instruction manual and the operating instructions shall detail the extent to which any hazardous materials are used in the equipment. Instructions shall be given regarding the disposal of such materials or components containing such materials.

Information relating to hazardous materials shall refer to the use of beryllium, mercury, selenium, asbestos and other toxic elements or compounds, which might constitute a hazard in use or in the event of damage to, or overheating of a component or equipment.

Materials used in equipment shall as far as possible be either non-combustible or shall be resistant to flame propagation.

The plant shall be designed and provided with fire protection and detection systems conforming to NFPA/TAC/LPA standards and OSHA guidelines.

14.00.00 MAINTENANCE REQUIREMENTS

The plant and equipment shall be designed such that where maintenance work is required, appropriate plant item can be isolated electrically and if necessary mechanically; drained, vented or purged as required to ensure safety from the system and the isolation made secure by the use of lockable devices. The Contractor shall provide sufficient number of standard pattern padlocks to satisfy all isolation requirements during commissioning, normal operation and maintenance periods.

15.00.00 OPERATION AND MAINTENANCE TRAINING

15.01.00 Maintenance Training of Personnel

The Contractor shall state any conditions that he would impose should the Owner or its appointed agents wish to operate, maintain and service the plant.

15.02.00 **Requirements for Operator Training and Commissioning personnel**

The Contractor will provide comprehensive training courses covering all aspects of the power station plant, equipment and systems, equipment, operation and maintenance. Training will include appropriate periods for the Owner's personnel or his agents to be in the manufacturer's works during assembly of the major plant items, on site training during installation of key plant items, and training during commissioning.

The Contractor shall be responsible for the setting to work, commissioning and operation of plant up to the issue of the Taking Over Certificates. The Owner will provide operation personnel to be involved in the commissioning process, working to the instructions of the Contractor as part of the training program and the responsibility of plant and equipment during this period will be with the Contractor only.

The Contractor will train, instruct and supervise the Owner's operating staff to a standard adequate to ensure safe and efficient commercial operation of the plant and to enable performance guarantees detailed in this Contract to be met. Such training shall commence sufficiently in advance of commissioning to enable staff to become familiar with the Works and intended operation techniques.

The Contractor shall exercise reasonable efforts to ensure that the Owner is given reasonable opportunity to utilise simulators owned by the Contractor, or by his subcontractors and manufacturing associates, for personnel training.

The Contractor will ensure that all of his commissioning staff is fully conversant with the commissioning, performance testing and operation of the plant.

The Contractor's outline training programme shall be submitted to the Owner early in the contract period allowing sufficient time to mobilise operation staff for training as described above.

The trainees will receive appropriate education in their field of activity. The number of trainees will be agreed between the Owner and the Contractor.

15.03.00 The scope of services for training of Owner's personnel shall necessarily include training module covering at least 43 man months. This shall cover all disciplines of operation and maintenance viz. Mechanical, Electrical, C&I, Civil, etc. and shall include all the related areas like Design/Engineering, Manufacturing, Construction/Erection, Commissioning, Quality Assurance & Testing, Operation & Maintenance aspects at Manufacturer's/ Sub-vendor's office/ works.
The Contractor shall ensure that training of Owners executives should be comprehensive & should ensure adequate/appropriate access to all information in the relevant field so as to enable these executives either undertake individual responsibility i.e. O&M of the Station and/or serve as the key resource person to train other officers in the Owners organization. For this purpose the Contractor

shall ensure that necessary documents/training manuals, drawings etc should be provided as a training kit for Owners personnel.

	Area	Discipline	Duration Man months
a)	Steam Generator, Steam Turbine, Generator- design familiarization, product design features, engineering, manufacturing, erection and commissioning	Mechanical Electrical Civil	9
b)	Plant Operating Features, governing system, performance monitoring and performance improvement	Mechanical Electrical	16
c)	Steam Generator and Turbine Components repair and refurbishment assessment methods	Mechanical	6
d)	Electrical system, Generator protections, excitation system, GIS, SAS, Numerical relays etc.	Electrical	6
e)	Control & Instrumentation	C&I	6

15.04.00 Contractor shall furnish details of training module(s) covering above requirements, which shall be subject to Owner's approval. Consolidated training period included above (i.e. 43 man months) is indicative only.

15.05.00 Exact details, extent of training and the training schedule shall be finalized based on the Contractor's proposal within two (2) months from placement of award.

15.06.00 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Owner's personnel including local transportation shall be at the cost of Contractor. The Contractor shall make all necessary arrangements towards the same.

16.00.00 **PERFORMANCE TESTING**

The Contractor shall submit to the engineer not later than 12 months from the date of "Letter of Awards", a proposed procedure for all tests.

The Contractor shall co-operate with the Engineer's requirements in the temporary utilisation of unassigned inputs to the Data-Acquisition and Display System, and in the production of application programs for temporary logs and displays.

Steam Tables for use on the project shall be in SI Units.

The Contractor will be responsible for providing any temporary services or test equipment to the appropriate accuracy to conduct the tests at site.

Reliability Demonstration Tests

The reliability demonstration tests will commence when the Engineer is satisfied that the plant offered for reliability testing has been fully proven with regard to its safety and that training of the power plant operators is complete.

Acceptance Test

Acceptance tests shall be carried out on the power island and plant components, as specified hereinafter, as soon as possible following the satisfactory completion of the Reliability Demonstration Run.

Should the plant or any portion thereof fail under these tests to give the performance required, then any further tests which may be considered necessary by the engineer shall be carried out in a similar manner.

The whole cost of the repeated tests shall be borne by the Contractor, including the costs for fuel and consumables necessary to carry out the tests, less any revenue received by the Owner from electricity sales, up to the agreed cost of fuel and consumables used.

The performance measurements shall be undertaken with the plant set up and operated in accordance with the recommendations of the Contractor for maximum plant life and integrity.

The coal supply for the boiler testing will be identified by the Owner prior to the tests. Sampling of the coal will be agreed between the Contractor and the Owner to ensure that it is acceptable in relation to the guarantee fuel prior to testing. All coal sampling during the tests will be to the agreed test standards. The necessary apparatus for taking and containing the fuel samples shall be supplied by the Contractor under this Contract.

Three separate samples shall be taken in each set of sampling. One of each set of three samples shall be fully analysed by an independent authority and the costs of these analyses shall be borne by the Contractor. The other two samples of each set of three shall be properly labeled and handed over to the Owner.

In order that the unit may be heat-saturated at the commencement of the trials it shall be operated as per the Reliability Run Test & PG test procedure elaborated elsewhere in this document.

For one hour preceding the test period, the load and all other conditions shall be in accordance with the test requirements and all readings shall be taken during this hour.

During the test period the conditions shall be held as steady as possible compatible with safe and effective operation of the unit. The boiler shall operated without blow down and the soot blowers shall not be operated. The fuel condition should be similar at the start and finish of the test period.

Cooling tower performance tests shall be undertaken to the requirements of PTC/ BS 4485 or equivalent standard. These tests shall be scheduled for seasons during which appropriate ambient conditions may be anticipated to prevail; it is desirable for these conditions to be as steady as possible. Test readings shall be taken over several hours and the most stable period over at least one hour used for each test.

The method and the number and location of measurements and the provision of and duties of observers shall be mutually agreed upon before the trial. In relation to the electrical measurements the following procedure may be applied:

- The gross electrical power output may be measured at the terminals of the generator.
- The power consumed by electrically driven auxiliaries supplied as part of the Works shall be measured at the agreed inputs.
- Suitable current and voltage transformers shall be provided in the contract for the measurement of auxiliary power and for the efficiency and output test.

In addition to the test measurements required by the agreed test standards, it may be necessary to log additional measurements to provide baseline operational data. These extra readings shall be defined by the Owner and agreed with the Contractor as part of the testing programme and all equipments/instruments required shall be provided by contractor.

17.00.00 CLEARANCES AND APPROVALS FOR THE PROJECT

The Owner will provide only the following clearances/approval from the concerned authorities/regulatory bodies.

a) Water allocation approval.

b) State Pollution Control Board Approval.

c) Civil Aviation clearance.

- Environment & Forest clearance.
- Approval for drawl of underground water for construction water purpose.
- Approval for drawl of construction power from state grid.

All other necessary clearances/approvals required for execution, implementation and operation of the plant from various concerned authorities shall be obtained by

the successful Contractor on Owner's behalf. These include, among others, the following:

- Approvals as per Explosives Act and Rules
- Approvals as per Indian Boiler Regulation
- Approvals as per Indian Electricity Act and Rules for Electrical Installation
- Approvals as per Indian Petroleum Act and Petroleum Rules for storage and transport of Petroleum Products
- Approvals as per gas cylinder rules and handling and transport of compressed gases
- Approvals of Fire Protection Scheme, building layout with fire safety concerns and receipt of No Objection Certificate
- Approvals of Chief Inspector of Factories of the proposed design and construction of power station , fuel facility and fire fighting capacities.
- Chief Electrical Inspectorate of Govt for electrical installation before energisation.
- Labour Department
- EPF Department
- Local authorities

18.00.00 BOILER PLANT

The steam generators envisaged are assisted circulation, drum type, double pass, water tube, direct pulverised coal fired, using coal as the principal fuel , single reheat, dry bottom type suitable for outdoor installation. The various major components are described below. No operating part of Boiler or its auxiliaries be installed bellow the ground level

(18.01.00 Pulverised Fuel Handling System

a) The function of the pulverised fuel (pf) handling system is to provide the boiler coal burners with an evenly distributed quantity of coal of specified fineness and in the correct quantities and proportions with air to meet the requirements of the boiler operating regime.

The system shall consist of storage bunkers, feeders, mills, primary air fans where applicable, distribution pipe work to the burners and all ancillary equipment associated with the above.

b) An important feature of the pf system is that it shall operate within safe parameters in respect of minimum transport velocity and pf/air mixture at all times to minimise the risk of explosions within the system.

c) The system shall be designed to be fully automatic under all normal operating conditions including start up and shutdown and require minimum operator intervention.

d) The geometry of the storage bunkers and coal chutes to feeders and mills shall be designed to give mass flow of coal under all conditions particularly

when reclaiming wet coal from stock, without material holding up on the chute or, bunker sides or in any valley angles.

e) The feeders shall be variable speed(VFD) and shall be able to supply the required quantity of coal to the mill under all circumstances without interruption. There shall be no dead areas in the feeder casing where coal can accumulate. The feeders must be equipped with coal weighment measurement to the accuracy of ±0.5% at all feed speeds.

f) Under all loading conditions, (where applicable) the mill shall automatically reject all tramp metal and other non-grindable materials but shall not reject any coal. Hydraulic system shall be provided to convey the mill rejects to silo along with water recycling separate for each unit. The mill reject handling system shall be designed considering 1 % of total coal at worst condition.

There shall be no dead areas in the mill, classifier or primary air system where coal or pf can accumulate under any circumstances.

g) The mills shall have sufficient drying capacity for the specified fuel range when the fuel has been reclaimed from stock during the period of highest rainfall. This shall be achieved with the minimum hot air temperature at mill inlet.

h) The pf pipe work system shall be arranged such that an equal quantity of pf is distributed to each burner from each mill under all loading conditions.

i) The whole of the pf system shall be designed to withstand an internal explosion without a breach of containment although the mill shall be protected by a suitably designed explosion vent.

j) The coal storage bunker sloping sides shall be lined with low friction wear resistant materials (stain less steel)..The lining system shall have a wear life in excess of 25000 hours at boiler MCR when handling the worst coal specified. The vertical sides at the top of the bunker shall be protected against corrosion.

Suitable poking holes shall be provided on the bunker. The bottom conical portion of the coal bunkers will be provided with stainless steel liners of at least 3 mm thickness.

Powered means of isolation shall be provided between bunkers and feeders. The feeder shall be fitted with liners to combat abrasion and corrosion such that the feeder casing is not sacrificial.

The liners for the feeders shall have a wear life in excess of 25000 hours at mill MCR when handling the worst coal specified.

The coal transfer chutes between feeders and mills shall be manufactured from abrasion resistant stainless steel. Bunkers emptying facilities shall be

provided which shall allow the bunker contents to be discharged in an approved, controlled and safe manner.

k) Facilities shall be provided to fully isolate each mill to allow safe access for internal maintenance with the remaining mills in service.

Means shall be provided for isolating a standby mill from the furnace to prevent blow back in the event of furnace pressurisation. This shall be achieved by means of a gravity operated non-return flap valve or a power operated isolating valve sequenced to close on mill shutdown. In either case, the device shall be installed in the pipe work to the burners after the final split.

l) The PF pipe work system shall be manufactured from ductile materials with wear resistant liners in all components. To improve the wear life of bends, long radius bends are preferred where practicable. Where bifurcators are proposed, internal flow splitters or riffles should be fitted. Means shall be provided to withdraw the internals without removing the entire bifurcator from the pipe work system. The use of brifurcators may be acceptable, but the Contractor shall demonstrate that such devices can consistently achieve an equal division of pf flow down each of the outlet pipes.

The pipe work system shall be fitted with suitably designed sampling ports in each mill outlet pipe and in each burner leg after the final split.

m) Auto control system shall allow sequenced starting and shutdown of mill groups from a single initiation. The system logic shall take full account of the potential hazards associated with exceptional conditions such as loss of coal, mill trip etc. Operator intervention shall only take place in exceptional circumstances.

The PF handling system shall be equipped with suitable instrumentation to allow the operator to be aware when a potentially hazardous situation exists. Parameters which shall be monitored include: PF carrying velocity, PF/air mixture strength, fuel/air temperature at mill outlet, air temperature at mill inlet, air flow measurement at mill inlet, loss of coal feed and fire detection. The PF handling system shall not require any maintenance or replacement up to one year of operation at rated load with worst coal

n) Mills shall be provided with fire detection and fire fighting system.

o) Sealing air piping shall be provided for mills and coal feeders.

p) Mill maintenance arrangement with hoist shall be provided.

q) Mill hydraulic and lubrication oil system shall be under closed controlled environment and away from dust generated by mills.

18.02.00 Coal Combustion System Including Low NO_x Burners

a) The function of the coal burners shall be to provide stable and efficient combustion of the pulverised fuel supply to the furnace and to minimise emissions of oxides of nitrogen (NO_x), unburnt carbon in dust and carbon monoxide (CO) for the range of fuels specified under all defined operating conditions.

The pulverized coal burners shall be low NO_X type with NO_X emission (both fuel NO_X and thermal NO_X) not exceeding 262 ppm

b) The minimum life of any burner component shall be equivalent to that required to ensure that no maintenance or repair is necessary between major plant overhaul outages.

c) Fly-ash samples will be taken during the overall plant performance tests for determination of carbon content.

d) The burners shall be fitted with adequate lifting and handling arrangements for erection and maintenance purposes.

e) Provision for the fitting of PF flame monitors shall be included. The PF flame monitor sight tube shall be suitable for mounting a PF flame monitor of the cross correlation type. The sight tube shall be of 100mm minimum internal diameter.

Equipment shall be provided to detect the presence or absence of a stable flame at each burner under all conditions.

f) All dampers and controls for adjusting the burners and regulating the combustion air supply to burners (from local or for emergency conditions) shall be arranged for easy operation at a convenient gallery level.

Means shall be provided for measuring the combustion airflow rate through each burner air register. All local and remote instrumentation and controls necessary for the safe and efficient operation of the coal burners shall be supplied and shall be rated to withstand the maximum local ambient temperatures.

An interlock shall be provided to prevent any burner being lit against a closed flue system.

g) The flame scanner system shall be of proven design. The scanner shall be able to detect both coal flame (fire ball) and discriminating flame and it shall be at all required levels- at least 3 levels

18.03.00 Ignition and Support Firing Equipment

a) The functions of the ignition and support firing equipment shall be to provide:

- a means of lighting up and warming the boiler prior to the admission of the main fuel to the furnace.
- satisfactory and reliable ignition of coal for all defined firing conditions.
- a means of coal combustion support during periods of reduced boiler load operation.
- a part load carrying facility on the support fuel.

The oil burners and ancillary equipment shall be designed to fire the specified fuel range under all operating conditions.

The system shall be designed for automatic operation of all control sequences, that is manual intervention shall only be required for lighting up and extinguishing the oil burner and where applicable, adjusting the oil burner firing rate.

Each oil burner shall be supplied complete with its own burner specific ignition, oil flame monitoring, core air supply and burner management equipment.

b) The burner construction shall permit the separate removal of the following components while the boiler is on load:

- Igniter assembly.
- Local control equipment including the flame monitor(s). The construction shall be such as to allow the complete ignitor, oil gun and oil sprayer to be changed with the boiler on load.

The oil burner assembly shall be fitted with a positive mechanical interlock to ensure that the burner assembly cannot be disconnected with the oil supply on, and that oil cannot flow to the burner unless the burner assembly is in the firing mode.

c) An IP-65 rated limit switch shall be fitted to each changeover valve for indication of the burner operating mode, i.e. `firing' or `circulating', on the unit control desk in the central control room (CCR).

An IP-65 rated limit switch shall be fitted to each burner to indicate that the burner gun is connected. Indication of the status, the connected or otherwise, of each burner shall be provided on the unit control desk in the CCR.

d) A local oil tray shall be mounted immediately beneath the oil burner coupling assembly to contain any small oil seepage that may occur during burner gun removal.

e) All oil burner control and sequencing shall be controlled by a Controller in DCS with facility to maneuver the settings from DCS engineering station.

The Common Burner Management Logic shall include for the repeating of all common signals between burners, including the firing trip and starting interlock derived from the boiler protection equipment. Due regard shall be given to ensuring that a single fault has minimum affect on burner availability and the integrity of plant protection. Therefore, where single component failure may result in major plant loss of generation or plant damage, the common protection circuits shall include adequate levels of redundancy.

All equipment necessary to provide sequence completion check signals shall be supplied, including:

- Oil ring main pressure check.
- Oil ring main temperature check.
- Ignitor flame established check.
- Main oil flame established check.
- Second/purge fluid pressure check (where applicable).
- Second fluid temperature check (if steam).
- Furnace purge check.

f) The oil gun should be universal type. Preferably, the oil guns be retraceable type and will have HEA ignitor.

The circuitry for both power and control supplies shall be organised to ensure that any individual burner unit can be isolated and its associated electrical equipment can be worked on without hazard whilst the remainder of the burners remain in service. Such isolation shall be by means of an OFF/LOCAL/REMOTE lockable selector switch.

The normal mode of oil burner operation and status monitoring shall be from the Unit Control Desk situated in the Central Control Room.

For individual burner control only local stop/start push button oil burner status indicators (FIRING or READY/STAND-BY) units shall be located at the boiler front.

Each individual boiler front burner control cubicle shall have a minimum rating of IP-65.

The FSSS (Furnace Safeguard and Supervising System) shall provide comprehensive diagnostic facilities. As a minimum the diagnostic display shall indicate the precise position that has been reached in the oil burner light up sequence in the event of a sequence failure. Additionally a facility for interrogating individual burners local to the boiler front shall be provided.

Lamps local to the burner management equipment shall be provided with separate lamp test facilities.

18.04.00 **Boiler Structural Steelwork**

The Contractor shall describe the design method for calculating the maximum lateral and vertical deflections of the top boiler support steelwork and how the boiler design accommodates these movements.

Sling rods shall be designed so that it is possible to measure the load being carried by individual main rods and allow the load to be adjusted during future maintenance. A complete schedule of sling loads, including design margins, shall be supplied prior to boiler commissioning.

During the design phase the Contractor shall provide details of the boiler thermal expansions in each of the three major axes. The Contractor shall provide a method of indicating the thermal expansion of the boiler in each of the three major axes relative to the fixed building steelwork.

18.05.00 **Unit Fittings, Casings and Access Gantries**

a) The boiler shall have main stop valves to provide full isolation local to the outlet from the super heater. These stop valves shall be capable of closure by remote operation.

b) The Contractor shall provide details of all safety valves to be fitted to the boiler.

Each drum shall have minimum 2 nos. safety valves

Each final super heater outlet shall have at least one mechanical safety valve and one electrically assisted emergency safety valve.

Each final reheater shall have at least two safety valves, at least one of which shall be on the outlet side and one on inlet side.

Safety valve relieving capacity shall meet the requirement of Indian Boiler Regulations (IBR) and applicable ASME codes.

Safety valves shall be accessible for testing and maintenance and set pressure adjustment when the Boiler is in service. The superheater and reheater header shall have a provision of nitrogen filling.

c) A suitable gas tight boiler casing shall be provided to enclose the dead space areas.

The Contractor shall provide all necessary galleries and access and inspection doors to allow comprehensive visual monitoring of boiler and provide ready access for tube failure repairs in any area of the boiler. In particular, properly placed observation ports shall be provided to permit

inspection of the furnace and wind box. Operating platforms shall be provided to allow operation of all valves and on load maintenance of boiler cleaning equipment. Walkway access shall also be provided for furnace and dead space areas for planned maintenance during overhauls.

The Contractor shall provide an acoustic furnace tube leak detection system to give early warning of steam and water leaks in the convective super heater and reheater zones and the boiler dead spaces.

d) Boiler Block insulation shall be of ribbed Aluminum sheet

e) Platform and stair case for Boiler shall not be less than 1000 mm except for places where space constraint is there minimum 800 mm shall be provided.

18.06.00 **Pressure Systems Design & Fabrication**

a) The design, fabrication and erection of the boiler pressure parts shall be subject to survey by an Independent Inspecting Authority (the Third Party Inspecting Authority) as required by the Inspectorate of Boiler, Indian Boiler Regulation (IBR). The Third party Inspection Authority shall be acceptable to the Engineer.

b) Headers shall be manufactured by seamless process.

Headers shall be provided with access arrangements to allow full internal visual inspection and cleaning.

Final super heater header and reheater header that are designed on a time dependent basis shall be fitted with creep check/ measurement device, to allow periodic measurement of diametric creep.

c) Membrane panel construction shall be either by a fusion welded fin or integral fin method. Resistance welded fin construction will not be allowed unless appropriate satisfactory reference experience can be demonstrated.

All tubes shall be manufactured using a seamless process and the wall thickness of the tubes shall meet the results of strength calculations as per IBR.

No tube bend shall contain a circumferential weld.

d) The qualification/approval of welding procedures and welders shall be carried out to ASME standard.

Permanent backing rings shall not be used.

Oxy-acetylene welding shall not be used.

The material composition of both parent and weld metal shall be checked and confirmed after welding components in micro alloyed carbon

manganese steels and all ferritic alloy materials. The method to be used shall be approved by the Engineer.

e) All start up vents on superheater/ reheater outlets shall be provided with two valves in series - one motorized isolating and one motorized regulating type as per IBR.

f) Pressure withstand capability of the furnace shall correspond to minimum +/- 660 mmwc at 67% yield strength or maximum expected pressure/draft of fans, whichever is higher

18.07.00 **Economiser**

Adequate access shall be arranged for routine, cleaning, inspection and maintenance of the economiser tube elements.

18.08.00 **Drum**

The Contractor shall define, during the design phase, the allowable drum temperature differentials corresponding to boiler pressure and provide sufficient instrumentation to enable the operator to confirm compliance with the specified limits, particularly during transient operation.

All drums with internal fitments shall be fitted with a mechanically connected man access opening at each end (i.e. a minimum of two man access openings per drum). The minimum opening size shall be 406 mm diameter.

The Contractor shall describe the facilities for indicating water level in the main steam drum. These facilities shall cover both the local and remote (in the control room) indications and the system proposed shall be acceptable to both the Engineer and the National/Local Regulatory Authority/should meet IBR requirement.

Startup vent, safety valves for drum, superheaters and reheaters shall be provided with Silencers.

18.09.00 **Main Steam Piping**

All main steam and hot reheat pipe work shall be manufactured by a seamless process. Materials shall be to recognised international standards.

Pipe work design analysis shall be submitted to the Independent Inspection Authority and Owner for approval prior to construction.

18.10.00 **Cleaning of Pressure System Internal Surfaces**

The Contractor shall describe the proposed method for cleaning the internal surfaces of the boiler tubing and headers prior to commissioning. All necessary services, chemicals and connections and tappings to the plant shall be provided as

part of the contract, including the removal of all byproducts and unused chemicals from the site.

A steam purge shall be carried out on the boiler super heater sections and the main steam pipe work prior to commissioning of the plant. The Contractor shall provide all necessary temporary pipe work, equipment and connections.

18.11.00 **Furnace and Tube Cleaning**

Equipment shall be provided for the purpose of cleaning the furnace and boiler tubes to meet the overall performance requirements of the boiler for the complete range of fuels and anticipated operating conditions.

The system design and installation shall accommodate a future need to increase the boiler cleaning equipment capacity by minimum of 25%.

Soot blowers should be electrically operated with provision for manual retraction.

Section valves shall be provided to minimize outages of the tube cleaning system due to a single soot blower failure.

The soot blowing system shall be provided for the waterwall, superheater, reheater, economizer and air preheater.

18.12.00 **Air Heaters**

a) The air heaters shall be used to heat the combustion air, provide hot air for fuel drying and transportation and maximise the heat recovery from the flue gas. Additional steam air heaters shall be incorporated to control flue gas exhaust temperature temperatures during start up and low load operation.

b) The air heater shall be fitted with the necessary ducts, dampers and operating gear for isolation of air/ gas path whenever required.

c) Steam coil air preheater (SCAPH), 2 nos for each unit shall be provided on the secondary air path.

d) Means should be provided for the easy replacement of cold end packs without disturbing other layers.

e) The air heater system would be expected to work automatically with no operator intervention for seal adjustment.

f) Provision shall be made for draining water from the air heaters arising from steam leaks and/or cleaning operations.

g) The air heaters shall include proven fire detection and fire fighting systems.

These shall be commissioned and fully available prior to first gas to the air heaters.

h) Forced lubrication oil system for the air prehetaer system shall be provided with DC back up (One working and one standby) as required

i) 2 nos Electrical hoist of adequate capacity per unit with basket handling system for APH should be provided

18.13.00 **Dust Hoppers**

a) The function of the dust (fly ash/coarse ash) hoppers is to collect dust fallen out of suspension in the gas stream such that it can be transported from the boiler for disposal.
Fly ash hoppers storage capacity shall be for 8 hrs at BMCR load.

b) The supporting system for the hoppers shall be adequately designed and constructed to support each hopper when full of wet dust without distortion of the supporting structure or the connection to the main boiler.

c) The sides of the hoppers shall be insulated as required to maintain the skin temperature below permissible levels under all circumstances.

18.14.00 **Particulate Extraction Equipment**

a) The particulate extraction plant shall be a dry electrostatic precipitator plus Bag filter of a proven design on existing plants operating with similar fuels. The primary function of the particulate extraction plant is to control dust emissions both to the atmosphere and to downstream gas treatment systems, (where applicable) safely, and within specified emission levels, for the range of fuels, operating conditions and ambient conditions. The collected dust should be then delivered to a suitable hopper system for onward transmission to the dust collection and removal plant.

b) Where, to meet availability requirements, individual flows are taken out of service for routine or breakdown maintenance with the unit off load, these should be safely isolated. Motor operated isolation gates with seal air shall be provided at the inlet and out of each ESP + bag filter paths.

c) Details shall be provided to indicate how the particulate extraction plant will be operated satisfactorily and without damage to components whilst oil firing. It is not acceptable to bypass the particulate extraction system.

d) Flow modeling shall be carried out for ensuring uniform gas distribution in the ESP. The same will be witnessed by the Owner.

e) Each zone of a precipitator should have an independent drive for the rapping of both the discharge and collecting electrodes.

f) High voltage support insulators should be installed out of the gas stream. Insulators in contact with flue gas should be fitted with electrical heaters. The heaters shall be controlled by ON/OFF adjustable thermostats.

g) Hoppers should be electrically heated over an area sufficient to maintain the flow characteristics of the collected particulates. Safe arrangements

should be made, such as poke holes, to aid clearing of the hoppers. Provision for a safe means of hopper emergency emptying should be made by flanged outlet (a blanked pipe chute) at the bottom of the hopper, with an isolating valve. Openings shall be provided at bottom level of hoppers for providing fluidizing pads.

h) **Safety Requirements**

- No access shall be possible into the gas passages unless all the zones in that particular flow are safely isolated and earthed. Key exchange boxes shall be provided as necessary. A non-masterable key interlocks will be provided so that it would be impossible to enter the screened area on a zone until the electrical equipment in that zone is de-energised and earthed.

- Provision local to each access door and on the equipment within the casings for the fitting of earth clamps. Portable earthing cables shall have terminations that conform to National Standards.

- Measures will be included in the design to ensure that access to the body of the casing cannot be gained from inlet or outlet flues.

- Where the roofs of gas chambers are used for the installation of electrical equipment immersed in oil, oil retaining walls will be incorporated and be so designed that oil cannot leak into the gas chamber.

ESP and Bag filters shall be designed for the worst coal with ash distribution of fly ash as 90% of total ash. The ESP and Bag filter hoppers shall be inverted pyramidal type with minimum valley angle with horizontal 60° and shall have provision of high and low ash level indications.
Contractor to provide the online degassed cation conductivity meter.

Discharge Electrodes shall be of Stainless steel make.

18.15.00 **Draught Plant**

a) The draught plant comprises ductwork, dampers, air and gas fans associated with the boiler plant.

b) The fans shall operate in a completely aerodynamically stable manner over their entire operating range when operated alone or in parallel with another fan. The operating range includes transient states such as boiler load changes, start-up and shutdown.

Emergency shutdown of the fans, initiated by either the operator or protection systems, shall be entirely automatic. A provision shall be made for bringing a decelerating fan to rest and preventing fan impeller rotation during maintenance shall be provided.

c) All air intake ductwork shall have safety grillage, suitable to prevent damage or blockage of fans and downstream components.

d) Automatic drainage provision should be made for all flues and ducts where significant quantities of water are liable to collect including condition such as air heater fire fighting or boiler tube leakage.

e) All dampers shall be operable and have position indicators both locally and from the control room. A manual method of operation, such as a hand wheel, shall be provided on all dampers.

19.00.00 STEAM TURBINE PLANT

19.01.00 General

The steam turbines shall be of axial flow design with all the turbine and generator rotors directly coupled in tandem. With the exception of the HP turbine outer casing, which may be of barrel construction, all other turbine casings, bearing housings and covers shall split conventionally at center line horizontal half joints to facilitate maintenance. The steam turbine shall comply with latest versions of IEC-45 or equivalent.

The Turbo-Generator unit and its associated auxiliaries shall be located within a building surmounted by a permanent crane.

Appropriate thermal insulation shall be applied to all high temperature turbine outer casings, steam chests and ancillary plant vessels and pipe work as necessary.

19.02.00 Emergency Stop Valve

Emergency stop valves situated in series with control valves shall be provided at all steam turbine inlets for HP as well as IP stages.

To demonstrate the effectiveness of the turbine protection without taking the machine out of service, it is preferred that all stop valves shall be capable of being tested with full valve stroke and minimal load reduction. Alternative arrangements proposed for testing the protection systems shall be fully described.

It is preferred that all major pipe connections to the turbine casings and steam chests are welded, the use of bolted connections being retained only where necessary for maintenance purposes.

19.03.00 Steam Strainers

Permanent steam strainers (Dynamic Separator System) shall be provided upstream of all pairs of stop and control valves to prevent ingestion of any material which may cause damage to the machine during both the initial commissioning period and subsequent operation.

19.04.00 Casings

Cast iron shall not be used for any casing or, part of a casing, which may be subjected to a temperature in excess of 220°C.

All the casing joints shall be designed to remain steam-tight for a minimum operation period of 45,000 hours without the need for bolt re-tightening or gasket replacement. The necessary tightening equipment (for bolt heating device - one set of Bolt heating and tightening tools for every three units) shall be supplied by the Contractor and shall remain the property of the Owner.

LP cylinder exhaust hood shall be provided with suitable bursting diaphragm and water spray system for protection against excessive pressure rise.

19.05.00 **Rotors**

The turbine rotors shall be of forged or welded construction. The use of shrunk on bladed discs are not acceptable.

Rotor designs shall be such that all combined rotor critical speed on the turbine foundations are adequately clear of running speed to ensure satisfactory operation of the unit. Adequate provision and access shall also be provided for in situ site balancing of the rotors without incurring major dismantling.

19.06.00 **Blading**

Moving blades constructed with integral roots and tip shrouding are preferred.

Details of the sealing arrangement at the blade tips and at any diaphragm interstage glands shall be provided. These seals should be optimised to minimise leakage consistent with accommodating, all anticipated rotor to casing differential expansions. They should also be touch tolerant.

The Contractor shall demonstrate successful service elsewhere of the LP turbine blading, indicating where and when units with identical blading have been commissioned.

The Contractor shall state the proposed method of protecting the leading edge of the LP moving blades from erosion in the wet region.

19.07.00 **Glands**

The proposed type of labyrinth sealing arrangements at all shaft end glands and internal glands including thrust balance pistons shall be fully described.

Each seal arrangement shall be optimised, to minimise leakage consistent with accommodating, all anticipated rotor to casing differential expansions. They should also be of an established touch tolerant design, with fixed type fins on rotor and Gland segments as stationary.

19.08.00 **Gland Sealing System**

The gland sealing system shall be fully automatic in operation, controlling the gland steam pressure and temperature, including provision for adjustment and manual control.

The system shall be capable of fully sealing the turbine shaft end glands without the main steam stop valves being open.

The elimination of steam leakage into the turbine hall at the shaft end glands and at the various stop and control valve spindles is required.

Gland steam desuperheaters of the direct injection type are preferred. They shall be designed to operate satisfactorily during all conditions of operation, including temporary loss of electric power.

A suitably rated gland steam condenser (GSC) shall be incorporated into the condensate system to permit heat recovery from the leakage steam.

19.09.00 **Turbine Drains System**

Drains shall be provided at all locations where water may accumulate within the turbine casing and any steam lines situated between the stop and control valves and the turbine.

These drains shall discharge through individual lines to the condenser such that the condensate is recovered, via a flash vessel if necessary and the pipes with similar pressure can be joined to one header discharging to the condenser.

To prevent the inadvertent discharge of superheated steam, powered valves, with both local and remote controls, shall be supplied with provision of orifice plates in the lines to limit the quantity of steam in drain lines going to Flash tank.

19.10.00 **Turbine Steam Bypass**

If steam bypasses are required to facilitate start ups of the plant, the Contractor shall include all necessary provision. These bypass systems shall incorporate all necessary protection and system trips required to ensure the integrity of the plant. The capacity of the HP bypass system shall be 60% of BMCR steam flow. Capacity of LP Bypass shall be designed matching with HP bypass design. Both HP and LP bypass shall be of Electro hydraulic actuation type.

The bypass line(s) shall be automatically controlled through Control valves to ensure tight steam shut off and suitably rated non-return valves shall be incorporated into the cold reheat lines from the HP turbine. For maintenance purpose isolation valve before and after PRDS (water side control valves) in HP bypass line shall be provided.

The proposed system and its controls shall be described, including features which prevents the generation of excessive noise and minimise any deleterious effects upon the condenser and other equipment and piping.

19.11.00 **Turbine Hydraulic Control Systems**

The oil used for turbine governing (control) shall be either from the lubricating oil system or from a separate control oil system. For the control oil system, the pumps provided shall be 2x100%.

The Contractor shall describe the proposed method of hydraulic control of the turbine and the bypass system valves. 100% standby capacity shall be provided within the control systems.

No oil or hydraulic fluid pipes shall be run adjacent to steam pipes. Guards and drip trays shall be provided where the possible escape of the fluid could impinge on hot pipes or turbine casings.

For Control oil system fire resistant fluid shall be used. All tanks and other metallic components coming into contact with the control fluid should be of stainless steel.

The use of compression type couplings in hydraulic lines conveying high pressure control fluid shall not be permitted.

19.12.00 **Bearing**

The thrust and journal bearings of the Turbo-Generator unit shall be readily accessible, adjustable and replaceable without disturbing major items of plant. All necessary design measures shall be taken to prevent the leakage of oil and vapour from the various bearing pedestals and pipe work under all conditions of operation including shut down.

Bearing shall reliably accommodate both normal operation, situations of transient operation and seismic events.

Both the journal and thrust bearings shall be split horizontally at the centre line to facilitate inspection and replacement.

19.13.00 **Lubricating Oil System**

The lubricating oil system of the Turbo-Generator shall be capable of maintaining the continuous operation of the unit under all conditions of load, start up and shut downs.

Following pumps and systems shall be provided:
1 x 100% shaft driven MOP, 1x100% AC driven AOP, 1 no. DC driven EOP with 2 x 100% of oil cooler, 2 x 100% Vapour Extraction Fans, oil cleaning (separator/centrifuge), and 1 x 100% reusable oil filters and 1 x 100% duplex filters with online changeover for each unit of 600 MW.
The temperature of the oil leaving any bearing shall not exceed 75° Celsius.

DC driven emergency standby lube oil pump of capacity atleast 30% of main oil pump capacity and jacking oil pump are required to fully safeguard the Turbo-

Generator unit during run down to barring speed in the event of failure of both the main and standby pumps.

Capacity of MOT (Main Oil Tank) shall be equal to Normal Working Level + Total oil volume in Oil circuit + 10% Margin.The main oil tank shall be sized to hold all the oil that may be drained from the complete TG oil system and Generator seal oil system and incorporate facilities for the settling out of water and sludge and the detraining of foam. Drains to decant completely the oil tank and oil system as far as practicable shall also be provided.

Two nos (1 working + 1 Standby) Vapour extraction fan shall be provided for each MOT.

The outboard end bearing of the Generators, all Exciter bearings shall be insulated from the bedplate and foundations to prevent the circulation of shaft currents.

Jacking oil system, with 2x100% jacking oil pumps (One AC driven and other DC driven), shall be provided to supply high pressure oil to each bearing of steam turbine-generator to lift the rotor during starting or turning gear operation.

Lubricating oil piping shall be of SS material.

Lubricating oil pipes should be surrounded by the Return oil lines so that oil leakage in pressurized lines will not cause any fire in the Turbine Area.

19.14.00 **Barring gear**

Barring gear is required to rotate the Turbo-Generator shafts continuously for warming during start up and also after shut down to ensure even heating/ cooling of the shaft system. The Bid shall describe the proposed barring gear arrangement, including motor, engaging mechanism and any torque limiting devices as appropriate. The barring gear shall automatically engage/disengage as the shaft speed falls below/rises above some pre-set values.

Facility for manual barring may be used for "Inching" the rotors during maintenance shall be provided. The torque capacity of the manual gear shall not be less than the main barring gear unit. It shall work with one man (i.e. equivalent to effort of 40 kgm) operating the lever on manual barring.

19.15.00 **Feedwater Heating System**

The feedwater heating system shall comprise of staged low pressure (LP) heaters, a deaerator decanting to the boiler feed pumps and staged high pressure (HP) heaters. These items of the plant shall be connected in series with all associated pipe work and control systems.

With the exception of deaerator, it is required that there should be no significant limitation in generated output arising from isolation of all feed water heaters. No vertical LP Heaters are acceptable in the condenser neck.

HP and LP heaters shall be provided with motorized valve for inlet, outlet and bypass lines.

19.15.01 **Bled Steam Supply Lines**

The turbine shall be safeguarded against the ingress of water and the reverse flow of steam from the heaters, the deaerator and associated bled steam lines in conformance with ASME, TDP-I. Pneumatic operated NRV shall be provided in all the extraction lines (except No.7&8 extraction lines) .

Excepting No.7&8 extraction lines, it is preferred that quick closing bled steam isolating valves are provided near to these vessels to protect the turbines in the event of heater flooding, and that the valves open slowly with adjustment over a range of 30 seconds to 2 minutes.

Near the turbine, free-acting assisted closure non-return valves shall be provided within the bled steam lines, these valves being force closed within one second of a turbine trip signal to prevent reverse flows of steam.

The Contractor shall describe the type of valves and actuators proposed for both bled steam isolation and non-return duty and his valve closure rate philosophy.

All bled steam isolating valves shall have facilities for both local and remote manual control with status indication in the DCS system in CCR.

19.15.02 **Deaerator**

The deaerator shall be designed and arranged for the efficient removal of non-condensable gases from the feedwater under all conditions of operation, with freedom from condensate surging and vessel vibration.

19.15.03 **LP and HP Heaters**

a) Heaters are required to last the life of the station with minimal maintenance. The Contractor shall, therefore, describe the design features incorporated into the design of the feedwater heaters to minimise or, eliminate problems of:

i) Tube vibration and corrosion.

ii) Tube fretting at baffle and shroud plates.

iii) Tube erosion and fretting adjacent to bled steam and flash drain inlets.

iv) Distortion and cracking at the tube plate.

v) Stagnant pockets of non-condensable gases.

vi) Division plate cracking and damage.

b) The use of shells with a minimum number of joints, welded tube plate to channel joint, and welded feedwater pipe attachments are preferred.

All tubes shall be produced from single lengths of tubes and be hydraulically tested to the requirements of HEI, USA/BS 3606 or equivalent standard.

c) Automatic facilities shall be provided to permit the continuance of feedwater flow whilst heaters are isolated due to fault conditions or for maintenance purposes.

Valves at inlet, outlet and bypass of all heaters shall be motor operated and automatic in response to signals from protective equipment and have a stroking time of not more than half the time to fill a heater, as determined by a double ended tube fracture co-incident with a blocked feedwater outlet.

d) Automatic modulating drains system shall be provided to control the condensate levels within the shell side of the HP and LP heaters.

Where cascaded heater drains are proposed, automatic diversionary drains which operate when the condensate level exceeds the normal operating range, shall also be provided to discharge condensate directly to the deaerator/condenser, via a drain receiving vessel if appropriate. Further increase in level shall instigate automatic isolation of the particular heater.

e) The feedwater heater vents shall be led separately to the condenser or deaerator as appropriate and must not be cascaded from heater to heater. Whilst internal orifice plates may be used to enhance ventilation within the heater, flow controlling orifice plates shall also be fitted within the pipe work external of the heater. Isolation valves shall be fitted to the vent lines.

f) Relief valves on feed heater shells shall be sized to pass flow from one ruptured tubes (two open ends), or 10% of design water flow, whichever is higher.

19.15.04 Minimum 460 mm diameter manhole openings shall be provided on feed heater and deaerator channels/shells where required.

19.15.05 **Boiler Feed Pump Sets**

The overall design of the feed pump sets shall ensure that there is adequate space for access to enable pump internals to be replaced quickly.

Remote monitoring and alarming of either the bearing shell metal temperature or drain oil temperature shall be provided at each bearing together with provision to permit the fitting of devices to measure vibration.

The feed pumps shall be suitable with adequate margin for the NPSH available with partially blocked filters in the suction line.

The feed pumps shall be designed to supply BMCR flow even at frequency 47.5 Hz with required pressure..

Motor operation valve at the outlet of Boiler Feed Pump shall be provided with integral bypass.

Boiler feed pump speed control shall be by scoop control for motor Driven and governor control for Turbine driven pump

Recirculation Arrangements

Minimum flow recirculation systems shall be provided at each pump set such that the plant operates in a smooth and satisfactory manner over the entire operating range and under conditions where the pumping duty is met by one or more pump sets in any manner permitted by the overall pump control system.

Appropriate isolation shall be provided to permit maintenance of the associated flow control devices, actuators and pressure reducing components whilst the pump set is shutdown but with the Turbo Generator on-load.

Filters

A filter shall be provided on the suction pipe work of each boiler feed pump. The filter shall be of (basket type -with drain water pipe)self-cleaning type and rated for the duty flow rate.

The filter element pressure drops at full flow with the filters at the high differential pressure alarm condition, shall be such that the pump is protected against damage due to inlet pressure conditions.

Means shall be provided for removing the internals from the filter body.

Gear Boxes

All gearbox casings shall be mounted onto a rigid bedplate, which provides for later adjustment of the input and output shafts that may be necessary due to changes in alignment during the life of the plant.

Means of checking the oil level whilst the feed pump set is at rest or in service shall be provided. When the gearboxes are of the wet sump type, readily accessible oil drain and top up facilities shall also be provided.

All gearboxes shall be rated for continuous operation at full speed and maximum motor shaft power. When attached to variable speed drives, they must also be suitable for continuous operation at any speed from 30% of rated speed.

Oil System (Lube oil, and working oil)

Where a forced oil system is required, a common system shall be provided for the pump, motor and gearbox with main and motor driven standby self-priming oil

pumps, each having a capacity adequate for the total requirements of the feed pump set.

Drive Unit

Boiler feed pump may be either motor driven or, steam turbine driven as specified elsewhere. Each motor driven boiler feed pump shall be with Hydraulic coupling (of VOITH make only) and control etc. and steam turbine driven boiler feed pump shall include all accessories and auxiliary equipment without gear boxes, to make a complete and a well integrated unit.

19.16.00 **Condensate System**

19.16.01 **General**

A condensate system shall be provided to extract saturated water from the condenser hotwell at the requisite rate and deliver this water to the Deaerator via the LP feedwater heaters.

It is envisaged that the condensate system will comprise of condensate extraction pumps, polishing plant, a reserve feedwater storage tank, a gland steam condenser, etc.

Low load re-circulation line(s) connecting to the condenser from downstream of the gland steam condenser is typically required to facilitate early start ups of the turbine gland system.

19.16.02 **Condensate Extraction Pumps**

- Each Unit shall be provided with two (2) nos. 100% capacity condensate extraction pumps (1 working and 1 standby). Any one of the pumps shall be capable of handling the full condensate from the condenser to the deaerator through L.P. heaters, gland steam condenser etc.

- The pumps shall be required to handle hot condensate at or near saturation temperature and shall be designed for very low NPSH service. The pumps shall be designed to withstand transient due to load swing of the unit from full load to no load. Adequate design margins shall be provided in the pumps for turbine bypass operation.

c) The pumps shall start automatically as and when required. Each pump shall be capable of continuously operating on its own against run-out or on stand by.

d) Pump materials shall be chosen to resist deterioration by cavitations, pitting or corrosion. Bearing or mechanical seal life of less than 20,000 hours operation will not be acceptable.

e) The pumps shall be designed to yield the rated flow with frequency remaining 47.5 Hz.

19.16.03 Gland Steam Condenser

A gland steam condenser shall be provided to condense all gland leak-off steam and return the same to the cycle. The turbine glands shall be connected to gland steam condenser, which shall be maintained at a slight vacuum to prevent leakage of steam from turbine to the atmosphere at the seals. The gland steam condenser shall be provided with suitable exhausters (A.C. motor driven)' and necessary isolating and non-return valves. Exhausters shall be 2x100% capacity and the exhaust shall be led outside the building.

19.16.04 Condensate Polishing Unit

Each TG Unit shall be provided with its own full capacity on-line Condensate Polishing Unit (CPU) in order to achieve high order of availability of various power cycle equipment as well as to ensure quick start up of the unit and continue the unit operation without any restriction by maintaining desired quality of condensate water as recommended by Boiler manufacturer. The CPU should also be capable of maintaining specified condensate quality with condenser tube leakage (clarified water).

The CPU shall consist of 3 x 50% condensate polisher vessels in parallel, and shall be provided with inlet isolation, outlet isolation and bypass valves. The CPU shall have external regeneration facilities, resin transfer system (between polisher vessels and regeneration vessels), anion, cation and inert resins from reputed suppliers with proven operating experience for the intended service, proven resin separation mechanism for regeneration, necessary chemical storage, chemical solution preparation and dosing system for regeneration, collection and transfer of regeneration wastes etc. as required.

For design condensate inlet and outlet conditions, mode of regeneration, operating period between regeneration etc. Section-VI of this Volume may be referred. These are based on typical sub-critical units. The design condensate inlet and outlet conditions shall be verified with the requirement specified by the Turbine Supplier selected by the Contractor.

Resin traps shall be provided after each condensate polishing vessel.

For Pneumatic transfer of resins for Condensate Polishing Units, Main plant compressed air shall be used.

19.17.00 **Tubular Surface Condenser**

General

The condenser shall be capable of effectively condensing all the steam exhausted by the turbine at its rated as well as VWO output whilst achieving the design exhaust pressure at the same time cooling/condensing the flash steam from all the feed heater drains and other system drains coming to it. The condenser shall also be suitable for operating at lower exhaust pressures through reduced CW temperatures and during part load operation without being limited by the air extraction equipment.

In addition, the condenser shall be designed to take 60% of HP bypass and corresponding LP bypass load and the exhaust temperature shall be limited to 60 deg C.

Divided flow waterboxes shall be provided to facilitate on load leak testing of each condenser half.

In general, means shall be provided to avoid damage to condenser internals from impingement of flashing steam and incoming condensate or spray water. Where incoming high pressure drains may contain substantial superheat, the supply of a drains receiving flash vessel is preferred.

The condenser along with the rest of the condensate system shall be designed to ensure freedom from hydraulic shock under all conceivable conditions of operation.

Provision shall be kept for complete emptying of the condenser hotwell in case of contamination.

DC solenoid operated vacuum breaker valve shall be provided along with local air receiver and one NRV in air filling line to receiver. Vacuum breaker permitting rapid reduction with remote operation shall be provided. The valve shall be of gate type with provision of sealing against leakage of air.

Condenser Shell

All connections and joints associated with the condenser shell present possible air ingress routes and shall where possible, be welded or include features that are maintenance free with high reliability for the life of the plant. Vacuum tightness and structural soundness of all joints forming the vacuum containment shall be demonstrated on completion of erection.

Waterbox

a) The shape of the water boxes shall be designed to minimise hydraulic pressure loss and ensure that the uppermost tubes remain filled with circulating water under all operating conditions. The selection of material for water box construction and all associated fittings in contact with the cooling water shall be on the basis of electro-chemical compatibility or be suitably isolated and protected by proven coating method(s).

b) Low level hinged access doors shall be provided to permit safe man access to the tube plate for leak testing, inspection and general maintenance reasons. Safety grids across the cooling water connections shall also be fitted where appropriate. At least one manhole of 460 mm size shall be provided in each divided section of the water box.

c) Motor operated butterfly type Isolation valves shall be provided adjacent to the water box connections to provide isolation for man access or removal of

the water box cover to facilitate on-load testing in the case of divided passes.

The condenser inlet and outlet branches shall be joined to the associated cooling water pipe work by pressure balanced type flexible bellows as required. These shall be capable of safely withstanding both full vacuum and CW pump shut-off head whilst accommodating resultant expansions for the life of the plant.

Additionally the Contractor shall provide drain and purge connections at suitable points in the condensate system to permit system clean up after shut down. These connections shall be piped to TG building effluent discharge point.

Tubes, Tube Plates and Support Plates

The proposed method of fixing the tubes to the tube plate should ensure complete integrity and leak tightness for the design life of the station. The Contractor shall describe the joint construction procedure and quality control measures applied to ensuring the soundness of the tube to tube plate joints.

The tubes shall be supported such that they completely drain when not in operation.

19.18.00 **Air Extraction Equipment**

Vacuum maintaining equipment shall be provided, sized for MCR operation using the HEI Standards for Steam Surface Condensers or equivalent standard. Standby capacity shall be provided such that failure of any single plant item in the system shall not result in a loss of vacuum with the HEI rate of air ingress.

Where liquid ring pumps are proposed, they shall be selected for reliable operation such that cavitations and pitting corrosion do not produce mechanical failure or loss of air handling capacity in excess of 10% over 45,000 hours of operation with 100% redundancy.

The air extraction plant shall be complete with all piping, valves, supports and hangers and accessories including vents, drains and exhaust piping. Exhaust piping shall be suitably silenced and arranged to avoid creating a hazard to plant and personnel.

19.19.00 **On-line cleaning of Condenser Tubes**

To maintain the cleanliness of the waterside of the main condenser tubes through the life of the plant, to the design cleanliness factor, on-line tube cleaning equipment shall be supplied of the recirculating sponge ball type, along with ball circulation monitor, ball oversize monitor, ball sorter etc.

20.00.00 COAL HANDLING PLANT

The coal handling plant shall be an integrated system designed to provide complete facilities within boundary of the Plant site for:

a) Unloading of coal from bottom discharge wagons.

b) Any required coal processing including screening, crushing, detection and removal of ferrous tramp material, etc. to ensure that the coal is adequately prepared for handling, storage, milling and any other plant requirement.

c) The conveying and handling of coal from the rail delivery and unloading system to an above ground coal stockyard.

d) The conveying and handling of coal from the rail delivery and unloading system to the main plant boiler bunkers.

e) The conveying and handling of coal from the above ground coal stockyard to the main plant boiler bunkers;

The plant shall be designed to handle with the whole range and condition of coal that may be delivered to the site in a safe, reliable, economic and environmentally acceptable manner.

Safety devices must be provided to allow safe operation of the plant and conveyors including: alarms, trip switches, interlocks, emergency trip systems along the length of all conveyors heat detectors (included in fire fighting) etc.

Coal settling pond shall be provided with adequate capacity pumps and piping to ensure proper evacuation. Ventilation and drainage along with sump pumps to be provided for Track hopper, crusher houses and all Transfer Towers.

All chutes shall be provided with door for cleaning & poking. Galleries with Windows and translucent sheet for proper lighting shall be provided. Medium velocity spray system shall be provided as protection system in conveyor galleries.

20.01.00 Rail Delivery and Unloading of Coal

a) Coal shall be delivered to the plant in rakes of bottom opening hopper (BOBR) wagons.

Two covered track hoppers shall be provided in the rail track for receipt of coal from the wagons.

b) All signaling equipment, line side equipment and other facilities shall be provided to allow the unloading of coal safely and reliably with minimum manual intervention.

c) Feeders shall be provided to remove coal from the track hopper and feed the conveyor system to the coal crushers

d) The system shall incorporate automatic operation of opening of BOBR wagons from signaling system by compressed air as it enters the track hopper.

Necessary air compressors and piping up to the wagons shall be included in the scope of the Contractor. The track and signaling system will be arranged by the Owner. BOBR's specification and requirement for track hopper shall be provided by the owner during DBR.

e) As received Coal auto sampling arrangement shall be provided over the Railway track hoppers.

20.02.00 **Conveyor System**

a) Each conveyor shall be fitted with a centrifugal speed switch for use in the sequential starting and tripping interlock scheme and for ensuring that the driving motor shall be shut down automatically in the event of the belt slipping or breaking. Start-up and shutdown of each conveyor shall be by remote control with provision for local control.

b) Plant shall be designed for ease and flexibility of operation including:

- All conveyors and transfer towers shall be totally enclosed with a central access walkway, maintenance walkways at each side of conveyors. Adequate access shall be provided for cleaning all conveyors.
- Transfer points shall be designed to give good material flow and central loading of conveyors without spillage. Access shall be provided for chute cleaning.
- High quality belt scrapers shall be provided. They shall be positioned and chutes designed such that all scrapings fall into the main chute, to merge with the main flow of material.
- All operational areas shall be well-lit with special lighting provided where the interiors of chutes, hoppers and bunkers must be inspected frequently.

c) All conveyor belting shall be of the fire resistant plied construction type. Fire resistant properties shall conform to IS 1891 Part-5 or any International Standard like ISO-340/ CAN/CSA – M 422 – M 87 of the Canadian Bureau of Mines standard.

The friction surface of the belt shall be suitable for safe operation on gradients of up to 14° from the horizontal for uncrushed coal and up to 16^{0} from horizontal for crushed coal.

d) All surfaces of the chutes liable to come into contact with the coal shall have sufficient lining to assist free flow of coal and to minimise wear.

A suitable arrangement should be provided to indicate a blocked chute.

e) The driving gear for each conveyor shall comprise one or two electric motors as the required power demands, reduction gears, clutches and fluid couplings to permit a soft start of the conveyor belt-moving parts. All gears should be totally enclosed and oil immersed and capable of operating on a twenty-four (24) hour continuous basis.

The coal conveyors and coal transfer plant shall have a complete interlock system installed to ensure the correct sequential operation of the plant.

20.03.00 **Coal Processing**

a) Screening equipment shall be provided to protect the coal handling plant from damage by any extraneous material delivered in the coal including, but not limited to, rock, large metal items and other tramp material.

b) Suitable coal crushing equipment shall be included between the rail delivery system and the coal stockyard/ Boiler Bunkers. This shall crush the delivered coal to a suitable size for use by the boiler coal milling plant. Dust suppression equipment shall be included to ensure a safe working environment and to limit the release of dust to the external environment to acceptable levels. In-line magnetic separators shall be provided to protect the crushing equipment, the main boiler bunkers and coal milling plant from damage or poor operation due to any tramp metal.

c) Screening equipment should be included to ensure that only correctly sized coal is fed to the main boiler bunkers and coal milling plant.

d) Stone picking shall be carried out manually in between Crusher and track hopper where the speed of belt is less than or equal to 2 m/sec.
Any rejects from any item of the coal processing plant shall be delivered automatically to suitable ground level containers designed for ease of emptying. The designs shall avoid the rejection of any correctly sized coal.

e) The coal fineness achieved from the pulverisers shall be at least 70% thru 200 mesh (75 microns) and 98% thru 50 mesh (300 microns) at rated capacity of the pulveriser, with an input coal size up to 50 mm.

20.04.00 **Coal Storage Stockyard**

20.04.01 A complete, fully operational and safe working coal storage stockyard with all associated equipment and environmental controls shall be provided to meet the functional requirements of the power station.

20.04.02 The facilities of the coal storage stockyard shall include:

- Fully automatic stacking and reclaiming facilities;
- Bulldozers

- All environmental controls including dust suppression sprays and waste water treatment.

20.04.03 **Stacking and Reclaiming Facilities**

Stacking and reclaiming facilities shall include the provision of three combined bucket wheel stacker/reclaimer with reversible conveyor to undertake both stacking and reclaiming operations.

Control of the rate of reclamation shall be exercised and displayed in the operator's cab by which the operator shall be able to maximise reclamation productivity. All drives shall be designed so that they may be operated continuously during the reclaiming operation.

20.04.04 **Mobile Plant**

a) **General**: Six self-propelled bulldozers shall be provided with a minimum of 300 kW of flywheel power. Each dozer shall be equipped with all the necessary components and controls to provide a complete and independent unit as specified herein and as delivered to the plant site. Each dozer shall be fully assembled and ready for production when delivered, blade mounted; fuel tank full of fuel; coolant system filled with heater/engine coolant; and crankcase, transmission, differential and final drives (each), hydraulic system, and windshield washer reservoirs filled.

b) **Unit Description**: Each dozer shall be new, large, self-propelled units with a minimum of 300 kW of flywheel power to be used for coal storage pile maintenance.

Each bulldozer shall have a large heavy-duty coal blade for coal pile maintenance. Coal blade size shall be at least 5500 mm length x 2000 mm height.

c) Each dozer shall be complete with the following or equivalent equipment:-

- Lighted instrument panel.

ii) Monitoring systems for alternator charging and voltmeter; fuel level and pressure; transmission oil temperature and filter service; coolant flow and temperature; pilot system filter service; hydraulic oil level, temperature, and filter system service; engine oil level, temperature, and pressure; air cleaner service; brake oil pressure and parking brake application; and clock hour meter. Monitoring systems can include lighted gauges and/or electronic monitoring system with warning horn.

iii) Key start.

iv) Muffler.

v) Safety glass in windshield.

vi) Backup alarm.

vii) Warning horn.

viii) 50 amp alternator and heavy-duty batteries.

ix) Lighting system, six forward lights, two rear mounted lights, and rear mounted stop lights.
x) Electrical diagnostic connector and diagnostic tool.
xi) Fast oil change system.
xii) Fast fuel system.
xiii) Fire suppression.
xiv) Draw bar.
xv) Front counterweight.
xvi) Power shift transmission.
xvii) Supplemental steering.
xviii) Guards on power train.
xix) Heavy-duty crankcase guard.
Tool kit.
xxi) Multiple row module radiator.

Necessary number/ capacity of bulldozers shall be provided to assist in stacking of coal.
If same capacity or more is available in China market, same shall be provided by Contractor, otherwise nearest capacity shall be provided.

20.04.05 **Environmental Controls**

Environmental controls on the coal storage stockyard shall comprise of dust suppression sprays, good housekeeping techniques including compaction to prevent spontaneous combustion and surface water run-off treatment and recirculation.

20.05.00 **Coal Bunker Delivery System**

The coal bunker delivery system shall include suitable equipment for the detection of coal bunker coal levels and an automatic system for directing coal to a bunker which requires filling. This system should be fully monitored and controllable both from the coal plant control room and locally. Suitable ventilation, fire protection and other safety equipment shall be provided.

Radar non contact type bunker level indicators shall be provided.

21.00.00 **FUEL OIL HANDLING SYSTEM**

The fuel oil storage and handling system shall follow the rules and regulations of the Indian Explosives Act and Indian Petroleum Act.

The function of the fuel oil storage and handling equipment is to provide a continuous supply of both LDO (light diesel oil) and HFO (heavy fuel oil) to the ignition and support firing oil burners, at the desired flow rate, temperature and pressure.

The storage tanks shall be fitted with heating equipment and thermal insulation as appropriate to maintain the temperature of the storage tank contents at or above the required outflow temperature of the fuel oil specified.

Provision shall be made for filling the storage tanks from both road tankers and railway wagons.

The complete oil storage and handling system shall be arranged to operate automatically, with the minimum of operator intervention.

The fuel oil systems shall be configured to preclude contamination of HFO and LDO or vice-versa.

Means shall be provided to indicate the tank contents, with the fuel oil level clearly visible external to the tank and the empty and full levels clearly marked.

Means shall be provided to vent the tank to atmosphere through flame arrestor and to guard against inadvertent overfilling of the storage tanks; specifically:

- The tank content indicators shall be clearly visible form the filling point.
- The vent pipe terminal shall be clearly visible from the filling point.
- A high fuel oil level alarm shall be provided.

Means shall be provided to drain the storage tank(s).

The tank heaters shall be controlled automatically to maintain the pre-set temperature. Means for adjusting the temperature set point shall be provided.

Electric immersion heaters (if used) shall incorporate a high temperature safety cut-out, set approximately 10^{O} C above the operating temperature.

Where steam is used as the heating medium the economic case for a condensate recovery system for HFO tanks and SCAPH shall be considered. Condensate recovery system shall have collection tanks and pumps.

Each tank discharge line shall be fitted with:

- Means for isolating the fuel oil supply.
- A first stage fuel oil strainer.
- Vent connection with isolation valve.

Adequate fire detection and automatic fire fighting facilities shall be provided. A remote fire alarm signal shall be provided in the station control room.

Pipe work shall be designed and installed in a manner to permit emptying and purging of the entire system and to avoid accumulation of oil vapor to the extent possible. Air vents shall be provided at all high points. Two isolation valve will be provided.

The oil pipeline, including all fittings, valves, strainers, pumps, etc. shall be trace heated and lagged as appropriate to maintain the required temperatures.

Relief valves shall be fitted in all positions where a rise in pressure may occur due to a rise in temperature of oil enclosed between isolating valves.

Where the oil system configuration requires fuel oil to be recirculated back to the storage tank(s), means shall be provided to ensure that under normal circumstances the recirculated oil is returned to the supply tank.

Means shall be provided to measure the fuel oil consumption of each individual boiler. Where a recirculation line is included, flow measurement equipment shall be provided for both supply and return pipelines.

The fuel oil pumps and heaters shall be supplied together with all associated electrical equipment, e.g. motors, starters, switchgear, cabling and wiring, etc. Motors for HFO and LDO pumps shall be Flameproof.

Each fuel oil pump shall be fitted with the following pump specific associated equipment:

a) A pump suction strainer (two simplex strainers in parallel), fitted with baskets of the aperture size specified by the pump manufacturer.

b) Inlet and discharge isolating valves.

c) Inlet and discharge pressure gauges.

d) A non-return valve in the pump discharge line.

e) Reciprocating pumps shall be fitted with accumulators to limit pressure fluctuations.

f) The system shall have adequate drainage and purging provision with relevant recovery system including drain oil pit.

Oil tanks and dyke volume should have 20% margins as per Indian Petroleum rules and CCOE guidelines..

Required control valves shall be provided for temperature control of oil tanks and heaters.

Fuel oil heaters shall be provided to raise the temperature of the fuel oil from the storage/outflow temperature to the desired discharge temperature (the firing temperature plus any allowance made for temperature loss between the heater discharge and the oil burners).

Each heater shall be provided with inlet and discharge isolating valves, a relief valve and means for measuring the fuel oil temperature.

22.00.00 ASH HANDLING PLANT

22.01.00 Description of System

a) The Bottom Ash Disposal System shall be provided for the collection and removal of bottom ash from the boiler furnace. The coarse ash from economizers shall be transported to bottom ash silo.. The bottom ash shall be collected by dry ash conveyor from bottom ash hopper (6 hours storage capacity) and shall be transported to intermediate ash silo of 6 hour capacity by conveyor system. From Intermediate silo ash will be transported to main silos by 2x100% belt conveyor system (common for all six units) which is placed near ash dyke. Belt conveyors shall be enclosed with a closed Canopy/hood with a hinge connection. One common walkway will be along the conveyor for maintenance. The bottom ash main silos storage capacity shall be 12 hours for each with worst coal for all six boilers. The equipment specification of ash belt conveyors shall be similar with coal conveyors.

b) Pneumatic Combined Vacuum and Pressurized System shall be provided for handling fly ash. The system shall cover the ash collected in hoppers of ESPs air preheater sequentially and shall be collected in dry condition in ash silos. The redundancy for vacuum pumps and transport air compressors shall be as specified in Section-VII.

The ash system shall be designed for following data :-

i)	Coal calorific value (gross)	:	3800 kCal/kg
ii)	Ash Content	:	40%
iii)	Bottom ash	:	20% - of Total Ash
iv)	Fly Ash	:	90% - of Total Ash
v)	Coarse Ash	:	10% of total ash (Eco-5%, Air Heater – 5%)

vi) Typical Ash analysis is given separately.

From the fly ash silos, the ash can be transported by truck for industrial uses, or the ash can be sent to the ash dump yard by High Concentration Slurry Disposal (HCSD) system as deliberated in Section-VI.

c) Arrangement for transportation of ash from ash silos by High Concentration slurry Disposal (HCSD) system up to the Ash disposal area/dump area shall also be provided.

22.02.00 **Furnace Bottom Ash Extraction and Handling System**

a) The function of the Furnace Bottom Ash Handling System is to extract ash from the boiler furnace bottom on a continuous or intermittent basis with the boiler either on or off load; reduce the ash in size and transfer it to the bottom ash conveyors for transportation up to the main silos near Ash Dyke area. The system shall be designed for minimum operator intervention. The sizes of the crushed bottom ash shall be reduced to suit flow (using air blower / vibrator) unloading from Intermediate & Main silo. The Metallic conveyor shall be designed at 150% of the Ash generation with BMCR and worst coal. The downstream equipments of the metallic conveyor upto bottom intermediate ash silo shall be designed at 150%. The common ash

belt conveyors from bottom ash intermediate silo to main bottom ash silo shall be designed at 2×100%.

The ash extraction system will be required to handle the entire bottom ash produced with the unit on 100% BMCR while burning the worst fuel specified. This shall include any peak due to the removal of slag from the boiler tubes during tube cleaning,

b) Not used

c) The design of the furnace bottom ash extraction system shall conform to the relevant requirements of IS:8633: "Technical Requirements for Location of Boiler Installations and Boiler Houses" as well as any generally recognised International Standards.

d) The bottom ash/ coarse ash collection and disposal system for each unit shall comprise the following equipments/ components.

One self supported type bottom ash hopper (SS plate or equivalent not less than 10mm) with cast able ,refactory lining with SS anchors etc to withstand radiant heat and ash heat arround 800-900 degree. All other accessories including, poke holes Manholes, bottom gate with hydraulic system/pneumatic system, inspection door etc. shall be provided.

The hopper shall be provided with expansion joint around its top periphery to prevent ingress of air and at the same time accommodating three dimensional movement of the boiler bottom header as per design.

The Bottom Ash hopper equipped with adequate number of bottom doors which shall be hydraulic operated/pneumatic operated and shall enable to store ash inside the hopper. Complete hydraulic driving system including oil tank, oil pump, valves, piping, fittings, accessories and control device for the bottom Gate.

One metallic belt conveyor and gates for isolation between hopper and conveyor..

One bucket conveyor/conveyor for collection of ash to bottom ash Silo.

A hydraulic/ activated facility to break lumps of very large dimension which might be present in bottom ash.

One crusher for grinding of clinkers to bring in suitable sizes for conveying thru the system up to the Ash main silo

One intermediate bottom ash silo for each unit(capacity 6 hrs) , the capacity shall be sufficient for maintenance of down stream system. Below each intermediate silo three outlets shall be there. one shall be for feeding to down streams conveyors (2x100%), one for unloading of conditioned ash to truck thru ash conditioner and one for emergency/future purpose.

Main silos shall be provided with four streams of ash unloading to dumper/trucks. All three shall work concurrently. In each silo further one outlet points shall be provided for future use. Refer design criteria for detail of bottom ash conveying system.

22.03.00 Fly Ash Handling System

a) The function of the Fly Ash Handling Plant is to remove fly ash from the dust extraction plant hoppers and transport it to the storage silo(s). This shall be carried out by combination of pneumatic vacuum and pressure system. A set of vacuum pumps shall extract the ash from hoppers under vacuum up to a buffer vessel (fitted with bag filter) and thereafter the ash will be transported to the fly ash silos by a set of transport air compressors.. The equipment shall be suitable to handle the ash burden from the specified worst fuel as per design under all loading conditions.

The fly ash extraction system and transport system capacity shall be designed for evacuation of 200TPH.The buffer vessels for each unit shall be sized to provide minimum effective storage capacity equivalent to 30 minutes of rated fly ash extraction/conveying capacity.

Contractor shall also arrange fly ash removal from fly ash storage silos up to the ash dump yard by the High Concentration Slurry Disposal HCSD mode.

The fly ash storage silos shall be fitted with suitable equipment to load dry ash into road tankers and conditioned ash into open lorries so that the same may be received by ash utilisation plant as and when required. Dry ash shall be loaded in Road/rail tankers by telescopic unloading spout and Conditioned ash shall be loaded by ash conditioner to open truck.

The systems including silo ash removal shall be designed to function with minimum operator intervention.

b) Moisture may be present in the ash collection plant during cold starts of the boiler. The ash handling plant must be designed to cope with this eventuality.

c) Fly-ash storage silos capacity shall be sufficient to contain the maximum dust production for the maximum period that dust removal ceases with all boilers on MCR and burning the worst coal specified. The minimum storage capacity of the ash silos shall be equal to 12 hours of ash production under this condition, considering 90% of the ash generated is fly ash.

d) All the major components shall have inspection and cleaning facilities in the event of system blockage. It shall be possible to isolate each section of the system for maintenance whilst retaining the remainder of the system in service. The entire plant shall be capable of smooth starting after a reasonable stoppage of the system (which tripped during its full load operation for some system disturbance).

The bends in the pipe work system shall have material of construction proven in service. Wear resistant linings should also be considered where appropriate.

Components subject to high temperatures shall be insulated to protect personnel. Other components may be insulated at the discretion of the Supplier. Due allowance shall be made for the expected ambient conditions local to the plant.

e) **Storage Silos**

Storage silos shall be of cylindrical RCC construction fitted with access doors, pressure relief vents and local and remote level indication; silo venting arrangement etc. The silos shall be designed for mass flow and the discharge shall ensure an even flow of dust to the dry loading or conditioning equipment. The silos shall be supported such that there is head room below for lorry access. There shall be space provision for housing the high concentration slurry forming devices, unloaders, dry dust loading spout equipment, fluidizing blowers & heaters etc.

The ash transfer pipe work into the silos shall be arranged such that each pipe can feed any silo. The changeover shall be automatic when a silo is full and it shall also be possible to bias the flow to a particular silo by remote operation from the Control Room. Each ash conveying lines shall be branched to silos provided with isolation valve for each silo.

Each silo shall be fitted with vent filters sized to meet emission standards. The filters shall be cleaned automatically on load by pulse-jet system. Instrumentation shall be provided to warn when a filter is defective. The silos shall be of proven FLAT bottom type fitted with radial air-slides, hoods and related arrangements.

f) Where disposal of fly ash by truck is envisaged, sufficient loading points shall be provided such that all the ash can be processed either all dry or all conditioned within the specified time periods. The plant arrangement shall be such that dry and conditioned ash can also be loaded into vehicles concurrently.

The conditioning equipment shall be suitable to supply conditioned ash with water content within ± 1% of the set point. The water content set point shall be adjustable.

Both the dry and conditioned ash loading systems shall be automatic following manual initiation of the loading cycle. The driver will be responsible for positioning the vehicle under the loading point and for connecting and disconnecting the dry loading spout. The design of equipment and systems shall ensure zero dust degrees at all stages of the filling process.

g) The total ash silo 100 meter radius area and roads shall be paved with RCC.

23.00.00 PLANT WATER SYSTEM

23.01.00 General

The raw water storage at site and treatment plant, including pump house, raw water pumps clarified water reservoir necessary piping etc. shall be provided by the Contractor.

Raw water reservoir of capacity as specified elsewhere shall be provided at site. The reservoir water after necessary clarification/treatment shall be used as make up water for condenser cooling purpose in a recirculating system consisting of cooling towers. Contractor shall provide with necessary intake structure, supply pumps, conveying piping, raw water treatment/clarification plant, and make-up water system to feed make-up water to the cooling towers, as also for use in other systems like water Demineralising (DM) plant, fire water, potable water etc.

23.02.00 The Contractor shall fully demonstrate the design intent of the raw water treatment and CW make-up system including:

a) that he will demonstrate to the satisfaction of the Engineer that the design of the cooling water system is suitable for the 30 years design life of the power station. This will include modeling to demonstrate stability and security of supply at the proposed intake position with the proposed design.

b) that the water treatment plant being used for providing the cooling water and the industrial water supply shall perform adequately, make-up water shall be of a suitable quality for the design of the cooling tower and other cooling water system plant and equipment being adopted.

c) that the design and construction of any water works associated with the make-up or discharge arrangements shall be satisfactory to the relevant consenting statutory authorities.

23.03.00 Pre-treatment Plant

A complete raw water treatment plant shall be provided to meet all make-up water requirements of the plant as well as DM water, potable water (both plant and Colony), fire water, service water requirement, water requirement for coal handling and ash handling plants if necessary, along with sludge collection, and disposal arrangement. Prechlorination shall be provided for raw water supply system. Clarifiers shall be provided for plant water supply to all facilities.

Clarified water reservoir of specified capacity and feeding arrangement to water demineralising plant and other required systems shall be provided.

23.04.00 Demineralising Plant

a) The duty of the Demineralising plant shall be to provide make-up water of a specified quality and daily volume throughput to meet the total

requirements of the power plant. Primarily this will be for make-up to the boilers and this duty will normally govern the purity required.

The system shall be designed to function with a minimum of operator intervention.

b) The plant shall be designed to minimise the consumption of process chemicals, regenerants and power.

23.05.00 **Chemical Reagent and Regenerant Supply, Storage and Transfer**

The equipment for the storage and handling of chemicals and regenerants shall be designed such that:

a) The manual handling of chemicals during unloading and transfer to storage shall be kept to a minimum.

b) Solid chemicals shall be delivered and stored in dry, covered conditions and silos shall have moisture traps fitted.

c) Liquid chemicals shall be stored in tanks constructed from or lined with corrosion resistant material.

d) Tank or silo filling connections shall be separated from each other within an individual locked enclosure and clearly marked with the chemical type.

e) Chemicals releasing volatile or harmful vapours shall have suitable traps and scrubbers fitted to the tank vents.

f) Automatic safety showers shall be installed adjacent to chemical unloading facilities and within the water treatment plant.

If the bulk chemicals are to be used for other water treatment plant applications, e.g. condensate polishing, they shall meet the minimum purity standards for the more onerous duty.

23.06.00 **Cooling Water System**

A cooling water system shall be provided that is capable of providing the cooling duty necessary to meet the rated plant performance requirements.

The principal criteria for the design of the system shall be to ensure a supply of cooling water to the condenser during all possible conditions at all times.

An auxiliary cooling water system shall be provided to circulate demineralised water to various plant auxiliaries as necessary.

23.07.00 **Main Circulating Water Pumps and Pump house**

The Contractor shall describe the number, type and duty of the main cooling water pumps proposed. These pumps and associated ancillary equipment shall be based on plant proven in service elsewhere.

For system designs that include pumps in parallel operation, each pump shall be capable of continuous operation at maximum run-out condition.

A pump house (unless otherwise specified, elsewhere in this specification) shall enclose the main circulating water pump sets and provision shall be made to enable all maintenance actions to be undertaken on this plant.

Provision shall be made for isolation of individual pumps for maintenance. All isolation valves for the CW system shall be motor-operated butterfly type with zero leakage, except the discharge valves of the CW pumps will be hydraulic type

The pump forebay design shall allow operation of any permitted pump combination whilst ensuring reasonably uniform flow conditions to each pump inlet of the three units in one phase with separate isolation steel gates. It shall prevent the generation of vortices or any other mechanism, which could induce air into the pump inlet. Validation of the design shall be substantiated during the Contract phase from computational fluid dynamics (CFD) modeling. The design of the C.W. pumps forebay and sump shall conform to the latest edition of the Hydraulic institute standard, USA. Additionally, data on satisfactory performance of identical system may be provided.

To facilitate safe maintenance within the cooling water system, the pipe work shall incorporate appropriate isolation and man access points, approach ladder and platforms where necessary.

Any specific corrosion control system provided shall be fully described and the Contractor shall demonstrate that the plant offered is suitable for the station design life, the water quality and the anticipated duty.

Details shall be provided of any provisions made to ensure that valves and stop gates do not foul on trapped silt and corrosion products. Suitable vents shall be provided at all points where air pockets may form.

23.08.00 **Control of Biological Growth, Fouling and Hygiene**

The Contractor should assess the need for and accordingly provide a suitable system to control fouling in the complete cooling water system by treatment with biocide to control biological growth, biofouling and hygiene.

The residual chlorine levels permitted in the purge water shall be limited to no more than permitted by the local regulatory authority. The Contractor shall make provisions to ensure compliance with these limits and shall provide the necessary monitoring instrumentation.

The make-up screening plant should have sufficient capacity and redundancy to ensure an uninterrupted cooling water supply under all extremes of variation in local water quality and during cleaning operations. Screening shall therefore be undertaken in two or more streams to provide redundancy.

Inlet and outlet isolation by means of stop gates shall be provided at all traveling/revolving type strainers, as also to facilitate the cleaning/maintenance of pump sumps and water reservoirs.

23.09.00 **Auxiliary Cooling System**

The principal criteria for the design of the system shall be to ensure a continuous and reliable supply of auxiliary CW to the plant concerned in all conditions and at all times.

Acceptable arrangements for the auxiliary cooling duty include but are not restricted to:

a) Primary closed circuit treated demineralised water system.

b) Secondary open circuit taking clarified water from the main cooling water system through separate pumping.

23.10.00 **Cooling Tower**

IDCTs shall be provided. The proposed towers shall be of proven design with a design life equal to that of the main plant offered.

Where a cooling tower thermal performance guarantee is required, a design allowance for recirculation shall be included in accordance with BS 4485/PTC.

The cooling tower thermal and structural design shall take into account the quality of make-up water.

The Contractor shall justify his choice of cycle of concentration factor, taking into account the general requirement to minimize water abstraction and pumping costs whilst not risking significant scaling of wetted heat transfer surfaces or excessive dosing costs.

To enable compliance with health and safety requirements the tower shall include provision for drainage of all water contained in the distribution system and pond and access for de-sludging. The cooling water system shall be provided with suitable treatment system including.

- Acid dosing system.
- Dosing of corrosion and scale inhibiting chemicals.
- Chlorination systems.

The design shall include space provision for side stream filtration, if required in future.

23.11.00 **RO Plant (RO system will be confirmed as per designing requirement to meet zero discharge)**

23.11.01 The schematic arrangement of the treatment of residual effluents by UF/RO system as per agreed flow scheme The plant shall consist of UF/RO streams of net capacity as per approved water balance diagram along with necessary pre and post-treatment and chemical dosing/ storage arrangement. The UF/ RO streams with all accessories shall be capable of continuous parallel operation.

The operation of the UF and RO plant will be "fully-automatic". The plant operation shall be possible without constant operator attendance other than for start-up / commissioning and shutdown. All protections and safety features shall be in-built in the instrumentation and PLC based Control System. Off-normal system parameters shall be annunciated.

The system shall be generally as shown in the Flow diagram and shall consist of the following major items:

a. Piping within the Plant Boundary.

b. Pretreatment (clarification and filtration by multigrade filters) to reduce the suspended matters, chlorination to avoid bio-growth, chemical dosing for control of pH, scale and corrosion, Redox Potential etc.

Necessary chemical dosing shall be used to boost pH before the water gets recycled to the water treatment plant inlet, to about 8.0. One dosing tank and two (one working and one standby) dosing pumps shall be provided for this purpose.

c. UF modules, Feed pumps, Fast and back flush pumps and piping

d. RO feed pumps, micro filtration and RO modules to achieve desalination.

e. Product water storage tank, through suck back tank.

The major portion of the plant, viz. pumps, pressure filters, chlorinators, chemical dosing systems, high pressure pumps, micro-filters, UF and RO modules, electrical and control panels, etc. will be housed indoor. The clarifier, acid /alkali storage tanks, product water storage tanks will be located outdoor.

23.11.02 The clarified water shall be pumped through 2x100% pumps to the UF/RO Plant, through 2x100% dual media pressure filters and cartridge filters, as required for the process. The complete set of chemical dosing system for pH reduction, scale control, de-chlorination, silica level control etc. shall be included in the scope. The cleaning and flushing arrangement for the UF/RO membranes shall also be included. The Contractor shall indicate the recommended dosing rates of various chemicals for this application

The RO plant shall be provided with necessary safety interlocks and annunciations, monitoring instruments for critical parameters before and after the plant.

23.11.03 The reject from the RO shall be utilised to the maximum extent for HCSD system, road wetting, dust suppression, Ash silo area cleaning etc. In case reject water cannot be totally utilised, it should be collected in an evaporation pond for removal of accumulated salts from the reject quantity collected. The pond shall be sized considering total average annual rainfall quantity along with the expected waste quantity to be evaporated, and assuming the evaporation rate as 5mm per day.

The pond shall be constructed with an earth base suitably compacted to 95% Proctor density compaction. Minimum 0.75 mm thick HDPE liner shall be placed on the earth base and sides. A sand bed, 75 mm thick shall be laid on this lined base. The sides of the pond shall have suitable slope of 1:2 (V:H). The pond(s) shall be shallow with effective height of 1.5 m. The sides shall be lined with 0.75 mm thick HDPE and then strengthened with cement mortar.

The liner shall be laid, seamed and tested and shall be protected from mechanical damage by providing a layer of minimum 100 mm PCC with chicken mesh.

23.11.04 The RO effluent shall be equivalent to or better than the filtered water quality being obtained from the Water Pre-treatment plant.

23.11.05 The RO plant shall be designed so that if any stream is not in service for a long duration because of less input water, then it shall have provision of preservation of the modules.

23.11.06 Before the RO plant inlet the liquid shall pass through adequately sized treatment facilities comprising clarifier, PSF/DMF, UF etc. with proper treatment for suspended matters, colloidal matters, silica etc if necessary.

23.12.00 RAIN WATER HARWESTING SYSTEM

Rain water harvesting is a scheme where the rain water drains from roofs and surface run-off water are collected and allowed to percolate into the ground. The basic purpose is to assist the ground water table stability. Also, it is a compulsory provision for a new project as per the recommendations of the statutory / Environmental bodies.

For details of the rainwater harvesting system, please refer Civil and Structural specification, Volume-II, Section-17.

24.00.00 STEAM/ WATER CIRCUIT CHEMISTRY

The overall aim of the steam/water circuit chemistry is to minimise the corrosion of all materials within the steam/water circuit and to ensure the plant integrity over the plant life.

The Contractor shall specify the chemical regime under which the boiler shall be operated and provide details of the dosing, sampling, monitoring. and blowdown arrangements that will maintain the chemistry within defined parameters. The chemical regime and the equipment supplied to maintain it within specification should be compatible with the source and type of condensate coolant and the anticipated staffing levels at the plant.

The Contractor shall specify the chemical regime for the condensate, feed water and boiler water, indicating target values and acceptable operating ranges for each of the specified parameters. The Contractor shall also specify the maximum impurity concentrations in the superheated steam to be produced together with evidence of its compatibility with the steam turbine. The proposed chemical regime will be assessed against national and international standards.

The Contractor shall supply a schedule including a process flow or P & I diagram for the steam water circuit indicating the positions of the dosing and sampling points and the chemicals to be dosed and the parameters to be measured at each point.

24.01.00 Dosing System

The dosing system shall be designed to maintain the steam/water circuit chemistry under all normal operating conditions including condenser leaks and also for wet off load storage of the boiler(s).

The dosing plant shall be designed with operator safety as priority with a minimum of handling of bulk chemicals. The Contractor shall provide dosing equipment, including chemical storage, mixing and dilution tanks, dosing pumps, pipe work and double isolation valves, drainage and wash-down for spillage. The Contractor shall offer the option of remote control of the dosing pumps including closed loop control from on line circuit chemistry monitors.

HP dosing system (Phosphate) and LP dosing system (Ammonia and Hydrazine) comprising of one tank and two pumps shall be provided for each unit.

24.02.00 Sampling and Monitoring System

The duty of the steam/water circuit sampling system is to take continuous representative samples from the steam/water circuit, to cool such samples to ambient temperatures and to deliver these samples to a central facility where on line monitoring and manual sampling will take place. Those sample lines linked to on line monitors shall have an additional facility for taking a manual sample.

The Contractor shall provide all necessary steam/water circuit sample points, pipe work, isolation valves, sample coolers and sampling valves appropriate to the pressure rating of the sample points. The cooled sample target temperature shall be 32 ± 2°C. All sampling lines, valves and fittings shall be in stainless steel.

The Contractor shall provide all necessary equipment to monitor the chemistry of the condensate, boiler feed water, boiler water, saturated steam, superheated steam and reheated steam. The Contractor shall provide a schedule of chemical parameters that require routine measurement and the required frequency of measurement if not by continuous on-line monitor. All routine chemical control parameters shall be monitored by means of continuous on-line monitors, with appropriate indications and alarms relayed to the main control room.

25.00.00 COMPRESSED AIR SYSTEM

Total compressed air supply and distribution systems shall be supplied for the power station and for other interfacing systems. A general service compressed air system shall be provided, to enable the use of air-powered maintenance tools etc. A separate compressed air system for Control and Instrumentation shall be provided, if such an air supply is required by control and instrumentation equipment proposed by the Contractor.

The compressors shall be complete in all respects, including filters, coolers, moisture separators, receivers, etc. The systems shall be automatically controlled; all arrangements and configurations shall take due account of operational and maintenance requirements of the station.

The general service compressed air system shall be designed and suitably manifolded to allow adequate discharge points in all operational and maintenance areas. Suitable sectioning and zoning of the system shall allow isolation of plant areas for maintenance without outages on the remaining plant.

The control and instrumentation air system shall have self contained driers etc. to give continuous supply of air at the quality required for the control and instrumentation equipment under all expected atmospheric conditions.

26.00.00 FIRE PROTECTION SYSTEM

The design and construction of the fire detection and protection equipment shall be to internationally accepted standards (e.g. NPFA) and in compliance with the LPA and TAC requirements for the licensing and fire insurance (with minimum premium) of the complete power plant.

A comprehensive fire detection and alarm system and fire protection system shall be provided for the whole power station to provide a high degree of protection for plant, equipment and buildings and employees. Necessary interfacing with other systems (e.g. fuel and air handling plants, ventilation systems, etc.) shall be provided.

Underground fire hydrant ring main facility shall be provided. Strategically placed hydrant connections shall be provided on the system to suit the site/ plant/building configuration.

Risers shall be provided for internal protection to boiler galleries and turbine houses at various levels. All hose connection points shall be fitted with landing type

valves with instantaneous female connections. Top landing valves shall terminate at the boiler house/turbine house roof levels.

Fixed Water Spray Systems shall be fed by separate set of pumps and piping.

All gas type fire protection shall be designed for Inert gas system. Fire protection and detection systems shall include remote indication/alarm facilities, zoning of fire protection and detection installations, and facilities for the containment/removal of smoke and the containment/removal of spray water.

In control buildings and other areas where cable fires could result in unacceptable corrosion damage and/or the obstruction of fire fighting procedures, cable routes containing more than 3.5 l/m of combustible cable volume shall be enclosed, the enclosure to have a minimum fire rating of one hour to BS: 476 Part 20 [or equivalent standard].

All fire barriers proposed for the containment of smoke or fire shall have a minimum fire rating of one hour to BS: 476 Part 20 [or equivalent standard].

The Contractor shall identify the fire risks presented by the proposed plants and provide appropriate fire protection equipment accordingly. It is expected that these will include (but not necessarily be limited to) the following:

a) Electrical Bays (switchgear room, MCC room, cable spreader room etc.)

b) Fuel handling and storage plant

c) Steam generator burner zone

d) Steam Turbine Generator lubricating, jacking, governor and seal oil systems

e) Boiler feed pump set lubricating oil systems

f) Oil filled transformers

g) Diesel engines and fuel tanks

h) Boiler light up gas store and pipe work

i) Hydrogen filled machines, store and pipe work

j) Flammable cables

k) All other indoor and outdoor stores where any inflammable substance may be present.

The significant fire-fighting requirement has been covered under Section VI. Theses are highlighted below for reference.

- Conveyor belts, Cable galleries and Cable spreader rooms shall be protected by medium velocity spray system. The design shall follow the guidelines of NFPA/ Tariff advisory committee (TAC) and shall include fire detection with alarm, actuation of spray system, quenching and extinguishing of fire. The areas to be protected shall be zoned suitably and shall be provided with automatic isolation valve for each zone.

  The detection system for cable galleries shall be (i) linear heat sensing cables (ii) Smoke detectors (iii) sprinkler heads. In case of conveyor belts, the linear heat sensing cable type detectors shall be provided to stop the conveyor on detection of fire.

- For oil filled transformers, high velocity spray system with deluge valve shall be provided. The system have its automatic fire detection and actuation system. The design shall follow NFPA/ Tariff advisory committee (TAC) recommendations.

- The fuel oil storage tanks shall be protected by automatically operated fixed foam system, along with required foam generation system and piping connected with the hydrant system. The design shall be in line with the recommendation of NFPA.

- Portable fire extinguisher shall be provided covering the complete power station. The type and number of the extinguisher shall follow the recommendations of TAC for different types of fire.

- Fire detection and fire protection system shall be cover the entire power station, including all buildings, transformers, coal handling and storage, fuel oil handling and storage, open yard storage etc.

- The hydrant system shall cover all coal conveyors. Sprinklers shall be provided for the coal piles.

27.00.00 AIR-CONDITIONING AND VENTILATION SYSTEM

Air-Condition and Ventilation system as necessary for the plant and as detailed out elsewhere in this specification shall be supplied.

Adequate dust extraction and dust suppression system shall be provided at transfer towers and crusher house of coal handling plant.

28.00.00 WASTE WATER TREATMENT

28.01.00 The waste water treatment plant shall take waste water produced on site as a result of the power generation process and as a result of building and surface drainage, and shall ensure that the final discharge point meets the requirements of national and local environmental and pollution control legislation. The Contractor shall demonstrate that the proposed plant is capable of meeting those requirements under all likely operating and local weather conditions.

The potential sources of waste water are typically, but not exclusively: building and surface storm drainage; domestic waste water and sewage; boiler and turbine house drains; boiler blow down; boiler waterside chemical cleaning; boiler gas pass cleaning; make up water treatment plant effluent and from outside the power island, sources such as coal stock pile drainage and wet ash disposal system.

The following factors shall be considered when designing the waste water system:

a) Where appropriate and practicable wastewater streams should be combined to feed a common treatment facility.

b) Waste water shall be recycled or reused to the maximum extent possible.

c) Domestic wastewater and sewage should be treated to an agreed standard before combination with other streams. This treated waste shall be used mainly for gardening/green belt irrigation system.

d) Boiler blowdown is of high purity and after cooling, may be returned to the inlet of the make up water treatment plant.

e) Boiler cleaning liquors, waterside or gas side, should be neutralised and stored in a separate on-site lagoon prior to discharge or be removed from site for separate treatment and disposal.

28.02.00 SEWAGE TREATMENT SYSTEM

Domestic sewage from the plant shall be conveyed through closed drains to the domestic sewage pump house. Then, the sewage shall be pumped into the complete sets of equipment for sewage treatment conducting biological contact oxidation treatment. The treated water shall be disinfected before pumped into Industrial waste water system in the waste treatment plant. The sediment shall be collected in a Sludge Tank.

For details, Sewage Treatment Flow Diagram shall be referred.

29.00.00 PACKAGE BOILER AND AUXILIARIES

The Contractor shall supply dual Light Diesel Oil (LDO) fired package boiler, rated to meet the cold start steam demand requirements of the power station including VAM requirement..

The plant shall be complete with all the necessary equipment and auxiliaries for its safe and efficient operation.

All equipment shall be designed and constructed to meet the requirements of the Indian Boiler Regulations and to other national or international standards applicable to steam raising plant.

The Contractor shall specify the proposed chemical conditioning and the design steam purity targets. The necessary provisions for the preparation and injection of feed water conditioning chemicals shall be kept. Provision shall be made for the sampling of boiler water to ensure safe and correct operation of the plant. The

Contractor is responsible for ensuring that the water treatment plant design is adequate for water supply to provide boiler make up purity.

The Contractor shall show that the stack temperatures are, under all operating conditions, in excess of those likely to give rise to corrosion. The boiler shall be manufactured in a manner that facilitates inspection and maintenance of critical components.

Complete compliance with the Central and State Legislation is required and therefore the Contractor shall be required to supply all necessary documentation to demonstrate compliance.

Flame detection equipment shall be provided to ensure the safe operation of the plant.

Sufficient stand-by capacity of feed pumps shall be provided to ensure that plant availability\reliability targets are met.

Each pump set shall be capable of operating continuously at the rated duty with feed water at minimum suction temperature.

Each pump set shall be capable of auto-standby duty so that stand-by pump automatically starts in the event of failure of an operating pump.

Proposals for feed pump isolation to ensure safe onload maintenance, measures taken for protection against reverse flow and provision for draining and pump priming shall be fully described in the Tender.

The Contractor shall specify all fans required for the operation of the plant.

The method of fuel to air ratio control over the range of burner turndown shall be stated in the Tender.

The Contractor shall specify the method of burner isolation.

All main steam pipe work shall be manufactured by a seamless process and shall be designed to meet the requirements of the Indian Boiler Regulations. Isolation of each boiler from any common steam main shall be provided following the requirement specified in 18.05.00(a) of this section.

A single free standing stack shall be supplied for each boiler.

Steel chimney structures shall be designed to meet the requirements of the Indian Boiler Regulations and/or CICND Model Code for Chimneys and BS:4076 or equivalent.

Lightning protection shall be provided for the stacks.

All chimney structures are required to receive thermal and corrosion protection to ensure that damage does not occur over the operational life of the boilers under normal operating conditions.

30.00.00 FLUE-GAS DESULPHURISATION (FGD) PLANT

FGD plant is not in the scope of Contractor. However suitable space provision for the same shall be kept in the layout for future requirement

31.00.00 GASES

Suitable storage, distribution and control systems for gases which are necessary for the operation of the plant, shall be provided.

For the hydrogen cooled Generators, a suitable hydrogen generation, storage and distribution system with control stations and connections to Generators shall be provided.

CO_2 and Nitrogen storage, distribution and control systems associated with hydrogen cooled Generators, for emergency and/or routine purging purposes and also for nitrogen blanketing, mill fire protection and such other requirements as applicable shall be provided.

32.00.00 OTHER FACILITIES

32.01.00 OVERHEAD HANLDING FACILITIES

The Contractor shall provide all overhead traveling cranes, hoists, runway beams, etc. necessary for the safe and efficient operation and maintenance of the plant. All parts of the plant shall be provided with a convenient arrangement for slinging or handling during erection and overhaul.

Three (3) nos. EOT cranes shall be provided in the turbine hall. Each EOT crane shall lift safely the heaviest equipment in TG hall (Except Generator stator) and Generator transformer during maintenance in maintenance bay. Two (2) nos. EOT cranes shall be used to lift Generator Stator. SEPCO will supply one Lifting Beam to facilitate lifting of Generator Stator by two EOT cranes in tandem. Further, SEPCO shall design the TG building structure based on above requirement.

Where permanent cranes, hoists, etc. are used for the construction of the plant, these shall be refurbished to an "as new" condition before handing over to the Owner.

The Contractor shall include for a remote operation facility for main cranes and pendant operation of all small cranes and hoists.

32.02.00 FIRE TENDER

Four tanker type fire tenders/trucks shall be provided. The truck shall meet the requirements of all applicable codes and standards including NFPA 1901. Each truck shall come complete with, but not limited to, the following:

a) One (1) 3000 litre (min.) water tank.

b) One (1) 2250 litre per minute (min.) single stage centrifugal pump rated at 7 bar.

c) One (1) demountable monitor nozzle to allow 360 degree operation complete with 2250 liter per minute combination straight stream/fog nozzle.

d) Five (5) 30 minute duration OSHA approved self-contained breathing apparatus.

e) One (1) portable hydrant type gated wye, one inlet by four gated male outlets.

f) All required hoses including pump suction hoses, supply hoses, attack lines, and hose on the booster hose reel.

g) All discharge outlets as required by NFPA 1901 or TAC.

h) All required nozzles. Nozzles shall be UL listed variable pattern ball shutoff type. Nozzles shall be hard anodized aluminum alloy.

i) Standard 4.3 meter roof and 7.3 meter aluminum extension ladders shall be provided.

Each of the fire tender shall be furnished with trailer fire pump driven by Kirloskar HA494 air-cooled diesel engine or approved equal. The centrifugal pump with reciprocating priming system shall have a capacity of not less than 1800 lpm at 7 bar. The trailer chassis shall be constructed out of MS channels mounted on 2 detachable wheels having semi-eliplical springs and shock absorber. The tyres shall be pneumatic; and the weight of the engine and pump is equally distributed on the chassis to ensure free movement. Provision shall be made to carry suction hose and ancillary equipment with unit. The trailer shall be provided with front and rear stands for steady operation. Hook type towing arrangement with spring loaded bracket and over-run device automatically the break mechanism shall be provided.

32.03.00 **FORK LIFT**

Fork lift shall be provided as per the specification mentioned below:

- Number – Four (4)
- Fork Lift Capacity – 3 Te.
- Engine – Four Stroke Diesel Engine Driven, Prime Mover – 50 HP min.
- Power Steering – Hydrostatic Power Steering with lateral steering cylinder on steer axle
- Load Centre – 500 mm
- Fork Height – upto 3.5 m
- Fork Length – Minimum 1 m
- Mast Height (Fork Raised) – upto 5.0 m.
- Mast Tilt –
  - Forward – 5 degrees
  - Backward – 10 degrees
- Drive Speed – 10 km/hr (Loaded)
- Lift Speed – 0.3 m/sec

- Turning Radius outer – 2.2 m
- Programmable controller – Micro-processor based to ensure effective speed control.
- Safety features like armature current limit. Potentiometer fault protection, thermal protection, under voltage protection are to be provided.
- Standard Accessories to be provided as follows:
  - Load back Rest
  - Battery

33.00.00 **VALVES**

Valves for vacuum service shall be designed for leak-tightness against leakage of atmospheric air, with water sealing at glands.

All valves shall be located such that safe access for operation is provided, and such that the valve maintenance is possible in-situ. Extension spindle/chain operator shall be provided where required.

Valves shall be fitted with a position indicator, which clearly shows the open and shut positions. Facilities shall be provided for isolation using padlock. Each valve shall be fitted with an approved nameplate.

Valves shall not be fitted in an inverted position.

The internal diameter of all valves at the ends adjacent to the pipes shall be the same as the internal diameter of the pipes to which they are joined.

Plug type valves for concentrated acid and caustic shall preferably be of the sleeved self-lubricated design.

Gear operator shall be provided wherever required to keep the maximum effort to open/close the valves within 25 kg.

All power operated valves shall be fitted with both hand and power operating gear, open and closed position limit switches, torque limit switches, space heater for infrequently operated drive motors, position indicators, 2-wire position transmitter with 4-20 mA DC output, etc. All valves of nominal size 250 mm or more, for which the normal working pressure is 40 kg/sq. cm(g) or more, shall be provided with integral bypass. For motor operated valves, the integral bypass valves shall also be motor operated.

The spindles of all valves for use in outdoor locations shall have weatherproof protection covers if necessary.

All hand-operated valves shall be of the outside-screw and Yoke type and shall be closed by rotating the hand wheels in a clockwise direction when looking at the face of the hand wheel.

All valves shall be permanently engraved with arrows for open and close direction of hand wheels and also preferred/design flow direction.

Drain, vent, instrument tapping and such other connections on piping/ equipment shall be with double isolation valves incase the system design requires valves of more than 600 lb pressure class.

The designing codes and material of all valves and pumps shall be provided as per submitted requirement.

34.00.00 PLANT BUILDING REQUIREMENT

All switch gears, MCC's, control panels and such other electrical items, as well as all materials, plant and equipment, requiring weather protection and/or regular attendance for operation/maintenance work, shall be suitably protected and housed in buildings provided with adequate Ventilation/ Air-conditioning, as specified elsewhere in this tender document, and as required.

35.00.00 PAINTING AND FINISHING

The Contractor shall furnish, for the Owner's approval, details of all the paint finishes he intends to use, including details of the surface preparation. The Contractor shall make good any defects in paintwork prior to hand-over of the plant to the Owner. All pipelines shall be color coded for identification as per IS-9409.

36.00.00 THERMAL AND ACOUSTIC INSULATION

The Contractor shall provide weatherproof Thermal insulation and acoustic enclosure to meet design requirement and various specification requirements stated elsewhere.

37.00.00 LUBRICATION

Provision shall be made for suitable lubrication wherever necessary to ensure smooth operation, heat removal and freedom from undue wear.

Lubrication shall be adequate during starting as well as during running down.

Gear boxes and oil baths shall be provided with suitable filling and drain plugs, and means of oil level indication. Where a large quantity of oil is involved, a drain valve shall be provided at the point of discharge. Access and space for suitably sized drain containers shall be provided, where possible, or drains piped to a suitable accessible point.

A separate nipple shall be provided to serve each lubrication point, and all grease nipples and dipsticks shall be readily accessible. Where necessary for accessibility, nipples may be remotely mounted at a point as near as is practicable to the lubrication point, and connected thereto by means of double wall copper brazed steel tubing. Where a number of nipples are in use, they are to be grouped together on a conveniently placed battery plate. Nipples of standard sizes shall be chosen to minimise the amount of greasing equipment required.

Access to lubrication systems shall be such as to permit maintenance, draining and refilling without contamination of the new lubricant and without the removal of guarding. Suitable spillage collection equipment shall be provided.

Lubricants marketed by the Indian Oil Corporation shall be used. The Contractor shall supply a schedule of lubricants based upon this supplier's products. Efforts shall be made to limit the variety of lubricants to the minimum.

The Contractor shall supply the first fill of oil, grease and hydraulic fluid, which shall be obtained from the nominated lubricants supplier.

38.00.00 **SPARES**

The Contractor shall identify all spares and consumable required during normal servicing and planned outages and all spares recommended to meet the availability targets.

Spares shall fall into three categories :

Consumable Spares	:	those Spares associated with the day-to-day maintenance, inspection and overhaul of the Plant which requires regular attention.
Overhaul Spares	:	those Spares associated with planned overhauls to ensure Plant conditions to meet availability or efficiency targets.
Strategic Spares	:	those items or assemblies which are generally high cost and/or long lead-time Spares, the deployment of which will either be unique in the life of the Plant or required infrequently.

(for overhaul spares and strategic spares supply is not included in this contract)

The Contractor shall include in his offer the supply of all Consumable Spares required upto successful completion of reliability test of the Plant,

All Spares shall be directly interchangeable with the corresponding parts installed in the Plant and shall meet the requirements of the original Plant specification.

The Contractor shall specifically identify those items which he recommends be manufactured at the same time as the main plant so as to gain benefits from concurrent manufacture.

The Contractor shall advise of major components held in the manufacture's works that could support unforeseen failures.

The Contractor shall provide all spares required during the period of testing and commissioning, and all spares to fulfill the Contractor's obligations during the Defects Liability Period. By agreement with the Engineer, the Contractor may use

those Spares held by the Engineer, but the Contractor shall be responsible for the cost and replacement of such spares.

The Contractor's plant design may need a significant Strategic Spares holding, in order to meet his availability guarantee. Therefore, the Owner may choose to hold certain key items, which he considers to be necessary because a higher holding may be commercially advantageous (for example higher availability). The Owner may thus wish to procure a "turnkey" spares building/facility, in which case, the following shall apply:

a) The Contractor shall provide a spares storage facility, which shall be equipped with suitable plant handling system (forklift trucks, mobile cranes, etc.). The Contractor shall also provide a suitable spares management system.

b) The Contractor shall offer a combination of open storage areas and enclosed buildings, which are wholly commensurate with the need to maintain the integrity of the spare parts. Integrity in this case is considered to be those properties, which enable the component to meet its required function, performance and life.

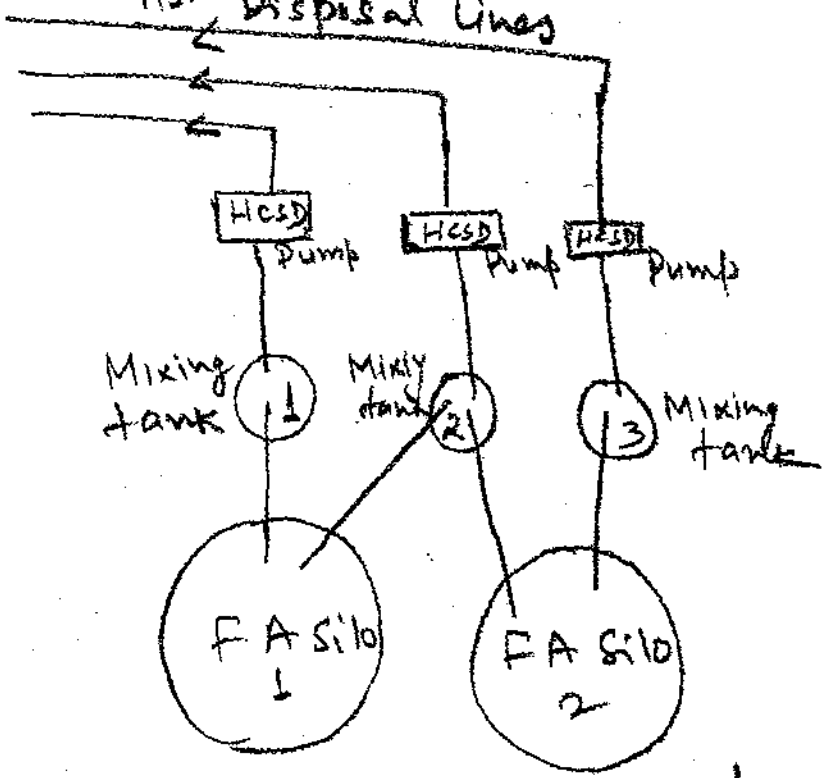
39.00.00 CONSUMABLES

The Owner will provide reasonable quantities of fuel necessary for testing, commissioning and initial operation. Should testing, commissioning and early operation be unduly extended due to failure of the Contractor to satisfactorily complete installation and adjustment of the plant then the Owner reserves the right to claim from the Contractor the costs of fuel used less an allowance for electricity sales received. The Contractor shall supply all other consumables including gases and water treatment plant chemicals necessary for the testing, commissioning and initial operation of the plant. The Contractor shall ensure that at the time of taking over the station storage systems contain quantities of all other consumables sufficient for at least two weeks continuous operation of the plant.

Contractor has indicated the maximum quantities of startup fuels like LDO, HFO and Coal for trials and reliability test runs. These shall be capped and any excess consumption shall be reimbursed by contractor beyond the guaranteed quantities as agreed in commercial contract.

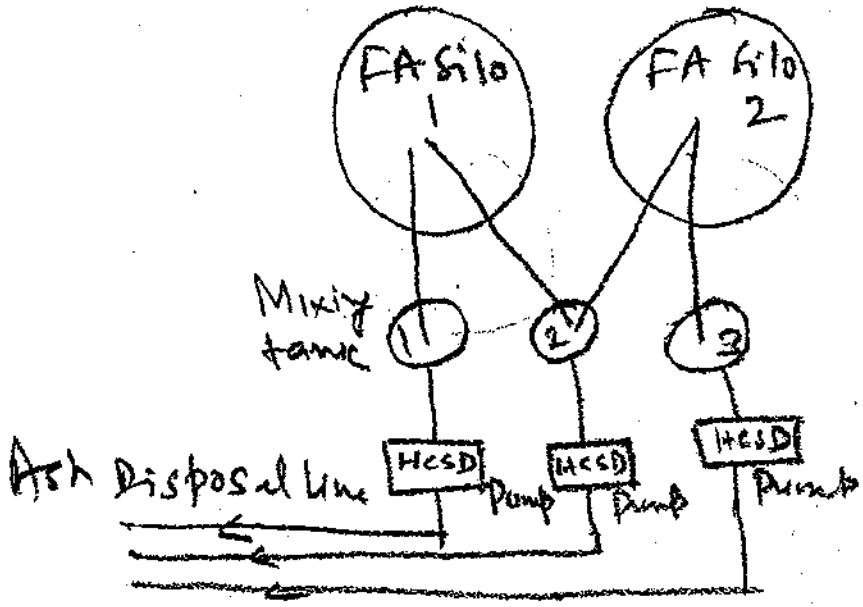
HCSD System

6 × 600 MW - WPCPL, CG



Phase #1

Phase #2



UNLOADING POINT ARRANGMENT FOR FA SILOS

6×600 MW

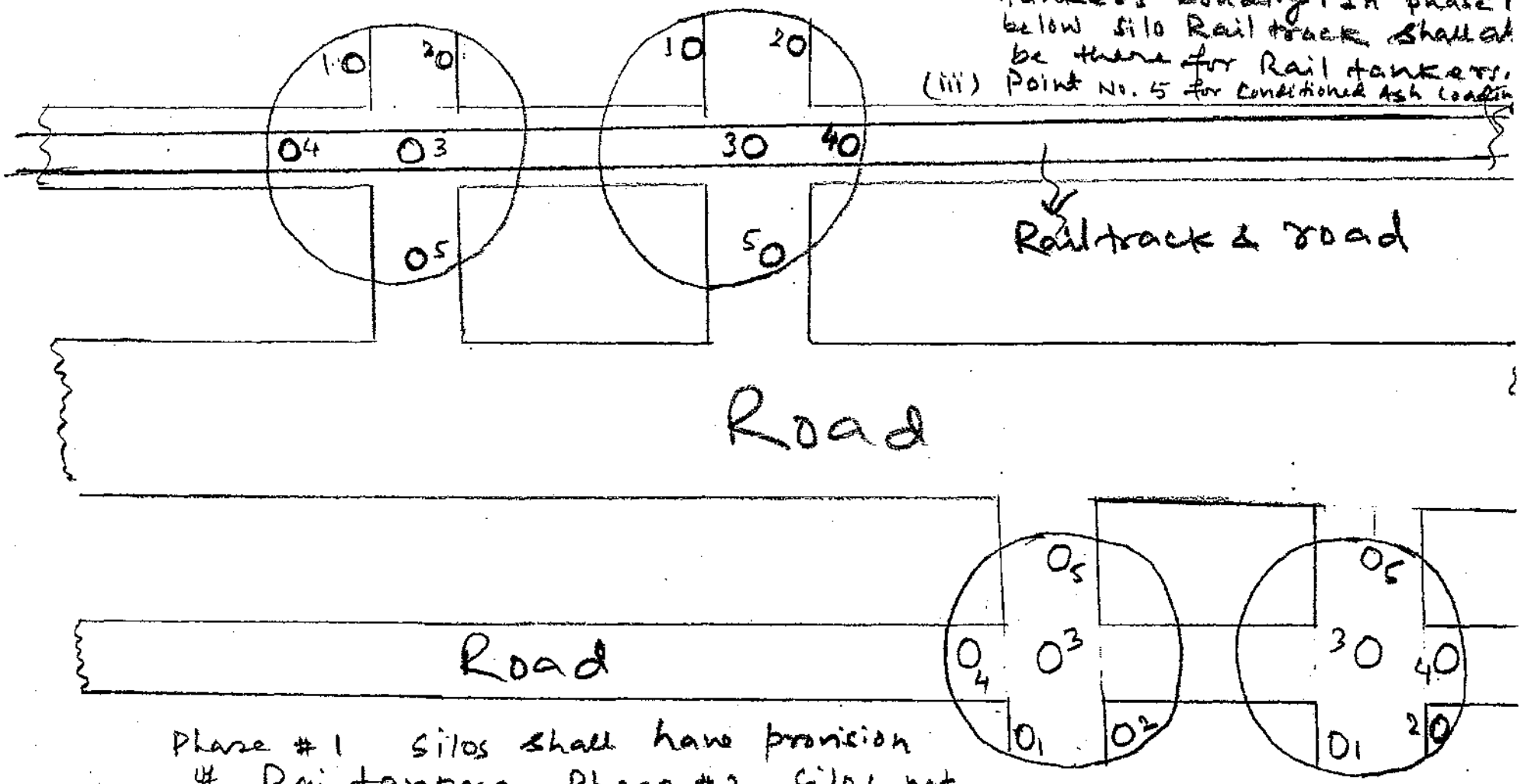
WPCPL-CG

① Five Nos. of Unloading Points shall be provided

(i) Unloading Point 1 & 2 for HCSI system

(ii) Point No. 3 & 4 for Bulkers/tankers loading. In phase I below silo Rail track shall also be there for Rail tankers.

(iii) Point No. 5 for conditioned Ash loading



Phase #1 Silos shall have provision of Rail tankers. Phase #2 Silos not required the same.

VOLUME-II

SECTION-IV

SCOPE OF WORK AND TERMINAL POINTS

26.03.09
(KIRAN PANDA)
WPCPL

(XUGUI)
2009.02.26

VOLUME-II

SECTION-IV

SCOPE OF WORK AND TERMINAL POINTS

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SECTION-IV
SCOPE OF WORK AND TERMINAL POINTS

The Contractor's scope covers design, material selection, manufacturing, testing at works, supply, installation, performance testing at site, commissioning and other related items of work for all plant and equipment, inclusive of all civil, structural and architectural works necessary for a complete working power station, including but not limited to the following (one set per unit, except for systems common for all the units).

SL. NO.	ITEMS	WHETHER INCLUDED
A.	**BOILER ISLAND**	
1.	Complete steam generating unit with milling and draught plant for pulverised coal firing system, along with ignition and support firing system and low NOx burner; refractories and insulation as required.	Yes
2.	Particulate extraction equipment (Electrostatic Precipitators + Fabric Filter)	Yes
3.	Multi-flue Chimneys with three flues. Two No., each 275 m high	Yes
4.	Goods-cum-Passenger Elevators for approach to boiler galleries, one elevator for each Boiler	Yes
5.	Elevators for the maintenance of the chimney (One for each chimney)	Yes
6.	Coal Feed System, Boiler cleaning system, soot blowing system for the furnace and air pre-heaters	Yes
7.	Raw coal bunkers with bunker level monitoring.	Yes
8.	Auxiliary boiler	Yes
9	Coal pulverizing system consisting of 7 bowl type mills (6 Working + 1 Standby)	Yes
9.	Coal mill reject handling system. By means of hydraulic conveyor system of proven design, upto Mill reject Silo along with water recycling- Separate for each Unit	Yes
10.	Raw coal bunkers emergency emptying system and arrangement for the disposal of the emptied coal.	YES
11.	Air pre-heater and coal mill fire fighting system	YES
12.	Chemical dosing system	YES
13.	Blow down system (continuous, with steam recovery, and also intermittent)	YES
14.	Fuel oil support system	YES

SL. NO.	ITEMS	WHETHER INCLUDED
15.	Boiler structural steelwork with all necessary stairs, galleries with roofs and side covers	YES
16.	Pent house on furnace roof with weatherproof enclosure and pressurised ventilation	YES
17.	Coal sampling system and air-flow measurement system at mill outlet	YES
18.	Fuel oil supply from Fuel oil storage tank outlet up to the boilers, with day tanks for HFO with necessary pumping and heating units.	YES
19.	Any other accessories as required	YES
B.	**STEAM TURBINE ISLAND**	
1.	Steam turbines with emergency stop and governing valves, gland sealing system, extraction steam systems, HP-LP bypass, all control, protection and monitoring devices, lubricating and governing/control oil systems, insulation etc.	YES
2.	Boiler feed pump sets with variable speed drive units (turbine driven working pumps and motor driven standby pumps) and booster pumps.	YES
3.	Regenerative feed water heating system including feed water heaters and deaerator, chemical dosing, condensate make-up and dump, reserve feed water tank etc.	YES
4.	Condenser with air evacuation system, condensate extraction pumps, continuous on-line tube cleaning system, etc.	YES
5.	Turbine oil receiving, storage, transfer and purification system.	YES
6.	Condensate polishing units	YES
C.	**Complete Power Cycle piping**, valves etc. as well as all auxiliary system piping, valves with hangers and supports etc. as required for the boiler and steam turbine islands and connected systems, with dummy stub for Wet steam washing facility including insulation, cladding etc..	YES
D.	**WATER SYSTEM**	
1.	Intake at Mahanadi river, Raw Water intake Pumps, intermediate reservoir and pipelines up to the raw water reservoir within plant boundary.	No
2.	Effluent water collection, treatment and reuse system to achieve zero discharge.	YES
3.	Not used	
4.	Raw water treatment plant.	YES
5.	Clarified water reservoir.	YES

SL. NO.	ITEMS	WHETHER INCLUDED
6.	Fire water reservoir (Clarifier water tank)	YES
7.	All circulating water, auxiliary cooling water and any other cooling water systems as required, including :	
	a) Induced Draft Cooling towers with back to back cells arrangement with one spare cell	YES
	b) CW pumps for main condenser cooling.	YES
	c) Cooling water pumps for TG and SG island coolers (e.g. auxiliary cooling water pumps, closed cycle cooling water pumps using demineralised water.)	YES
	d) Heat exchangers with closed cycle DM water primary cooling system and secondary circuit auxiliary cooling water pumps, as necessary	YES
	e) Blow-down and make-up water system.	YES
	f) Chemical dosing for the protection of cooling water system to control growth of algae/barnacle etc along with chlorine dosing unit.	YES
	g) Internal chemical control for the CW/ ACW system for prevention of corrosion and scale deposition on piping/heat exchanger surfaces.	YES
8.	Rain water harvesting system including piping and other accessories required,	YES
9.	Filtration plant with filtered water reservoir.	YES
10.	Demineralisation plant with necessary Demineralised water storage tank and transfer pumps for make-up to heat cycle system and make-up to closed DM water cooling system, as required, along with neutralising pit with pumps & piping for effluent disposal up to guard pond/effluent treatment pond.	YES
11.	Condensate make-up water storage tank for each unit.	YES
12.	Boiler filling system (pumps, piping etc.)	YES
13.	Service water, drinking water (for both plant and township) and other auxiliary water systems, including piping, pumps, storage tanks, etc.	YES
14.	All pumps, piping, gates, screens, trash racks etc. for the complete system.	YES
15.	All sump pumps/drainage pumps for the entire plant.	YES
16.	All piping, valves etc required for the water systems.	YES

SL. NO.	ITEMS	WHETHER INCLUDED
17.	Drinking water supply to colony (up to Plant Boundary)	YES
18.	RO Plant of adequate capacity to meet the zero effluent discharge requirement including following : 1. Chlorination system, Clarifiers, Multi Grade filters etc. 2. Chemical conditioning system 3. RO modules, RO feed pumps, Ultra filter 4. Related piping, fittings for completion of system	YES
19.	Guard Pond as required.	YES
20.	Control, protection and monitoring system with necessary interfacing with centralised Distributed Control System (DCS).	YES
E.	**COAL HANDLING PLANT**	
	Complete with coal wagon unloading system, coal crushing and screening plant with metal detector and inline magnetic separators, coal stacker & reclaimer (three (3) nos) for crushed coal stock piles (15 days design coal for BMCR storage requirement) coal conveyors from unloading station to crushing plant, to stock pile and to power house raw coal bunkers, as also:	YES
1.	Conveyor galleries, tunnels, transfer points.	YES
2.	Two (2) Track hoppers, crusher houses, transfer towers etc.	YES
3.	Complete dust extraction, dust suppression, ventilation and air-conditioning system.	YES
4.	Control, protection and monitoring system with necessary interfacing with entralized Distributed Control System (DCS).	YES
5.	Coal wagon weigh bridges for weighing loaded and empty rail-wagons.	YES
6.	One Road weigh bridges of 100 Te, Two Railway weigh bridges 120 Te each one at each side (total 4 nos Railway Weigh Bridge) of the track hopper complex.	YES
7.	Conveyor belt weigh scales upstream of coal crushers/stackers as well as downstream before entry to the power house bunkers.	YES
8.	Coal sampling unit upstream of coal crushers/stackers as well as downstream at power house raw coal bunker entry.	YES
9.	Rain protection shed with structures above track hopper, also, sidewalls for rain protection.	YES

SL. NO.	ITEMS	WHETHER INCLUDED
10.	Coal unloading and stockpile area storm drainage system, including the arrangement for collection, clarification, recycle and disposal of the drain water.	YES
11.	Railway Tracks	No
12.	Air compressors with piping for operating bottom opening rail wagons.	YES
13	Metal detectors on the conveyor before each crusher and before coal bunkers of each unit.	YES
14	Elevator, one for each Crusher house and one common for transfer towers of Phase-I & II before bunker provided with reversible belt interconnection.	Not Required
F.	**ASH HANDLING PLANT**	
1.	Complete with fly ash conveying systems to intermediate storage/ buffer hopper by vacuum extraction system and from there to main silos thru Densephase conveying system. Subsequently from Main Ash silo to Fly Ash dyke by High Concentration Slurry Disposal (HCSD) system.	Yes
2.	Bottom Ash Hoppers with dry bottom ash conveying system by a metallic conveyor (closed) to an intermediate silo via Crusher. Conditioned Bottom Ash from the intermediate silo shall be transported to the main bottom ash silos near bottom ash dyke through a conveyor system. Coarse ash from Economiser hopper also shall be routed to the Bottom Ash Intermediate Silo.	Yes
3.	Clinker crushers,, Ash conditioner, with other necessary equipments, piping etc. as required for bottom ash handling	Yes
4.	Lean phase slurry disposal for the bottom ash.	No
5.	Vacuum Pumps, compressors, blowers, heaters, piping with other necessary equipments etc. as required for Fly ash handling including extraction and Pressurized Conveying system.	Yes
6.	Fly ash silos, intermediate surge hoppers, dust extraction/suppression systems, unloader etc., and ash withdrawal system from both surge hoppers and fly ash silos for disposal.	Yes
7.	HCSD system comprising mixing vessels (with inside rubber liner, agitator and density meter), slurry tanks, water supply for conditioning and preparing the slurry, slurry tanks, piston diaphragm pumps, ash disposal, pipeline flushing system, with all accessories.	Yes
8.	Recovery of water from the bottom ash system, ash water	No

SL. NO.	ITEMS	WHETHER INCLUDED
	decantation, clarification and recovery etc.	
9.	Control, protection and monitoring system with necessary interfacing with entralized Distributed Control System (DCS).	Yes
10.	Ash pipelines beyond, upto Ash Dump Yard.	Yes
11.	Each silo shall have unloading facility • Two no unloading points for HCSD system • Two no. unloading Points for dry unloading into road Bulkers and or closed Rail tankers thru telescopic Chute.(Space privision for unloading two bulkers at same time from the same silo) • One no. unloading Point for feeding to open trucks thru ash conditioner • The rail unloading shall be available for one phase only.	Yes
12	Rain Water Escape structure of Ash dyke to meet Civil Specification	Yes
G.	**FUEL OIL SYSTEM**	
1.	Fuel oil system for unloading (from railway wagons and also from road tankers) and storage with necessary unloading pumps, storage tanks with tank heating system, Pipe tracing (as per design), dykes, complete fuel oil systems from Bulk storage tank to Boiler (in case of LDO) and to Day oil tanks (in case of HFO) including return oil line etc.	YES
2.	Oil-water separator to treat rainfall run off etc. from fuel oil tank farm and handling area.	YES
3.	Railway Tracks	No
H.	Complete fire detection and fire protection system for the protection of the entire power station, including all buildings, transformer, coal handling & fuel oil handling systems, coal stock piles, open yard storage etc. This shall also include portable fire extinguishers. Fire detection panels with all provisions in central control room, fire station and fire water pump house.	YES
I.	**OTHER AUXILIARY ITEMS**	
1.	Compressed air (service air/instrument air) station with air compressors, drying plant, distribution system (throughout the power station) etc.	YES
2.	Auxiliary system piping. (e.g. auxiliary steam, fuel oil, drinking, water, effluent etc.)	YES

SL. NO.	ITEMS	WHETHER INCLUDED
3.	Pipe supports and associated civil/structural works, including pipe racks, trestles, trenches etc. as required including all temporary frames for transport and erection.	YES
4.	All lifting and handling equipment, motorized type to facilitate the handling and transportation of all plant and equipment (heavier than 1000 kg) that may need maintenance/overhaul during the plant's lifetime. This shall include the cranes on rails for - a) TG Hall, b) Boiler feed pumps c) feed heater bay d) CW pump house, e) Raw water pump house, f) Clarified/ Fire water pump house, g) DM plant, h) Workshop & store etc., as also hoists, trolleys & monorails for other plant and equipment such as mills, ID, FD & PA fans, coal handling and ash handling plant equipment etc. Also, slide rails and pulling systems required for equipment handling where applicable and trolleys for feed heater tube/shell and boiler feed pump impeller removal. Portable hoists/platforms/fork lifts shall be provided, as required, for maintenance/overhauling of items below 1000 kg.	YES
5.	a) Effluent collecting, sampling, monitoring, treatment, recirculation and reuse system meeting zero effluent discharge norms.	YES
	b) All necessary equipment for testing, monitoring and control of pollution from within the plant to the environment for meeting stipulations, as required.	YES
6.	Flue gas desulphurisation plant.	No (Space to be provided in layout)
7.	Hydrogen generation plant with adequate number of cylinders, storage and distribution system. There shall be no direct piping from Hydrogen Generation Plant to the manifold at the Ground floor of Power House. From the manifold Hydrogen gas will be supplied to Generator thru piping.	YES
8.	Nitrogen cylinders (adequate number for refilling) storage, handling and distribution system for preservation purpose.	YES
9.	Carbon Dioxide bottles (adequate number for refilling) storage, handling and distribution system.	YES
10.	Laboratory for testing coal, fuel oil, turbine oil, transformer oil, ash, ambient air quality, stack emission, & other effluents; also steam and water analysing and sampling units including necessary samplers and monitoring kits etc.	YES
11.	Ventilation and Air conditioning systems as required, for power house and other auxiliary buildings as well as for non plant buildings within	YES

SL. NO.	ITEMS	WHETHER INCLUDED
	plant boundary.	
12.	Diesel generator set(s) as required for the safe coasting down of the units.	YES
13.	Goods cum passenger elevators for boilers (one for each boiler), TG building elevators (two), Capsule type high speed elevator one for each control room suitable for 10 persons.	YES
14.	Passenger lift for Administrative building (one) suitable for 10 persons, and stack elevators one for each stack suitable for 6 persons.	YES
15.	Plant maintenance workshop equipped with necessary equipment & facilities for best up Keeping of the entire plant. Bulldozer and other Vehicle maintenance shop.	Yes
16.	Supply and application of paints and thermal/acoustic insulation as required for the entire power station as well as all non-plant buildings.	YES
17.	Coating, Wrapping and cathodic protection (if required) of underground piping	YES
18.	Drive motors with gear reducer and coupling for all equipment wherever required.	YES
19.	Six bulldozer, Four fork lifts, Four fire tenders, Two Hydra Crane each of 12 Te and two Hydra Crane each of 10 Te as per relevant specification.	YES
20.	All the lab equipments (Mech/Elect/Inst), Workshop equipments, as per specification with commissioning spares.	YES
21.	Any other supply items not specifically mentioned but deemed necessary for safe, reliable & satisfactory operation of the plant.	YES
J.	**ELECTRICAL SYSTEM**	
1.	Main Generators with Static Excitation system, Digital Automatic Voltage Regulation, Surge Protection and Neutral Grounding Equipment and necessary controls.	YES
2.	Generator Transformers with required On Load tap-changer (OLTC) and all other fittings & accessories and Lightning Arrestors.	Yes
3.	Station and Unit Transformers with OLTC and OCTC respectively and all other fittings & accessories, neutral grounding resistors and Lightning Arrestors.	Yes
4.	LT (11kV/415V) Auxiliary Distribution Transformers complete with all fittings and accessories.	Yes

SL. NO.	ITEMS	WHETHER INCLUDED
5.	Generator Bus duct of isolated phase design, consisting main, tap-off sections and delta ducts complete with associated equipment.	Yes
6.	HV Busducts.	Yes
7.	LV Busducts.	Yes
8.	MV and LV Switchgears/Power Control Centres, Emergency Switchboard, Motor Control Centres, Distribution Boards, Starters for AC/DC drives, Fuse Boards etc.	Yes
9.	Battery, Battery Charger and DC Supply Distribution system complete with interconnection facility.	Yes
10.	AC uninterruptible power supply system complete with battery inverter, etc.	Yes
11.	Complete Plant Intercommunication and Telephone system (Connectivity of Public Telephone network to boundary of Power Plant is by Owner)	Yes
12.	Illumination system of whole plant including Non-plant buildings with accessories and dry type lighting transformers .	Yes
13.	Control, protection and metering systems including control/relay panels, hardwiring backup panels & synchronization panel for generator & transformers.	Yes
14.	All Local panels, local P.B. stations, Junction boxes & Local Control stations.	Yes
15.	400 kV switchyard complete with all equipment, safety devices, protective relaying, controls, metering, hardwiring backup panels etc.	Yes
16.	Separate C.T., P.T., tariff metering system.	Yes
17.	Cables and cable raceway system with necessary fire barriers, fire proof sealing and coating systems	Yes
18.	Grounding and Lightning protection systems	Yes
19.	Electrical laboratory equipment	Yes
20.	DG sets for emergency power supply	Yes

SL. NO.	ITEMS	WHETHER INCLUDED
21.	Neutral Grounding Resistors	Yes
22.	AC Motors, DC Motors & Motors Actuators	Yes
23.	Electrical system for auxiliary plants & other peripherals such as CHP, AHP, CWP etc.	Yes
24.	24V DC for C&I loads	Yes
25.	48V DC system for switchyard PLCC system and Plant communication system	Yes
26.	Construction power supply system at one point within plant boundary at 33 kV by owner. Contractor to do further distribution.	Yes
27.	SCADA for switchyard control and interface with main DCS	Yes
28	Remote Terminal Unit (RTU) in Switchyard	Yes
K.	**CONTROL AND INSTRUMENTATION SYSTEM**	
1.	Distributed Control System (DCS) comprising data acquisition sub-system, closed loop and open loop controls, data highways, OPC server/gateways for connecting packaged control systems, operator stations with Visual Display Units and control devices, printers, engineering work station, large video screen, historical storage unit, master clock system, necessary application, documentation, diagnostic and engineering software.	Yes
2.	Control room panels and racks including supervisor's console.	Yes
3.	All primary sensors like Flow elements, Temperature sensors etc.	Yes
4.	All field instruments - process switches, transmitters, local gauges etc.	Yes
5.	All final control elements like Control valves and drives.	Yes
6.	Steam and Water Analysis System (SWAS).	Yes
7.	Continuous emission monitoring system (CEMS).	Yes
8.	Continuous ambient air quality monitoring system	Yes
9.	Machinery Monitoring System (MMS). Mechanical Vibration monitoring & analyzing system (Diagnostic analysis) for Turbine & TDBFP is provided as part of normal scope. For other major rotating equipment online vibration monitoring system on DCS is provided.	Yes

SL. NO.	ITEMS	WHETHER INCLUDED
10.	All boiler integral instrumentation including Furnace Safeguard & Supervision System (FSSS), Flame monitoring system, Boiler & Auxiliaries Control & interlock, Soot blower control system, ESP Control System, etc. with connectivity to DCS.	Yes
11	All turbine integral instrumentation like Turbine supervisory instruments, Condition monitoring system, Automatic Turbine Run up System (ATRS) inclusive of Auto Synchroniser. Turbine Stress Control (TSC), Electro hydraulic Governor Control (EHG), Automatic Turbine Testing System ATT, Turbine Protection system, HP-LP bypass system etc. and interface with DCS.	Yes
12	All junction boxes, cubicles, enclosures, local panels, marshalling panels, pneumatic and process hook up hardware, cables and other erection materials and accessories.	Yes
13.	Maintenance and Calibration Equipments for Instrumentation Laboratory.	Yes
14.	a) Complete control, monitoring and protection system of all auxiliary systems and offsite like Coal Handling plant, Ash Handling plant, Water Treatment plant, Compressed Air Plant etc. with facility to interface with main DCS.	Yes
	b) Integration of BOP C&I Systems with Plant DCS	Yes
15.	Fire detection and Alarm System	Yes
16.	Inter communication system with dedicated UPS for Inter communication system	Yes
17.	Redundant UPS for DCS	Yes
18.	Redundant UPS for each offsite system	Yes
19.	Training Simulator	No
20.	CCTV system for plant surveillance	No
L.	**CIVIL, STRUCTURAL AND ARCHITECTURAL**	
	Design and construction, including supply of all materials and labour of:	Yes
1.	All civil, structural and Architectural works related to system/plant requirement covering all main plant buildings as well as non plant buildings.	Yes
2.	Miscellaneous non-plant building and structures, such as, Administrative buildings, Service building, Gate office, Time office, Fire station, Weigh bridge, Workshop, Vehicle repair and Bull dozer Maintenance building, Stores buildings, Open store yard, Telephone	Yes

SL. NO.	ITEMS	WHETHER INCLUDED
	exchange, Canteen, Medical centre, Watch Towers, Security buildings, Car park, Cycle shed, Scooter shed, Petrol Pumps etc. as per sizes mentioned in list of building.	
3.	Site grading including construction roads and drains.	Yes
4.	Drainage system with required segregation of clear water drains from contaminated water drains (such as oily water, sanitary Sewer, effluents from water treatment plant etc).	Yes
5.	Roads and Paving	Yes
6.	Boundary wall and fencing around the plant boundary with gates.	Yes
7.	Demolishing/removal of debris for any existing structure/foundations	No
8.	Breaking/clearing of any existing concrete/paving etc.	No
9.	Landscaping including green belts	No
10.	Topographical survey.	Yes
11.	Geo-Technical Investigation	Yes
12.	WPCPL temporary construction office of 500 Sq. M at site with toilets without furnishing.	Yes
13	Coal Storage yard with concrete paving for 15 days storage (design coal with BMCR)	Yes
14	6 lac cu.m storage capacity earthen reservoir with HDPE lining. Rock blasting shall be completed in full area (required for 12 lac capacity reservoir) before starting the construction of reservoir..	YES
15	Ash Dyke Construction (It is agreed that Bottom ash of 14,000,000 m^3 & Fly ash of 4,150,000 m^3 is considered to be quantities for designing total Ash Dyke. Whereas, SEPCO's scope consists of Ash Dyke to store one third of the above quantities. SEPCO shall design & construct the Ash Dyke in the area adjoining the Main Plant and make provision for future expansion towards the West side.)	Yes
16	Ash silo area around 100 m radius shall be completely paved;	Yes
M.	**SERVICES & GENERAL ITEMS**	
1.	Obtaining Statutory/Regulatory clearances/approvals from concerned government agencies regarding the project.	Yes
2.	Consents, licenses and permissions other than those to be obtained by the Owner.	Yes
3.	Complete design & engineering.	Yes
4.	Packing & transportation (ocean and inland), custom/port clearance,	Yes

SL. NO.	ITEMS	WHETHER INCLUDED
	reconciliation with custom authorities, receiving and unloading and storage at site.	
5.	Co-ordination & Project Management.	Yes
6.	Shop tests & Quality Assurance both at Manufacture & Field Quality Assurance	Yes
7.	Site temporary services (telecom, water, power, discharges etc.) during construction period.	Yes
8.	Complete Construction (including supply of material and labour, construction of site office, canteen, construction stores, residential accommodation of contractor's staff and labour etc.), Fabrication, Erection, chemical cleaning, steam blowing, Trial run, Commissioning and Testing of entire Plant.	Yes
9.	Supply of lubricants/consumables and all temporary provisions till handing over of the plant/ successful completion of Reliability test of each unit	Yes
10.	Not used	
11.	Not Used	
12.	Tools and tackle including all special tools and tackle, calibration and testing instruments etc. as required, for the entire plant.	Yes
13.	After Sales Services during & after warranty period.	Yes
14.	Plant stores for consumables and spares.	Yes
15.	Water and power supply for the colony at plant boundary	Yes
16.	Development of green belt around power plant, ash dump area and township	No
17.	Furnishing all documents, drawings, design basis reports, Optimization Study reports, design calculations, data sheets; quality assurance plans, testing procedures, operating and maintenance instruction manuals, commissioning documentation etc including "As-built" drawings.	Yes
18.	Training of the plant Owner's personnel on plant operation and maintenance.	Yes
19.	Carrying out river/well water analysis	Yes
20.	Carrying out pump sump model studies for CW Pumps and Raw Water pumps, wind tunnel studies for chimneys and N. D. Cooling Towers	No
21	Carrying out CFD analysis for sump and forebay of CW Pump house	Yes

SL. NO.	ITEMS	WHETHER INCLUDED
22.	Route survey for transport of large and heavy equipment up to site	Yes
23	CNC Lathe machine	No

NOTE :
The above list of work is not exhaustive. Any additional works, whether or not specifically described in this bid document, incidental to complete the power plant in all respects shall be deemed to be in the scope of work of the EPC Contractor.

N.	TERMINAL POINTS (FOR COMPLETE EPC PACKAGE)	
1.	Approach roads from NH-200 to Plant (Two numbers around 600 m length each)	Yes
2.	Rail - MGR rail-track with railway siding will be provided by the Owner.	Yes
3.	Raw water supply – at one point at inlet of raw water reservoir within plant boundary.	Yes
4.	Drinking water supply point to WPCPL colony at the plant boundary.	Yes
5.	Coal - outlet from BOBR wagons.	Yes
6.	Fuel Oil - at fuel oil wagon/road tanker outlet flange (Rail by Owner).	Yes
7.	Ash - at ash dump yard for both bottom and fly ash. (Ash dump yard is also in Contractor's scope)	Yes
8.	Storm water drainage system - at plant boundary.	Yes
9.	Tele communication - at Plant boundary.	Yes
10.	Outgoing gantries in 400 kV switchyard except line- side insulators	Yes
11.	Construction Water by Contractor	Yes
12.	Land - in as acquired condition for plant area would be made available to the EPC contractor.	Yes
13.	4 Nos. of 11 kV terminals at 11 kV switchgear for power supply to WPCPL colony and river water pump house.	Yes
14.	33 kV CSEB Construction Power at one point inside plant boundary. Emergency DG set will not be provided for Construction power by Owner.	Yes

VOLUME-II

SECTION-V

PERFORMANCE REQUIREMENT AND BID EVALUATION CRITERIA

25.03.09
(KIRAN PANDAY)
WPCPL

(XUE ZI)
09.03.25

VOLUME-II
SECTION-V
PERFORMANCE REQUIREMENT AND BID EVALUATION CRITERIA

	ITEM	SPECIFICATION REQUIREMENT
A.	**Ambient Conditions** to be considered in quoting the performance parameters:	
1.	Maximum monthly average wet bulb / dry bulbtemperature	Ref. Climatological Table
2.	Ambient Wet bulb temperature for quoting the plant's performance.	28°C (Except that for any mechanical (forced/induced) draft cooling tower the hot air recirculation allowance of 0.6°C shall be added)
3.	Corresponding relative humidity and Dry Bulb Temperature	60%/ 34.5°C
4.	Reservoir water temperature	32°C
5.	Site altitude	275 metres above mean sea level
B	Ambient Conditions to be considered for plant's availability	As per the prevailing ambient conditions.
C.	**Fuel specification** to be considered in quoting the plant's performance parameters.	See Coal Analysis in the enclosed **Annexure-I**.
D.	**Fuel specification** to be considered in quoting the plant's availability.	-Do-

Note : The Contractor shall furnish along with the PG test procedure all correction curves based on which his guaranteed performance parameters will be corrected for changes of any or all of the above conditions/specifications during the performance test.

	ITEM	SPECIFICATION REQUIREMENT
E.	**Transmission system** connection parameters to be considered in quoting the plant's performance as well as availability and load factor :	
1.	Voltage	400 kV ± 5% (*)
2.	Frequency	47.5 H_z to 51.5 H_z (*)
3.	Fault level	40 kA (*)
4.	Power factor	0.85 (lagging)
		(*) Figures indicated against percent variation in voltage and frequency, fault levels are subject to confirmation from Transmission Authority later on.
F.	**Performance Parameters to be Guaranteed:** (Considering 0% make-up for items F1 to F4 below)	
1.	Output power with 0% makeup at the Generator Terminals of each unit at turbine maximum continuous rating (TMCR).	600 MW
2.	Auxiliary power consumption [**Note**: The auxiliary power shall be determined on the following basis: a) No supply of power & steam to the plant from any external source or any auxiliary power/steam producer e.g. diesel generator/Auxiliary Boiler etc. b) When number of units operating simultaneously is more than one the average of the total auxiliary power due to all such units shall meet this guaranteed value.	7.017 % of 600 MW(excluding the power consumption for motor driven BFP, WPCPL colony, river water pump house and non-plant buildings like administrative building, Garage, Workshop etc). Auxiliary power consumption specified above is including transformer and switchyard/electrical losses.
3.	a) Turbine heat rate based on the design coal H.H.V and the output power at Generator Terminal as defined above, when fuel oil consumption is nil.	1950 kcal/kWh
	b) Boiler efficiency:	87.5 (HHV / GCV), % Turbine Heat Rate and boiler efficiency (heat loss method) to be evaluated

ITEM	SPECIFICATION REQUIREMENT
	based on PTC codes,
4. Output at generator terminals when the turbine governing valves are wide open (VWO) and inlet steam pressure and temperature are same as those at TMCR (as percentage of the TMCR output)	105%
5. Boiler Maximum continuous rating (BMCR) of steam generation rate, at pressure and temperature suitable for achieving the turbine inlet steam condition considered above.	2068 tph
6. Unburnt Carbon Loss (%)	Shall be not more than 1%. Unburnt carbon loss shall be calculated only as per method as explained hereafter. Sample of fly ash will be taken from fly ash silo. This sample will be passed through 200 mesh size screen. This screen material will be heated upto 105 Deg.C. Then, Weight (W1) will be taken. This sample will further heated upto 815 Deg.C and will be kept at the same temp. for 1 hour. Weight (W2) will be taken. Afterwords, unburnt carbon loss will be calculated as follows: Unburnt Carbon loss (%) =100 x (W1 – W2)/W1

G. **Other Performance Parameters to be Guaranteed:**

1. **Minimum working life**, without any unscheduled outage (i.e. except for regular maintenance), of all essential plant and equipment, needed to achieve the above-	Thirty (30) Years

ITEM	SPECIFICATION REQUIREMENT
mentioned guaranteed performance parameters.	
2. **Minimum availability** (as defined in the section-III of this specification) of the plant.	90% throughout plant life.
3. **Minimum working life** of coal mill wear parts	8000 hours
4. **Maximum pollutants** present in the plant effluent while working at 100% BMCR with the worst coal (Considering the coal Analysis in Annexure-I)	
a) **Particulate matter** in the flue gas at the outlet of ESP+FF, with any one of its fields/transformer-rectifiers in each gas path out of service.	50 mg/Nm^3
b) **NO_x** (expressed as NO_2) in stack gas, corrected to 6% Oxygen.	262 ppm
c) **CO** corrected to 6% Oxygen dry	100 ppmv
d) **Free chlorine** in CW Blowdown water	0.5 mg/l
f) **Particulate matter** in the exhaust/vent from	
• The coal crusher units	100 mg/Nm^3
• The fly ash silos/other ash handling equipment	100 mg/Nm^3
g) On-line continuous monitoring system with recording facilities shall be provided in the stacks for monitoring of	
i) Particulate matters	Yes
ii) SO_2	Yes
iii) NO_x	Yes
iv) CO	Yes
h) **Blowdown** :	
The blowdown shall meet the following standards	
i) Boiler Blowdown :	
Suspended solids :	100.0 mg/litre max.
Oil & Greese :	200.0 mg/litre max.
Iron (Total) :	1.0 mg/litre max.
ii) Cooling Tower Blowdown	

ITEM	SPECIFICATION REQUIREMENT
Free available chlorine	0.5 mg/litre max.
Zinc:	1.0 mg/litre max
Phosphate:	5.0 mg/litre max.
Chromate based treatment of water shall be avoided.	Yes

5. **Coal Handling Plant Capacity:**

a) Suitable for unloading and conveying coal from bottom opening type coal wagons in motion, running at a speed of 0.8 km/h — Each track hopper storage shall be suitable for 6500 Te coal storage with paddle feeders & conveyors operating.

(**Note**: Track hopper shall act as an intermediate storage to the extent that coal pile in it remains below the track bottom level).

b) Suitable for unloading and conveying within sixteen (16) hours (from first coal rake entry to last coal rake exit) the coal from - — Eighteen (18) rakes of coal wagons (if necessary the second belt conveyors shall be put into service.)

c) Suitable for supplying twenty four (24) hours' maximum coal consumption (with worst coal at 100% BMCR) of all units in 16 hours. — SEPCO to provide 1800 TPH Coal handling Plant capacity for each phase which will operate for 16 hrs per day to meet the coal requirement of the same phase

Note : i) The above are to be guaranteed for the entire coal handling plant with all possible modes of operation like (a) coal crushing and stacking, (b) crushing and conveying to power house bunker (c) reclaiming from coal stock pile and conveying to power house bunker. The entire plant capacity shall be at least compatible with the unloading rate.

ii) Number of wagons per rake — 58

Capacity of each wagon — 60 Te

iii) For coal specification see Annexure-I

iv) Coal density to be considered for -

v) Volume calculation — 0.8 Te/m^3

vi) Structural load calculation — 1.1 Te/ m^3

(Note: Track hopper shall act as an intermediate storage to the extent that coal pile in it remains below the track bottom level)

ITEM	SPECIFICATION REQUIREMENT
6. **Ash Handling Plant Capacity**	
a) Bottom ash and fly ash cleaning rates from respective hoppers: conveying up to the Dry ash silos/ fly ash silos/ HCSD System based on the maximum ash generation from all boilers working at 100% BMCR with the worst coal:	Suitable for permitting - i) 200 TPH for fly ash from ESP ii) 150% of the bottom ash generation capacity at BMCR with Worst Coal.
7. **Raw water Supply and Treatment Plant Capacity**	9000 cu.m / hr as per MOM. The water supply pumps & treatment equipment to be sized considering no water recovery from RO Plant. However Waste water treatment (RO plant) and recovery system shall be provided as specified. The complete system shall be provided to achieve zero water discharge. Total Water requirement and design shall be based on mutually agreed WBD to be submitted by SEPCO during DBR.
8. **Demineralisation Plant Capacity** (Continuous output of DM water of requisite quality)	3 x 240 TPH (2 W + 1 S) or 4 x 160 TPH (3 W + 1 S) and regeneration time is less than 4 hours
D.M. water quality (At mixed bed outlet) (This shall be checked with the suppliers of BTG equipment.)	
(a) pH at 25°C	6.8 - 7.2
(b) Conductivity at 25°C	0.1μ mho/cm
(c) Reactive Silica	<0.01 ppm
(d) Total hardness	Not detectable
9. **Air Conditioning & Ventilation System**	
a) Inside conditions to be maintained for all AC areas	24.4°C ± 1.1°C DB & RH of 50% ± 5% with only exception of area housing microprocessor based equipment, which will be maintained at 22°C ± 1.1°C & RH of 50% ± 5%.
b) Inside conditions to be maintained for spaces ventilated with evaporative cooling units	Maximum 2°C below design ambient (DBT) condition during summer or at least 5-6 air change rate per hour.

ITEM	SPECIFICATION REQUIREMENT
c) Inside conditions to be maintained for spaces with dry ventilated system.	Max. 3°C above outside DB temperature during summer or around 10 air changes rate per hour.
d) All extraction air quantities from various dust generating points of Coal Handling Plant	According to the recommendations of American Conference Governmental Industrial Hygienists (ACGIH)/ equivalent or superior Chinese Code
10. **Fuel oil unloading system capacity** (based on Heavy Fuel Oil as specified)	a) Sufficient to unload a full rake of 80 wagons of heavy fuel oil, capacity of each wagon being 22 m^3, within a total period of 8 hours between the rake entry and exit to & from plant site (i.e. including time for wagon marshalling, heating, coupling and decoupling of hoses etc.) b) Sufficient/capable to unload from road tankers also.

Note: For item "F" & "I" above

1. If the guaranteed performance parameters for which no liquidated damage figure is indicated, can not be achieved the related equipment shall be liable to be rejected by the owner.

2. The guaranteed values shall be without any tolerance except as permitted, by the agreed test code, for instrument inaccuracies. But no tolerance on any account will be permitted for Steam Generator and ESP performance.

J. **Other Performance Requirements**

1. **Steam Generator**

a) Superheater and Reheater outlet steam temperature control range	Within ± 5°C
b) Loads for which the above control range has to be maintained.	60% to 100% BMCR
c) Continuous steam generation rate achievable using heavy fuel oil only.	0% to 30% BMCR

ITEM	SPECIFICATION REQUIREMENT
d) Continuous steam generation rate achievable with LDO only	0 to 10% BMCR
e) Cold start-up, warming and load pick-up (to limits stated above) achievable with	HFO and LDO
f) Minimum achievable continuous steam generator output with pressure and temperature maintained within specified control range (and with stable flame) using	
i) Coal as only fuel	40% BMCR
ii) Coal with HFO support	20% BMCR
g) Minimum period for which the burner control system shall maintain a stable coal flame in the event of the voltage at the motor terminals of the drives for all equipment supplying coal to the burners falling to any value between normal and zero.	2 Seconds
h) Permissible number of firing/shut down cycles for any burner per day.	Ten (10)
i) Maximum steam temperature imbalance between SH/RH outlets (in case of multiple outlets)	10°C
2. **Overall plant performance :**	
a) Normal mode of operation	Base Load
b) Minimum permissible no. of starts in plant life	
i) Cold start (after more than 72 hrs. shut- down – Turbine metal temperatures below approximately 40% of their full load values)	100 Nos.
ii) Warm start (after 10-72 hrs from shut down – Turbine metal temperatures between approximately 40% to 80% of their full load values)	700 Nos.
iii) Hot start (after less than 10 hrs shut down – Turbine metal temperatures approximately 80% of their full load values)	3000 Nos.

ITEM	SPECIFICATION REQUIREMENT
c) Minimum permissible no. of cycles in plant life for part load operation	
i) Down to 40% TMCR (Continuous)	2500 Cycles
ii) 40-95% TMCR (for 1 hour)	50,000 Cycles
d) Maximum permissible time period for the following	
i) Cold start-up to synchronising	Less than eight (8) hours
ii) Warm start-up (as defined above) to synchronising	Less than one hundred fifty (150) minutes
iii) Hot start-up (as defined above) to synchronising	Less than forty five (45) minutes
iv) From synchronising to full load operation (During Hot Start-up)	45 mins.
v) Controlled unloading from full load to zero load.	45 mins.
e) Maximum permissible loading/ unloading rate (between 50% and 100% TMCR) that will be sustained by the plant without any detrimental effect on plant life & performance.	as per MOM- annexure-A2
f) Number of starts or, attempted starts per day or, per hour under hot, cold and warm start up condition	During Detailed Engg
g) Superheater and Reheater outlet steam temperature control range during the above-mentioned maximum rate of loading/ unloading	Within ±5°C
h) maximum permissible range of system frequency within which the plant can operate continuously.	47.5 Hz to 51.5 Hz
i) Maximum permissible man-power requirement for running the entire plant round the clock efficiently and continuously at all loading conditions and emergency conditions including security, administrative staff etc.	Contractor to furnish during DBR

3. Abnormal operation:

The plant and equipment shall be capable of

ITEM	SPECIFICATION REQUIREMENT
withstanding the following conditions of abnormal operation without any detrimental effect to the plant or, equipment and to the safety of personnel	
a) Sudden loss in load demand up to	20% TMCR when working at 60% to 100% TMCR.
b) Implication of variation in coal quality on the power station performance (MW output) thermal efficiency (gross/net), availability and maintenance requirement. Design coal will form basis of performance verification test with correction curves provided by the Contractor.	Contractor shall furnish the correction curve with PG test procedure
c) Emergency trip of Boiler feed Pump, Condensate Extraction Pump, C.W. pump or Intake water pumps and also of any other pumping units that involve long distance discharge pipe line prone to water hammer.	Yes
d) Sudden load throw-off/grid failure	Yes
e) Permissible time period for which reverse rotation at the maximum possible speed can take place for the -	
i) Boiler feed pump	To be furnished during DBR
ii) C.W. pump	To be furnished during DBR
f) VWO operation of the TG set with -	
•. Increased Main Steam pressure	Yes
•. Top HP heater out of service	Continious
•. All HP heaters out of service	Continious
g) Turbine HP-LP bypass condition while supplying the house load demand.	15 mins
h) Maintenance of a portion (one half) of the condenser while the TG is operating with a minimum load of	60 % TMCR.

ITEM	SPECIFICATION REQUIREMENT
4. Pulverised Fuel Handling System:	
a) Permissible turn-down ratio for each coal mill	Down to 30% output (with respect to 100% BMCR requirement with worst coal).
b) Whether any derating from the guaranteed performance requirement is permissible with wet coal expected during a rainy season.	Boiler output shall remain as per rated parameters, but coal consumption may increase
5. **Furnace Air-preheater** :	
Maximum permissible increase in air-leakage (to gas path) with respect to the initial value in new condition.	2% increase in 25,000 hours of operating period.
6. **Ash Handling Plant :**	
i) Maximum permissible shut-down period of the Ash Handling Plant, while 100% BMCR steam generation with design coal is continued, without affecting (then or later) the guaranteed performance of the boiler plant, the particulate extraction equipment (ESP) and the ash handling plant itself:	
a) For dry bottom - ash handling plant shutdown -	Storage capacity for the bottom ash hopper 6 hours
b) For Fly ash handling plant	Storage capacity of Fly ash hoppers 8 hours
ii) Maximum time required (including starting, stopping, changeover etc.) for -	
a) Cleaning 6 hours' maximum bottom ash	4 hour
b) Cleaning 4 hours' maximum fly ash	Evacuation rate of the system shall be 200TPH for fly ash
7. Coal Handling plant	
The maximum period within which each fully loaded conveyor belt can be started from rest and accelerate to its full speed.	3 mins

ITEM	SPECIFICATION REQUIREMENT
8. Furnace Draught Plant	
Maximum permissible leakage (as % of normal air/gas flow) through the draught plant isolation dampers	0%
9. Compressed Air System:	
All continuous and intermittent compressed air requirements for the plant shall be supplied, which may include the service air for - i) F.O. atomiser, ii) igniter cooling, iii) auxiliary drive for regenerative air-preheater, iv) cleaning of various bag filters of the ash handling and coal handling plants etc. and the instrument air requirement for the complete plant. In addition, the following performance requirements shall be met-	
a) Maximum permissible dew point of the Instrument Air at its maximum working pressure and discharge rate. With inlet air humidity at the maximum value.	(-) 40°C
b) Minimum number of service air outlets (with hose connected) that can be simultaneously opened in the plant.	Six (6) nos. of 15 mm NB each
c) Minimum required pressure of Instrument Air at the farthest point	5.50 kg/cm^{2}g; 6.00 kg/cm2 for HCSD and for bag filter at silo top, and for valve seal pressure
d) Minimum permissible service air pressure at the outlets opened, in number stated above, even considering the remotest points.	4 kg/cm^{2}g.
10. Fuel Oil Handling system:	
The maximum permissible time period within which the heavy fuel oil, remaining in any storage tank, can be heated up from its coldest possible condition to its required temperature for normal flow, considering the tank is filled to its capacity and the lowest ambient temperature.	24 hours for storage tank.

	ITEM	SPECIFICATION REQUIREMENT
11.	Steam Turbine:	
	a) Minimum permissible operating period between corrective maintenance work, including tightening of bolted joints of the casing, changing turbine blades etc.	45,000 hours
	b) Maximum permissible turbine rotor over speed in cold condition without affecting its guaranteed/specified working life.	20 %
	c) Maximum permissible range of turbine speed variation without affecting turbine blade life.	- 6% to + 6%
d)	Other abnormal conditions that the turbine rotor shall withstand:	
i)	120 degree malsynchronisation	Yes
ii)	3 phase short circuit of the generator at 100% voltage	Yes
e)	Maximum speed up to which the rotor may accelerate during a turbine trip from any possible working condition.	106% of 3000 rpm
12.	Boiler Feed Water Pumps	
	a) Minimum flow rate with which the pumping unit shall work continuously without affecting the guaranteed/ specified working life and healthy operation of any of its components.	25% of pump design flow.
	b) Capacity of feed water recirculation system	At least same as above
	c) Minimum permissible working life (operating hours) of pump shaft seals between overhauls.	10000 hours acceptable provided the shaft mechanical seal is supplied from M/s Bergmann, Germany
	d) Maximum permissible run-up time for each pump	Less than drum storage capacity in seconds from NWL to Trip Level at 100% BMCR.
13.	General Requirement for all centrifugal	

ITEM	SPECIFICATION REQUIREMENT
pumps, fans and blowers of the entire plant:	
a) Type of Head-capacity (characteristic) curve for each operating speed.	Continuously rising from maximum to minimum permissible discharge
b) Maximum permissible rotor vibration as measured at the bearings throughout the operating speed range	As per ISO 10816 and ISO 7919.
c) Margin in drive motor rating over the power requirement of the driven equipment considering any possible derating of the drive motor.	15% in rated condition, positive throughout the working range including any emergency condition.
d) NPSH required at 3% head drop condition	Not more than half the minimum NPSH available at design flow rate.
e) Best efficiency point	Shall correspond to the operating condition at TMCR as far as possible.
f) Balancing requirement	Rotor assembly shall be both statically and dynamically balanced meeting requirement/ recommendation of VDI-2060
14. Feedwater heating plant	
a) The number of HP heaters that may remain out of service, during continuous operation of the rest of the plant, without affecting the plant life.	three (3)
b) Maximum power generation in the above condition.	600 MW
c) Deaerator sizing criteria:	
Minimum time period (starting from the normal water level in the deaerator storage tank) for which the feedwater flow to the boiler, corresponding to 100% TMCR, shall be maintained during a turbine trip-out condition, without creating any NPSH non-availability problem for the Boiler feed pumps, (or Booster pump on their suction side)	Deaerator Feed water storage Tank capacity shall be minimum 6 min storage of 100% BMCR flow between Normal operating level & Low-Low level with a filling factor of 0.66. (Storage tank - 66% filled at normal level)
d) Minimum continuous turbine operating load with which all feed heater level control by the use of normal cascading drain (from higher to lower stage pressure) shall be possible.	40% TMCR

ITEM	SPECIFICATION REQUIREMENT
e) Maximum permissible O2 & CO2 contents (as measured by an internationally accepted procedure/standard) in the boiler feed water at the deaerator outlet:	
•. O_2 content	7 ppb (0.005 cc/l)
•. CO_2 content	Nil
f) Minimum turbine load down to which the deaerator shall not need any auxiliary steam supply to maintain its required pressure level (pegged pressure).	40% TMCR
15. Surface Condenser (for steam turbine)	
a) Hotwell storage capacity	Minimum 3 minutes (between "normal" and trip level) corresponding to maximum CEP discharge.
b) Required performance of on-line condenser tube-cleaning system.	Design cleanliness factor shall be maintained throughout the plant life without any need for shut-down or manual cleaning.
c) Air-extraction system	Vacuum pumps preferred.
d) Maximum oxygen content in condensate at hotwell outlet	0.015 cc/l.
Auxiliary boiler steam generation capacity	Shall be sufficient to supply all the steam (at appropriate pressure and temperature) needed to start one (1) unit from cold condition, until the unit starts supplying its own steam requirements. This shall also include the steam required for the unloading (from a full rake of wagons) and transferring of heavy fuel oil (as necessary)..
17. Limits on pollutants emitted from the auxiliary boiler unit. (If applicable)	Same as for the main boilers.
18. Performance of the plant's fire protection and detection systems	Shall follow all applicable regulations of the Tariff Advisory Committee and NFPA recommendations (where TAC regulations are not applicable).

ITEM		SPECIFICATION REQUIREMENT
19.	Performance of thermal insulation	To maintain pipe and equipment insulation surface temperature not more than 60 Deg.C at highest ambient temperature.
20.	Effluent Treatment a) Sources and quantities of effluent	Contractor to furnish during detailed Engineering
	b) Type of Treatment	Total recycle and zero discharge from the plant boundary shall be ensured by provision of RO Plant and RO reject evaporation pond as necessary.
21.	Noise Control	
	a) Maximum permissible surface noise level (to a reference of 0.0002 microbar) measured at a distance of one (1) metre from any point of the surface of the item and 1.5 metre above floor level under any operating condition for:	
	i) Air Compressors and Blowers	90 dB(A)
	ii) Coal Crushers	90 dB (A)
	iii) Safety valves, LP bypass valves and their discharge piping	105 dB(A) (Also within 75 dB(A) at 400 m distance)
	iv) Turbo-generator	90 dB(A)
	v) All other equipment, valves, piping, ducting and vessels	85 dB(A)
	b) Maximum permissible noise level in	
	i) Control rooms	
	• Background noise level	50 dB(A)
	• Speech interference level	40 dB(A)
	ii) Other control areas, where person-to-person or telephonic conversation is required:	
	• Back ground noise level	65 dB(A)
	• Speech interference level	55 dB(A)

ITEM	SPECIFICATION REQUIREMENT
iii) Other rooms/building where various plant and equipment are housed	89 dB(A)
iv) Residential areas located near the site boundary (At 400m distance)	50 dB(A), continuous and within 60 dB(A) for occasional intermittent noise.

Note : Noise level shall be measured with a calibrated integrating sound level meter meeting the requirement of IEC-651 or BS-5969 or IS-9779.

22. **C & I Requirement**

SL.NO.	DESCRIPTION	CONTROL DEAD BAND (MAXM.)	MAXIMUM FLUCTUATION WITH 3% LOAD CHANGE PER MINUTE
1.	Main Steam Pressure (at turbine inlet)	±1.00 ATA	±1.5% of Set Value
2.	**Boiler Air** :		
	i) Total Air Flow		±5% of desired steam air ratio
	ii) 02% in Flue Gas	±0.25%	±2%
3.	Furnace Draught	±2.5 mm Wg	±10 mm Wg from set value
4.	SH & RH Temperatures	±2.0 Deg.C	±5.0Deg.C
5.	Deaerator Pressure Control	±0.5% of normal set value	±5% of set value
6.	Boiler Drum level control	±10.0 mm	±25 mm
7.	Deaerator Level Control	±5.0 mm	±50 mm over dead band
8.	Condenser Hotwell Level Control	±2.0 mm	±20 mm
9.	**L.P. Heater Level**		
	a) High	±2.0 mm	±20 mm
	b) Normal	±2.0 mm	±20 mm
10.	**H.P. Heater Level**		
	a) High	±2.5 mm	±20 mm

b)	Normal	±2.5 mm	±20 mm

11. **DCS**

a)	Analogue closed loop execution time	250 ms max. (Except fast loop)
b)	Digital logic execution time	100 ms max.
c)	Screen refresh rate	1 sec max.
d)	Screen response to command execution	1 sec max.
e)	Controller switchover time	5 ms max.
f)	SOE resolution	1 ms
g)	Controller loading	60% max.
h)	Memory loading	70% max.
i)	Communication bus loading	60% max.

Note: a) For other control loops performance parameters will be furnished at later stage.

b) Contractor shall arrange for all Performance Guarantee test points and special instrumentation required for conducting site tests.

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SECTION-VI

DESIGN REQUIREMENT

VOLUME-II

SECTION-VI

DESIGN REQUIREMENT

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ZA.	ENVIRONMENTAL CONDITIONS
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VOLUME-II

SECTION-VI

DESIGN REQUIREMENT

SL. NO.	ITEM	CRITERIA
A.	**SITE CONDITIONS**	Unless otherwise specified, the following design conditions shall be considered for the equipment offered.
1.	Design ambient dry bulb temperature	48 Deg.C maximum, 8 Deg.C minimum 34.5 Deg.C to be used for performance calculation.
2.	Design ambient for all Electrical Equipment	50 Deg.C
3.	Design wet bulb temperature	Refer Section - V
4.	Annual Rainfall	1500 mm
5.	Basic wind pressure	As per IS : 875
6.	Seismic zone	Zone-II as per IS-1893 latest version
7.	Altitude	Refer Section – V

Note : 1. For detail Climatological Data and water analysis refer to Annexures of Volume-II.

GENERAL REQUIREMENTS:

Codes and Standards:

All the design and detail engineering, testing & inspection shall be based on the Codes and Indian / International Standards identified in the specification. The latest edition/revision of the Codes and Standards along with the addendums/amendments if any, shall be followed. In case the Contactor adopts any other standard, the Contractor shall substantiate that such standards and codes, meet the requirements of Indian standards and codes. However, in the event of any conflict between the requirements of equivalent codes and standards and the

requirement of Indian standards / regulations, the latter shall govern, unless specified otherwise in the specification.

P&IDs:

Post Contract, SEPCO shall submit all P&IDs, on the basis of technical specification and other documents attached in the contract, for WPCPL approval. Any comments made by WPCPL on these documents shall be discussed and incorporated by SEPCO without any price implication.

Regarding Pending points of Boiler:

a) SEPCO had supplied certain dimensions and characteristics of the boiler in their offer Such as type of circulation, type of firing, furnace dimensions and standby arrangement for super heater & reheater spray.
b) These were also discussed and agreed during the meetings at Mumbai and China and recorded in MOM.
c) Subsequently, post award of LOA, SEPCO have admitted certain errors in the boiler dimensions and boiler characteristics..
d) WPCPL have reviewed the above errors. In view of the special characteristics of Indian Coal and the need for thorough understanding of the boiler configuration, WPCPL could not agree for the changes.
e) Whereas, SEPCO restate that they will guarantee the boiler capacity based on Indian coal, which shall be followed on Boiler Design, so the boiler type & dimensions cannot be fixed as of now. And in the interest of quick finalization of the boiler design, SEPCO have requested WPCPL to send their experts to China to facilitate SEPCO in finalizing the design during discussion with their vendor.
f) WPCPL agrees to participate in a dialogue with the vendors of SEPCO with the understanding that the contractual relations of WPCPL are only with SEPCO and are determined by the boundaries of the agreement. The presence of the experts is only to facilitate quick finalization of the design and would not in any way compromise or dilute the contractual guaranteed parameters and responsibilities of SEPCO.

SL. NO.	ITEM	CRITERIA
B.	**STEAM GENERATOR**	
1.	Type	Assisted circulation, +/- 30 degree tilting tangential corner firing double pass, direct pulverised coal fired, balanced draft, reheat, dry bottom, semi-outdoor type.
2.	Design and Construction	Internationally accepted Standards & shall comply with the requirements of Indian Boiler Regulations (IBR). Furnace shall be non-slagging with adequate margin on (Departure from Nucleate Boiling (DNB).SEPCO to submit the calculations supporting above(DNB) for WPCPL approval.

SL. NO.	ITEM	CRITERIA	
3.	Expected Parameters (Indicative)	a) Steam flow at SH Outlet, Te/hr,	To suit Turbine Supplier's data at VWO, + steam generation plant's requirement
		BMCR Flow	2068 tph
		b) Temp. at SH outlet Deg.C	541
		c) Steam temp. at RH outlet Deg.C	541
4	a) Fuel allocation	The boiler shall be suitable for accepting feed water at a lower temperature corresponding to any heaters out condition with TMCR.	
		i) Primary fuel - 100% coal	
		ii) Start-up fuel - LDO up to 10% BMCR	
		iii) Fuel for low load operation - HFO/LSHS/HPS	
	b) Fuel analysis	iv) The unit shall be suitable for continuous and stable operation with entire range of coal firing without fuel oil support down to 40% rated output (BMCR) under automatic control.	
5.	Operation	i) Coal analysis } } Refer to Annexure-I & II ii) Oil analysis }	
		The plant shall be designed for base load operation. In case of load rejection, Boiler firing rate shall be brought down to 60% BMCR, and unit control shall be such that the unit is stable at house load condition.	
6.	**Furnace**		
6.1	Component Sizing Design Criteria		
	a) Maximum Volumetric Heat Liberation Rate	Should not exceed 1.1×10^5 kcal/hr/m^3	

SL. NO.	ITEM	CRITERIA
b)	i) Maximum Net Heat Input (NHI) per unit plan area of furnace.	Should not exceed $5x10^6$kcal/hr./m^2
	ii) Maximum Heat input per Burner	65 $x10^6$ kcal/hr/burner
	EPRS area	9435.5 Sq m at FEP(Nose tip vertical line)
c)	Number of coal & oil burners	28 No coal burners, 12 Nos HFO burners and 4 Nos LDO burners.
d)	Maximum design pressure	As per NFPA 85C but shall not be less than ±660 mm WC at 67% yield strength or maximum expected pressure/draft of fans, whichever is higher.
e)	Maximum gas velocity before gas flow changes direction	10 m/sec.
f)	Maximum furnace exit gas temperature from radiant zone	60 Deg.C below ash initial deformation temperature
g)	Furnace dimensions (Ht. x Width x Depth)	68 67 m (Height from top of furnace bottom ash hopper to Furnace roof) X 18.542 m (Width) X 17.448 m (Depth).

NOTE: 1) "Maximum heat input per burner" means the heat generated from fuel firing in one hour divided by the total number of coal burners.

2) "Net heat input (NHI) available in furnace per unit plan area" means the net heat input (i.e. heat generated by fuel/s fired in one hour plus the sensible heat of combustion air above 27^{0}C minus the radiation loss, unburnt combustibles, moisture in the air, latent heat of moisture in fuel and that formed by combustion of H_2 in the fuel) divided by the plan area of the furnace.

3) "Volumetric Heat Liberation Rate" is defined as the heat generated from fuel firing in one hour divided by the volume of the furnace.

6.2 **Drum**

a)	Design pressure	1.05 times of maximum continuous operating pressure or lowest safety valve set pressure whichever is higher

SL. NO.	ITEM	CRITERIA
	b) Drum Level	Three (3) sets of tapping points at each end of drum for remote control remote indication, interlock & protection and for local level gauge.
	c) Maximum permissible dissolved solid carry-over with saturated steam	
	i) Silica	< 15 ppb
	ii) Sodium	< 5 ppb
	iii) Chlorides	2 ppb
	v) Iron	< 20 ppb
	vi) conductivity at 25 Deg C	< 0.2 micro S/cm
		(The above parameters are to be checked and confirmed with the Turbine Supplier.)
6.3	**Water Wall**	
	a) Type of tube	Seamless Rifle tube, meeting the requirement of Indian Boiler Regulations (Length as applicable)
	b) Height of the centre line of the lowest water wall header	Shall be suitable to accommodate a bottom ash hopper of storage capacity specified elsewhere, and bottom ash handling equipment above the ground with maximum one (1) m below ground without affecting performance of the equipment. The sump pit shall be provided with proper slopping, curb wall and sump pit. Height of the lowest water wall bottom header shall be above the local ground floor level should be enough to accommodate the bottom ash hopper and dry bottom ash handling system
6.4	**Superheaters and Reheaters**	
	a) Convection pass gas velocity	Maxm. 12 m/sec.
	b) Reheater isolation device desirable (CR & HR lines)	Yes
	c) SH/RH attemperation spray water isolation	Spray control system shall consist of pneumatically operated control valves, upstream and downstream Motor Operated isolation valves and fast acting pneumatically operated block valves with standby spray system
		Tilting burner control shall be utilised as primary temperature control of reheat steam,

SL. NO.	ITEM	CRITERIA
d)	Type of tube	Seamless tubes
e)	Temperature control range	Refer Section - V
f)	Preferred transverse pitching of tubes for radiant heating surface	Minimum 600 mm
6.5	**Economiser**	
a)	Type	With Seamless tubes, Non steaming type
b)	Maxm. Gas velocity	Maximum 10m/sec.
c)	Erosion Margin	1 mm over and above the design thickness shall be provided
6.6	**Preferred Feed Regulating Station**	
a)	Normal load operation 25-100% BMCR	1 x 100% capacity motorized gate valve ; by speed variation/Hydraulic coupling (only Voith Make) for Boiler Feed pumps
b)	Low load operation 0-30% BMCR	1 x 100% capacity (corresponding to 30% load) control valve WPCPL has requested to provide the kicker stage to take care of spray flow requirements in all the loads particularly at low loads. SEPCO agreed to resolve the issue if the kicker stage is not there in BFP, in consultation with boiler manufacturer after placement of the order for the same. WPCPL further requested SEPCO to ensure adequate flow into the attemperator at all the loads.
6.7	**Air Heater**	
a)	Type	Trisector / Regenerative counter flow
b)	Number per boiler	Two Capacity of each air heater stream shall be sufficient for 60% Boiler MCR.
c)	Maxm. Gas velocity	Maximum 16 m/sec.
d)	Back end temperature	Flue gas temperature at air heater outlet shall not

SL. NO.	ITEM	CRITERIA
		be less than 125 °C at full load and not less than 140°C during load below 70%.. During start-up and low load operation with SCAPH in service flue gas temperature at air heater outlet to be maintained at the minimum temperature suitable for prevention of SO_2 corrosion considering HFO firing. Final agreed flue gas temperature at air heater out let is 135 Deg C (Uncorrected) and 128 Deg C (Corrected).
	e) Drive	For sizing of SCAPH a minimum ambient temperature of 8°C shall be considered. The heating element on the cold end side shall be of corten steel of 1.2 mm thick, hot and intermediate elements of 0.8 mm Carbon steel Two AC motors and one DC motor/air motor back-up for 10 minutes operational requirement shall be provided.
6.8	**Pulverisers**	
	a) Type	Pressurised, Direct fired Vertical Spindle bowl type Mill.
	b) No. of pulverisers per Boiler	7 bowl mills with front arrangement
	c) Guaranteed wear life of the grinding components	Not less than 8,000 Hrs.
	d) Capacity	.6W+1S with 90% loading in each mill, during BMCR condition with Worst coal, Mill reject handling system (by hydraulic transmission system) shall be provided and scheme for the same shall be furnished by the Contractor.
	e) Lubrication System	Lubrication system shall have 2x100% pump and 1x100% cooler, and duplex filter
6.9	**Coal Pipe**	
	a) Velocity in coal pipe	22 to 28 m/sec. under all operating conditions
	b) Material of coal pipe	Carbon steel conforming to International Standard with ceramic lining

SL. NO.	ITEM	CRITERIA
		Minimum thickness - 8 mm in lined portion. Minimum wear allowance - 4 mm.
	c) Special erosion protection at bend	Ceramic min. 10 mm thick for bend and 2D length on the downstream if space is available.
	d) Guaranteed wear life of the coal pipe	Minimum 25,000 hrs.
6.10	**Feeders**	
	a) Type of feeder	Gravimetric (microprocessor based control with electronic weighing-load cell). Coal shall be fed from raw coal bunkers through motor operated coal gates along with chain wheel to operate from the floor.(Contractor to ensure the problem free opening of the plate with full load of bunker coal loaded on to gate)
	b) Feeder Capacity	At least 1.2 times maximum mill output for vertical mill and 1.2 times maximum output of tube mill while feeding coal from one end only.
	Design pressure for pulverised fuel handling system, starting from feeder to fuel burner.	To withstand maximum possible explosion pressure that may be encountered.
6.11	**Fans**	
6.12	**Primary Air Fans**	
	a) Type	Axial with Rotor blade of Aerofoil design.
	b) No. of fans	Two fans per boiler. Each fan will be sized to meet the requirements of 60% BMCR. Fan sizing shall be such that it takes care of the transient condition when a stand by mill is changed to a working mill. Lubrication system shall have 2x100% pump and 1x100% cooler, and duplex filter
	c) Control	By variable blade pitch control
	d) Margins (Test Block)	Margins over theoretical calculated requirement at

SL. NO.	ITEM	CRITERIA
		BMCR when using coal having highest moisture, considering 10% leakage in air heater. Head : 20% Capacity : 10%
	e) Inlet air quality	48 Deg.C & 60% RH for atmospheric air
	f) Silencer	At suction
6.13	**Seal Air Fan**	2 x 100% Seal air fans per boiler for all mills
	a) Type	Centrifugal
	b) Margin	Flow - 10%, Head - 20%
6.14	**Induced Draft Fans**	
	a) Type	Axial fan. Lubrication system shall have 2x100% pump and 1x100% cooler, and duplex filter
	b) No. of fans per boiler	Two for normal operation at BMCR at rated steam parameters.
	c) Control	By adjustable static blade pitch variation. and connected to DCS.
	d) Capacity	Single fan operation should be able to meet the requirement of stable 60% BMCR at rated steam parameters & also all start-up (Hot/Cold/Warm) requirements.
	e) Margin (Test block) over theoretical calculated require -ment.	i) Head - 20% ii) Capacity - 10% iii) Temp: margin on inlet flue gas temp. 14 Deg.C
6.15	**Forced Draft Fans**	
	a) Type	Axial, with rotor blades of Aerofoil design. Lubrication system shall have 2x100% pump

SL. NO.	ITEM	CRITERIA
		and 1x100% cooler, and duplex filter
	b) No. of fans per boiler	Two for normal operation at BMCR at rated steam parameters.
	c) Control	blade pitch variation.
	d) Capacity	i) Each 60% BMCR condition. Also refer to Section-VII ii) Maximum ambient temperature shall be considered as 48 Deg.C at 60% R.H. for Fan capacity selection. iii) Minimum ambient temperature shall be considered as 8 Deg.C for BHP calculation of the Fan.. iv) Minimum excess air shall be considered as 20% while calculating theoretical capacity of the fan. v) Air heater leakage of 10% shall be considered for capacity selection of the fan.
	e) Margin (Test Block) Over theoretical requirement	i) Head - 20% ii) Capacity - 10%
	f) Silencer	At Fan Suction.
6.16	**Ducts**	
	a) Design pressure	± 660 mm WC at 67% yield strength or maximum conceivable pressure of the relevant fan.
	b) Maximum recommended velocity for duct sizing	Air 20 m/sec.(maximum) Gas 13 m/sec.
	c) Material of duct plate	ASTM-A 36 or equivalent (Shall be as per CEA guidelines a) Minimum thickness 7 mm in the flue gas ducts. However, duct plate thickness of 5 mm from outlet of

SL. NO.	ITEM	CRITERIA
		ESP to chimney can be considered provided the duct stresses remain in the normal range. b) Minimum thickness 5 mm in the air ducts. c) A corrosion allowance of 1.5 mm shall be considered for stress calculation for gas ducts.
d)	Type of damper drive	Control damper – Pneumatic Isolation - Electric/Pneumatic where fast closing is desirable from process point. For maintenance of ESP, ID fan, Mill and Air heater, motorized guillotine dampers(100% tight shut-off), shall be provided at: i) Inlet & outlet of each ESP+ Bag Filter gas stream, -inlet and out let of ID fans-motor operated isolation gates with seal air ii) PA inlet of each Mill. – pneumatically operated louver damper iii) Outlet of each PA fan and FD fan – motor operated gate
e)	Expansion Joint	i) Non-metallic expansion joints are preferable in cold air duty. ii) Metallic below with protection plates shall be preferred for gas ducts
6.17	**Fly Ash Hoppers below Economisers,**	
a)	Capacity	i) Minimum eight (8) hours' storage when operating at Boiler MCR, considering 100% of fly ash collected inside ESP hoppers. ii) For storage volume capacity ash density to be considered as 650 kg/Cu.m. iii) For structural capacity ash density to be considered as 1350 kg/Cu.m.

SL. NO.	ITEM	CRITERIA
6.18	**Soot Blower**	
a)	Type	Short retractable for furnace chamber Long retractable for vertical pendant section Rotary nonretractable for rear pass
b)	Medium	Steam
c)	Location	For Furnace(wall blowers), , For Superheater ,Reheater / and Economiser (long retractable type) , For Air heater (swiveling type)
d)	Type of control	Microprocessor based
6.19	Chimney	275 metres high, one multi flue type for each phase The top diameter of the chimney shall be decided for exit velocity of 25 m/sec at BMCR. The bottom dia design shall be governed by structural consideration and also shall ensure no back pressure at ID fan discharge duct.
6.20	No. of Elevators	
a)		One (1) Passenger cum Goods Elevator for each boilers and two Passenger cum Goods elevators for Power House(for ten persons) Boiler elevator Capacity : 3000 kg for goods elevator Rated speed : 0.75 m/sec Total travel & No. of floors : Contractor to indicate
b)		Stacks Elevators : 1 for each multi-flue stack.(6 persons)
c)		One passenger elevator for Admin building One (1) fast Capsule type elevator at the center of Power House up to the Control Room, suitable for ten passengers
C.	**ELECTROSTATIC PRECIPITATOR+BAGFILTER**	
1.	Location	On flue gas path between the air heaters and ID fans
2.	No. of Gas Paths per Boiler	} Refer Section-VII

SL. NO.	ITEM	CRITERIA
		) (The ESPs shall be suitable for low alkali content and sulphur content of coal.) 1.0 m/min (max) air to cloth ratio having four (4) passes and three (3) sections. Each section with two subsections. Filters shall be housed in subsections of ESP casing.
3.	No. of fields	To be decided by the Contractor. The minimum spacing between electrodes shall be 400 mm and treatment time shall be minimum 50 sec. Voltage shall be maximum 90Kv
4.	Velocity of flue gas thru' ESP	Maximum 1.2 meters/sec.
5.	Specific collecting area	25 Sq.m/Cu.m/sec minimum The gas volume considered for specific area calculation shall consider worst coal with 100% BMCR condition and 10% air heater seal leakages.
6.	Type of control	Semi pulse
7.	Minimum aspect ratio	1.5
8	Type of rapping Mechanism	Migi type
9.	Maintenance Requirement	Any of the parallel sections can be taken under maintenance in safely isolated condition without sacrificing limit of particulate emission.
10.	Gas/cloth	Max 1.3m/min
11.	Material	PPS
12	Fabric filter with bypass for oil firing , and total guaranteed life of bag filter should be minimum 30000 hrs with bag filter .operating temperature of 160 deg C.	
D.	**TURBINE**	
1.	Type	Multi cylinder, horizontal, Tandem compound, Reheat, Regenerative, condensing, Nozzle governing/Throttle governing, and directly coupled with generator at 3000 rpm, (double casing).

SL. NO.	ITEM	CRITERIA
2.	Critical Parameters	Continuous rated output at generator terminal (excluding excitation power) at 0.85 pf lagging under normal regenerative feed heating to meet the performance requirement as stipulated in the section-V of this specification under following conditions.

a) **Cooling Water Temperature**

	For Condenser	For Other Coolers
I) Design	* 33Deg. C	* Deg. C
ii) Maximum	* Deg. C	* Deg. C

* Contractor to indicate based on wet bulb temperature and relative humidity specified, and his optimization study considering the capital cost of the CW system, heat cycle performance and auxiliary power.

i) Refer Annexure - IV for condenser cooling water analysis.

ii) For other coolers, Contractor to specify cooling water analysis

b) **Condenser exhaust pressure**
   - i) Design - 10.3KPa
   - ii) Maximum - Later

c) Throttle Steam Temperature Before stop valve - 538℃

d) Reheat Steam Temperature at IP Turbine inlet - 538℃

e) Speed - 3000 rpm.

f) Grid frequency - 50 Hz

g) Frequency variation - 47.5 Hz to 51.5 Hz

h) Design DM water to thermal cycle. - 3% of BMCR make-up steam flow.

SL. NO.	ITEM	CRITERIA
3.	HP/LP Bypass requirement	60% Boiler MCR HP bypass & matching LP bypass (flow will be arrived during detailed engineering stage considering spray flow also in HP bypass) for parallel operation with T.G. under part load/house load condition.
4.	Mode of Operation	a) Fixed pressure in high load range and sliding pressure in low load range, start-up and shutdown. b) Capable of sustaining full load dump to house load with HP/LP bypass. c) Capacity to operate in parallel with HP-LP by pass system up to a maximum limit of 60% BMCR flow from boiler.
5.	Over Pressure operation	Steam Turbines shall be designed to accept short term & sustained main steam & reheat pressure as per IEC - 45.
6.	Design pressure	Turbine casing shall be designed for hydrostatic test pressure of at least 50% in excess of the maximum working pressure.
7.	Height of the last row of L.P. blades	SEPCO indicated approx. 800 mm.. However to be finalised during China meeting before ordering of Turbine package.
8.	Max. Continuous hours of Operation in VWO condition	AS per IEC- 45 guidelines
E.	**GENERATOR**	
1.	Type	As per electrical part. a) 2 pole, 3 phase, 50 Hz cylindrical rotor, WYE connected, directly driven. b) Stator winding – DM water in closed loop, DM water cooled by ACW water c) core & rotor - hydrogen in closed loop, hydrogen cooled by ACW water.
2.	Parameters	a) The generator capacity (at 0.85 pf) shall correspond to the station configuration selected by the Contractor nominal at 0.85 pf. lagging. The rating shall be selected by the Contractor meeting the following:

SL. NO.	ITEM	CRITERIA

i) Capability to generate power corresponding to peak output of turbine under VWO condition.

ii) Generated net plant power output at the high voltage side of the generator transformer.

iii) Max. Permissible temperature rise remaining within the limits as per IEC 34-1, 34-3 as applicable.

b) Terminal voltage : * kV

c) Frequency : 50 Hz

d) Minimum Capacitive MVAR rating at zero MW : Not less than 35% of its rated MVA

e) Short Circuit Ratio : 0.50 minimum

f) 3 ph. S.C. withstand capacity : As per IEC-34.

g) Voltage Waveform and THF : As per IEC-34.

h) Negative seq. current carrying capability : As per IEC-34.

i) Overload capability : As per IEC-34.

3. Class of Insulation — Class F but limited to class B.

4. Voltage & Frequency variation for continuous output

a) ± 5%* of the rated value for terminal voltage variation

b) + 3%, -5% of the rated value for frequency variation

c) Absolute sum of combined voltage and frequency variation 5%*

Note: This figure is on the basis that gen. transformer has OLTC and Unit Transformers have off-circuit tap changers. The Contractor is requested to give alternative offer with ±10% voltage variation. In that case, OLTC shall have to be provided in the Unit Transformers in place of the Generator Transformer.

SL. NO.	ITEM	CRITERIA
5.	Generator Excitation System	a) Static b) Accuracy of AVR within 0.5% c) AVR Reference voltage set point adjustable range - 15% to + 10% of nominal voltage for all loads Frequency range of operation: 47.5 to 51.5 Hz. d) Maximum change in generator voltage when AVR is transferred from auto to manual under all conditions of excitation: less than 0.5%. e) Maximum time to restore voltage to within 2% of nominal preset value = 3 seconds. f) Excitation system Response time (for field voltage increase up to 95% of the difference between ceiling voltage and the rated voltage) = within 50 ms.

F. FEED WATER HEATERS & DEAERATOR

1.	Regenerative Cycle	Design shall conform to ASME-TDP-I (latest edition). All heaters and deaerator shall be designed for vacuum condition also. All instrumentations shall be designed accordingly.
2.	Type of Heaters	LP & HP Heaters - Shell & tube Type. Horizontal preferred. Deaerator - Spray-cum-tray type or spray type (with at least 2 nos. spray control valves)
3.	Maximum permissible Extraction Line Pressure drop	5% of inlet pressure.
4.	Design manufacture and testing standard	As per Heat Exchange Institute, USA and ASME/ IS-2825.

SL. NO.	ITEM	CRITERIA
5.	Metallurgy of Tubes & Tube Sheets	All ferrous with minimum corrosion. Austenitic Stainless Steel tubes (TP-304) for heaters
6.	Velocity of water through tubes	Maximum 3 m/sec
8.	**Design Pressure**	
	Tubes	Shut-off pressure of the relevant pumps.
	Shell	10% margin over maximum extraction stream pressure.

G. **POWER CYCLE PUMPS**

1. **Boiler Feed Pumps**

1.1	Type	Horizontal multistage with suction booster and suction strainer. Main pumps– Barrel casing type.
1.2	Number	3 x 50%, two turbine driven and one motor driven
1.3	Rating	a) Total Capacity of Working Pumps - 100% BMCR flow rate (with 3% make-up) + 10% margin. b) Total dynamic head - 3% above the set pressure of highest drum safety relief valve plus static and dynamic head. Heads developed at the interstage bleed and kicker stage (if required) discharge shall be adequate for meeting the attemperation requirement of the boiler. c) Speed - Variable (stepless) for steam turbine drive; Hydraulic coupling for motor drive.
1.4	Material of Construction (Equivalent or superior to)	Cast steel outer casing; 13% Cr-steel inner casing, impellers, diffusers, shaft, shaft sleeve, balance drum and wear rings; bronze + Babbitt bearings.
1.5	Design, manufacture and testing standard	Hydraulic Institute, USA.

SL. NO.	ITEM	CRITERIA
1.6	Drive	Motor drives with variable speed control (Maximum pump efficiency that may be considered in calculating the drive unit rating and power consumption shall not be more than 83%)
1.7	Steam turbine drive type	Condensing, multistage, horizontal shaft type and operation shall be integrated with the main turbine operation. Each steam turbine shall be furnished as a completely integrated unit with soleplates, insulation material, lubrication systems and other accessories as required for a complete installation.
1.8	Base Plate	Common base plate for the complete assembly of motor driven pump (main & booster) , and the drive unit with built-in lub oil reservoir.
2.	**Condensate Extraction Pumps**	
2.1	Type	Vertical can type centrifugal design, provided with suction strainer
2.2	Number	2 x 100%
2.3	Rating	a) Total Capacity of working pumps - Maximum steam flow at turbine exhaust during VWO operation of turbine with maximum steam inlet pressure plus all heater drain and vents diverted to Condenser (plus 3% make-up). The pumps shall also be capable of sustaining emergency transient conditions like HP heater(s) out, Turbine HP & LP bypass in operation etc. The pumps shall also be capable with parallel operation of Turbine and HP-LP bypass. b) Head - Maximum deaerator pressure plus static and dynamic head under maximum capacity condition.
2.4	Margin on Capacity	10% over theoretically calculated capacity arrived at from 2.3a) above.

SL. NO.	ITEM	CRITERIA
2.5	Material of Construction	Equivalent or superior to C.I. casing and suction bell; S.S. impeller, shaft, shaft sleeve and wear rings.
2.6	Design, manufacturer and testing standard	Hydraulic Institute, USA.
H.	**CONDENSER**	
1.	Type	Single pass, water-cooled.
2.	Design Standard	As per HEI, USA or equivalent for thermal rating and /ASME Sec-VIII / equivalent for strength.
3.	Tube material and Tube plate material	Stainless steel (SS-304) tubes and carbon steel tube sheets, coated/cathodically protected as required.
4.	Thermal load	i) Turbine Exhaust flow during Turbine VWO operation with all drains and vents from Feed Water Heaters led to Condenser along with boiler feed pump's auxiliary turbine drive exhaust (if any). ii) Maximum flow under HP-LP Bypass condition with house load operation without tripping the turbine at low vacuum condition.
5.	Minimum permissible TTD (Terminal Temperature Difference)	3 Deg. C
6.	Cleanliness Factor	0.9, to be considered to achieve the specified design/ performance requirements, along with 5% margin for plugged tubes.
7.	Water box and connected system design pressure	Corresponding to CW pump shut off condition.
8.	Steam side design pressure	Full vacuum to 1.08 kg/cm^{2}g (min.)
9.	Velocity of water in tubes	Maximum 2.2 m/sec for S.S.

SL. NO.	ITEM	CRITERIA
10.	Cooling Water Temperature differential across condenser	$\leq$ 8.8 Deg C

I. AIR EXTRACTION SYSTEM

1.	Type	Vacuum pumps air evacuation system.
2.	Number	i) 2 x 100% mechanical vacuum pumps with all accessories. During start-up both the pumps may operate simultaneously.
3.	Capacity	As per HEI, USA or equivalent code of international repute.

J. TURBINE OIL PURIFICATION SYSTEM

1.	Type	Bowser/centrifuge/coalescent separated type
2.	Output	Free moisture - nil; particle size - shall be less than 5 micron after purification unit or as recommended by manufacture which ever is less
3.	Capacity	20% per hour of the total oil in TG system, or 10,000 litres per hour, whichever is higher.

K CONDENSATE POLISHING UNIT

1. Number of Polisher Vessels — 3 x 50% for each unit
2. The minimum design concentrations of various contaminants (adopted typically for sub-critical boiler and turbine.)

Contaminant		Design Normal Condition	Start Up Condition
Ammonia	Ppb	500	1500
Total Dissolved Solids	Ppb	100	2000
Conductivity at 20 deg C	Micro S per cm	0.5	2.0

SL. NO.	ITEM	CRITERIA	
Reactive Silica	Ppb	20	500
Iron total	Ppb	50	1000
Sodium	Ppb	10	20
Chloride	Ppb	20	100
pH		About 9.2	9.5
Total Suspended Solids	Ppb	100	1000
Temperature	Deg C	60	60

3. The System shall be designed to deliver the treated condensate as given below:

Contaminant		Design Normal Condition	Start Up Condition
Total Dissolved Solids	Ppb	Less than 20	Less than 50
Cation Conductivity at 25°C	Micro S per cm	Less than 0.1	Less than 0.2
Silica total	Ppb	Less than 7.0	Less than 50.0
Iron total	Ppb	Less than 5.0	Less than 100.0
Sodium	Ppb	Less than 2.0	Less than 5.0
Chloride	Ppb	Less than 2.0	Less than 10.0
Total Suspended Solids	Ppb	Less than 10.0	Less than 100.0

4. Operating mode to be considered for design of the CPU

Under the Design Normal Condition, each Condensate Polisher Vessel shall be designed to operate in hydrogen cycle for not less than 168 hours (7 days) and in ammonia cycle not less than 336 hours (14 days) i.e. total 21 days of continuous operation, while maintaining the above treated condensate quality.

Useful service run between regenerations during the above conditions of start-up, shall not be less than 50 hours.

5. Type of Resins

Cation resin: Strong acid, with sulfonic acid functional group, to the regenerated with HCl.

Anion resin: Strong base, with quaternary ammonium (Type-I) functional group, to be regenerated with NaOH solution.

Insert resin: Non-ionic compatible with the above resins

The resins offered shall be suitable for condensate polishing duty, with high mechanical strength and high resistance to attrition.

6 Ratio of Resins

1.5 : 1 (Cation : Anion)

7.	Free Board to be Provided	a)	Mixed resin storage vessel	50%
		b)	Cation regeneration vessel	75%
		c)	Anion regeneration vessel	100%
8.	Mode of regeneration	Regeneration shall be performed external to the main process vessel, by transferring the resins to the regeneration vessels. Proven and patented technology for resin transfer, separation, regeneration and return to the CPU vessels shall be offered. Nearby zero cross-contamination of the cation and anion resins shall be guaranteed.		

L. PIPES, PIPE SUPPORTS, FITTINGS & VALVES

Design, manufacturing, testing and installation shall be carried out in conformance with the following standards subject to the approval of the Owner and Statutory Bodies:

a) Indian Boiler Regulations (IBR)

b) ASME Boiler and Pressure Vessel Code - Section : I, II, V, VIII & IX.

c) ANSI B 31.1 : Code for Pressure Piping - "Power Piping" (including standards listed therein)

d) ANSI B 16.5 : Steel Pipe Flanges and Flange Fittings

e) ANSI B 16.9 : Wrought Steel Butt Welding Fittings

f) ANSI B 16.11 : Socket Welding Ends

g) ANSI B 16.25 : Butt Welding Ends

h) ANSI B 16.34 : Steel Valves - Flanged and Butt Welding Ends

i) AWWA-C-504 : American Water Works Association Standard for rubber seated butterfly valves

j) ANSI B 36.10 : Welding and Seamless Wrought Steel Pipe

k) MSS-SP-58 : Materials, Design and Fabrication of Hangers and Supports

l) MSS-SP-89 : Fabrication and Installation of Steel Hangers

I. Power Cycle Piping, Fittings and Valves

Material of Construction for power cycle pipes, fittings and valves should be equivalent or superior to the following:

System / Item	Main steam, Hot reheat piping including HP & LP bypass piping	Cold reheat, feed water drain and condensate piping	Other turbine cycle and boiler integral piping & auxiliary steam & condensate piping
a) Piping material	ASTM A 335 P-22 for temperature up to 525°C ; P-91 for temperature above 525°C (Seamless)	ASTM A 106 Gr.B or Gr.C (Seamless) and ASTM A 672 Gr.B-60 class 12/22 (plate formed electric fusion welded) for sizes 550 mm NB & above	ASTM A 106 Gr.B or Gr.C (Seamless) and ASTM A 672 Gr.B-60 class 12/22 (Plate formed - Electric fusion welded) for sizes 550 mm NB & above
b) Joints	Butt weld as per ANSI B 16.25. Socket weld for size 50 mm NB & below, unless radiography is required	Butt weld as per ANSI B 16.25. Socket Weld for size 50 mm NB & below, unless radiography is required	Butt weld as per ANSI B 16.25. Socket weld for size 50 mm NB & below, unless radiography is required
c) Fittings material	ASTM A 234 Gr.WP 22/WP91 (seamless) for 65 mm NB & above. ASTM A 182 Gr.F 22/F91 (Forged - Seamless) for size 50 mm NB & below	ASTM A 234 for 65 mm NB & above. ASTM A 105 Gr. WPC /WPB for 50 mm NB & below	ASTM A 234 for size 65 mm NB & above. ASTMA 105 Gr. WPC/WPB for size 50 mm NB & below
d) Material test and analysis:			
i) Mandatory require-ments	As per IBR and ASME B & PV code Section-II	As per IBR and ASME B & PV code Section-II	As per IBR and ASME B & PV code Section-II

System / Item	Main steam, Hot reheat piping including HP & LP bypass piping	Cold reheat, feed water drain and condensate piping	Other turbine cycle and boiler integral piping & auxiliary steam & condensate piping
ii) Non-destructive examination of welds	100% magnetic particle examination, 100% Radiography exmaination and 3% Hardness testing	10% magnetic particle examination, 100% Radiography for those whose design temperature is above 175°C and pipe thickness is over 19 mm. All pipes and fittings of 200 mm NB & above shall be ultrasonically tested	10% magnetic particle examination, 100% Radiography for those whose design temperature is above 175°C and pipe thickness is over 19 mm. All pipes and fittings of 200 mm NB & above shall be ultrasonically tested
e) Valve material :			
i) Body & Bonnet/ cover	ASTM A 217 Gr.WC9/ C12 for size 65 mm NB & above and ASTM A 182 Gr.F22/F91 for size 50 mm NB & below	ASTM A 216 Gr.WCB/WCC for size 65 mm NB & above and ASTM A 105 for size 50 mm NB & below	ASTM A 216 Gr.WCB/WCC for size 65 mm NB & above and ASTM A 105 for size 50 mm NB and below
ii) Trim	13% Chrome Steel (ASTM A-182 Gr. F 6a), hardfaced with stellite	13% Chrome Steel (ASTM A-182 Gr. F 6a), hardfaced with stellite	13% Chrome Steel (ASTM A-182 Gr. F 6a), hardfaced with stellite

NOTE :

1. Power cycle piping system material generally shall be carbon steel for design temperature up to 410°C and alloy steel for design temperature above 410°C.

2. All fittings shall be forged/manufactured at shop; however; Carbon steel fittings for low-pressure application may be fabricated/made at site for size 50 mm NB & below.

3. All high-pressure oil pipe line material shall be as per API 5L Gr.B or ASTM A 106 Gr.B and fittings material shall be as per ASTM A-234 Gr. WPB for 65 mm NB and above, ASTM A-105 for 50 mm NB and below.

4. ASTM A-105 & 106 materials used shall have less than 0.25% Carbon Content.

5. Pipe hangers and supports shall meet the requirements and recommendations of ANSI B 31.1, MSS-SP-58 and MSS-SP-89, subject to the Owner's approval.

II. Low Pressure Piping, Fittings and Valves

a) All piping systems and equipment shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 Years.

b) All the buried pipes shall be given protective coating, wrapping and cathodic protection (if required).

c) Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation.

d) In general, 65 mm NB & above are to joined by Butt-welding and 50 mm NB & below by socket welding/screw connections.

e) All rubber lined pipes shall be flange joined.

Material of construction for pipes, fittings and valves carrying various fluids should be equivalent or superior to the following:

System / Item	Raw Water, Ash Water, Circulating Water, Service Water or Similar Service	Demineralised Water and HP/LP Chemical for dosing	Drinking Water, Instrument air and plant air
a) Piping material	ASTM A-36/ASTM A-53 Type 'E' Gr.B/ IS-3589/IS-1239	ASTM A-53 Type 'E' Gr.B/IS-3589/IS-1239 with 3 mm thick rubber lining to IS-4682 or equivalent for size above 50 mm and S.S. to ASTM A-312, Gr. 304 (seamless) for size 50 mm and below	ASTM A-53 Galva-nised/IS-1239 heavy Galvanised/IS-3589 Galvanised to IS-4736 or equivalent
b) Fittings material	Same as piping material	Same as piping material	Same as piping material
c) Valves material (equivalent or superior to)			
i) Body and Bonnet/ cover	BS-1452 Gr.14/ IS-210 Gr.FG 260	ASTM A-351 Gr.CF-8M/ASTM A-182 Gr.304L for sizes 50 mm NB and below BS-1452 Gr. FG 260 for sizes 65 mm NB and above	ASTM A-216 Gr. WCB/ASTM A-105

System / Item	Raw Water, Ash Water, Circulating Water, Service Water or Similar Service	Demineralised Water and HP/LP Chemical for dosing	Drinking Water, Instrument air and plant air
ii) Trim	BS-1452 Gr.14/ equivalent	ASTM A-182 Gr. F 316 L for sizes 50 mm NB & below and BS-1452 Gr.14/ 210 Gr.FG 260/equivalent for sizes 65 mm NB & above	ASTM A - 182 Gr.F6

NOTE :

Applicable code and standard for valves:

i) IS-14846 Specification for sluice valves for water work purposes
ii) AWWA-C-504 : Standard for rubber seated butterfly valves

iii) ANSI B-16.34 : Steel valves (Flanged and Butt Welding Ends)

iv) API 600 : Steel gate valves (Flanged and Butt Welding Ends)

SL. NO.	ITEM	CRITERIA
M.	**COAL HANDLING PLANT**	
1.	General	Plant shall be designed for coal as per the analysis furnished and for continuous duty (for all equipment in this system).
2.	Feeding System Capacity	To meet the requirements of the Section-V of this specification subject to min. 4 X 1800 TPH total for the plant.(2 × 1800TPH feeding for 3 units). Operation of both streams of each phase shall be possible at the same time incase of emergency only if the feed is to boiler directly from crusher.
3.	Unloading System Capacity	2×1800TPH for each track hopper -
5.	Open Yard Storage Capacity	Fifteen (15) days BMCR coal requirement of the plant in six stock piles of crushed coal.
6.	Bunker Storage Capacity	Ten (10) hours capacity of each unit under BMCR coal requirement.
7.	Track Hopper Number/ Capacity	Two (2) each of 6500 T holding capacity. Height of Shed over track hopper shall be suitable to receive electric locomotive. Track hopper shall have three(3) escape routes for safety of personnel.
8.	Bulk density of coal for volume calculation (T/M^3)	0.8 (belt conveyor capacity)
9.	Bulk density of coal for weight calculation (T/M^3)	1.1 (Structure and all balance design calculations)
10.	Maximum belt speed	Within limits stipulated in IS-11592 subject to 2 m/s between Track Hoppers and Crushers for stone picking facility. 3.0m/sec in other areas .
11.	Maximum belt slope	16 Degree for uncrushed coal, 18 Degree for crushed coal
12.	Chute Valley angle	70 Degree minimum

SL. NO.	ITEM	CRITERIA
13.	Conveyor Galleries	Fully enclosed with 1.0 metre wide walk way on both sides and between both conveyors as specified.. Clear height of conveyor gallery everywhere shall be minimum 3.0 m after accommodating ventilation and fire protection system.
14.	Bearing life	30,000 hours
15.	Pulley width	Belt width + minimum 200 mm.
16.	Crushers:	
	o Capacity and turn down ratio	To suit CHP performance requirement and redundancy requirement as per Section-V & VII of this specification. Minimum 4, each of 1800 TPH capacity
	o Output	To suit the boiler's pulveriser input requirement, with coal size and quality as stated..
	o Type of crushers	Ring Granulators Crushers and roller type screen shall be provided
17.	Stacker-cum-reclaimer	Three numbers reversible bucket wheel type, capacity each 1800 TPH. Interconnection at discharge side of two stalker reclaimer.
18.	Bulldozers	6 Nos. of 300kW capacity.
19.	Conveyor and other equipment drives	Up to 200 kW - Single LT drive > 200 kW - HT drive With Traction type Fluid coupling above 30 kW and scoop tube controlled fluid coupling for HT drive. Hydraulic Motors (without any gear drive) shall be provided for CHP equipments and auxiliaries except paddle feeder, such as Stalker/ reclaimer.

SL. NO.	ITEM	CRITERIA
20.	Design, manufacture, testing and installation standard to be conformed for -	
	a) Conveyor and Belt	IS-4776/7155/11592 ISO 340/ IS-1891/BS-490/ CAN/CSA-M 422 – M87 /equivalent DIN-22102/JIS-K6322/Equivalent and the latest edition of 'Belt conveyors for Bulk Materials' published by CEMA (fire resistant)
	b) Idlers	IS-8598/Equivalent (With minimum double labyrinth dust seal)
	c) Pulleys	IS-1891/IS-8531/Equivalent
21.	Feeder for track hopper unloading conveyors	Paddle feeders with motor drive
22.	Coal samplers (for "as received" coal as well as the coal fed to the power house bunkers)	Automatic coal sampling units, to produce samples conforming to ASTM-D-2234 and ASTM-D-2013, with capacity to handle samples collected for eight (8) hours' CHP operation
23.	**Magnetic separators**	
	a) Magnetic strength	Minimum 1000 Gauss at 400 mm distance in hot running conditions.
	b) Heaviest pieces of tramp iron to be lifted	20 mm M.S. cube/30 kg M.S. plates/30 kg M.S. round bars of L/D ratio within 5.
24.	Belt protection switches -	
	a) Pull-chord type emergency switches	Every 30 m of conveyor length
	b) Belt sway switch	Every 50 m (min. 2 pairs per conveyor)
	c) Zero speed switch	For every crusher drive

SL. NO.	ITEM	CRITERIA
25.	Other protection devices :	a) On line vibration monitor (for Horizontal, Vertical & Axial position) for crushers b) Fail safe A.C. thrustor operated brakes and hand-operated rail clamps for movable trippers. c) Device for detection of longitudinal tear of belt to be provided for each belt.
26.	Belt scales -	
	a) Range	20% to 120% of rated capacity requirement with 100% overload protection.
	b) Accuracy	Max ±0.2% through out the range, one spare belt scale shall be provided.
	c) Measurement provisions	Flow indicator & totaliser
27	**Metal Detector**	Metal Detectors shall be provided for each of the belt conveyors, before feeding the crushers and before the coal to the coal bunkers.

28 All tunnels should have escape points on each end.

29. Maintenance hoist shall be provided at all suitable/ required location in the coal handling system

30. Deck plates shall be provided all along the Conveyors and shall be of minimum 3 mm thickness. (to be finalised during DBR).

31. Transfer Chutes and Liners:

For Crushed Coal:
Mild steel (IS 2062 / equivalent) of 10 mm thickness with Stainless Steel (Type 304) liner of minimum 6 mm thickness on sliding surfaces.

For Uncrushed Coal:

Hardened steel (Tiscral / Sailhard/ Equivalent) of 20 mm minimum thick ness on sliding and sticking surfaces, 10 mm minimum on non- sticking /sliding surfaces.

SL NO.	ITEM	CRITERIA
N.	**ASH HANDLING PLANT**	
1.	General	Ash Handling System shall be designed considering worst ash content in coal and 100% BMCR operation of all steam generators.
2.	Total ash generated	141.4TPH per boiler with worst coal
3.	Design capacity of Ash Handling system	To meet the performance and redundancy requirements as stated in section-V and VII of this specification, with the design ash generation rate and at least the following loading as percentage of the total ash for each unit : a) Bottom ash - 20% b) Economiser ash - 5% c) Airheater ash - 5% d) ESP ash - 90%
4.	**Bulk density of ash**	
	a) BA and FA for volume computation	650kg/Cum.
	b) BA/FA for strength computation	1350 kg/Cum.
	c) FA for ESP/APH/ECO hopper volume computation	650kg/Cum.
5.	Bottom ash disposal system	The Bottom Ash Disposal System shall be provided for the collection and removal of bottom ash from the boiler furnace. The coarse ash from economizers shall be transported to bottom ash silo.. The bottom ash shall be collected by dry ash conveyor from bottom ash hopper (6 hours storage capacity) and shall be transported to intermediate ash silo by conveyor system. From Intermediate silo ash will be transported to main silos by 2x100% belt conveyor system (common for all six units) which shall be located near ash dyke. Belt conveyors shall be enclosed with a closed Canopy/hood with a hinge connection. One common walkway will be along the conveyor for maintenance. The bottom ash main silos storage capacity shall be 12 hours for each with worst coal for all six boilers. The

SL NO.	ITEM	CRITERIA
		equipment specification of ash belt conveyors shall be similar with coal conveyors. The Metallic conveyor shall contain wire braided metallic cloth extended between chain links acting as the belt and supported on metallic rollers as per design. The main conveyor enclosure shall have provision to pass air above and below pans. There shall be a spill conveyor running below the main conveyor and taking spill from top. The conveyor shall be slow moving type to allow cooling of ash during the passage to the discharge end. The conveyor shall be totally enclosed in a casing with the enclosure having multiple opening with manually/automatically controlled valves/dampers allowing air to pass from top and bottom of the belt, into the boiler. Level switches (Low& High) shall be provided in each bottom ash silo as per design for safe operation. The crusher type shall be double roll, automatically reversible as per design.
6.	**Fly Ash removal**	
	a) From FA hoppers to silo	By combined vacuum and pressure mode; up to Buffer Vessels by Vacuum Extraction Pumps, and thereafter by Pressure pneumatic conveying by Transport Air Compressors up to the fly ash Storage Silos. The fly ash vacuum system equipment shall be sized for 200TPH.
	b) From Silo to ash dump	By HCSD mode (Ash to water ratio shall be maintained as 65:35 by weight.). Each fly ash silo shall have five ash unloading points. Two points for HCSD, Two dry unloading to Bulkers / closed rail tankers and one to open trucks through ash conditioner. Ash unloading System to rail tanker shall be in phase-1 only. Railway lines shall be provided by owner.
7.	Rate of ash slurry disposal to the ash dump area	To suit the maximum generation of fly ash at full load of the station, to the ash dump area.

SL NO.	ITEM	CRITERIA
8.	**Fly Ash Storage Silo**	
	a) Number	Two RCC Silos for three units for disposal by HCSD as well as for fly ash storage and disposal in dry mode by trucks. Vent fan provided at silo shall be designed to take care of one unit to three units.
	b) Capacity	12 hours capacity considering 100% BMCR operation with worst coal.
	c) **Silo unloading**	Each fly ash storage silo shall have unloaders of sufficient capacity to clear the complete silo in eight (8) hours using two unloaders. One shall unload into open truck and two points into bulker/ closed rail (rail tankers for phase-1) tanker. In addition, two outlets per silo for handling through the HCSD system. Dry ash unloaded into trucks shall be conditioned with 15-18% moisture. Unloading to two bulkers shall be carried out concurrently from each silo.
9.	**Bottom Ash hopper**	
	a) Type	One self supported type bottom ash hopper (SS plate or equivalent not less than 10mm) with cast able , refractory lining with SS anchors etc to withstand radiant heat and ash heat around 800-900 degree. All other accessories including, poke holes, bottom gate with hydraulic system/pneumatic system, inspection door, Manholes etc. shall be provided.
	b) Nos. of outlet in each hopper	Suitable number of outlets, with electro-hydraulically operated gates.
	c) Required storage capacity	Six (6) hours of storage capacity for rate of bottom ash generation with worst coal firing.
	d) Number of clinker grinders required	One for each boiler
	Minimum hardness - of Rolls/Roll teeth/cams - of Liner/Anvil	 BHN 500 BHN 350
	f) Submerged scraper chain conveyor not applicable)	
10.	**Hopper and Silo Fluidizing Blowers and Conveying Blowers/ Compressor**	Silo fludising blowers shall be kept inside a silo blower room near silos and room shall be supplied with clean air thru a unitary air ventilation system.

SL NO.	ITEM	CRITERIA
	a) Type	i) **For Fluidizing System** Rotary Positive Displacement Type (air cooled twin lobe construction)
		ii) **For Conveying System** Twin Lobe Rotary Positive Displacement type OR Screw Type OR Centrifugal Type
	b) Quantity Required	i) **For Fluidizing System** For Air Heater/ ESP +FF Hopper, Buffer hopper, Two (2) per unit (1 Working + 1 Standby) For two ash Silos 3 nos. (2Working + 1 Standby)
		ii) **For Conveying System** One set of vacuum pumps and transport air Compressors with air driers for each unit, with minimum 100% standby for Vacuum Pumps and 50% standby for Transport Air Compressors.
11.	**HCSD SYSTEM**	
	a) Total Ash Removal capacity	To dispose the total fly ash generated by all generating units.
	b) No. of HCSD streams	two for three generating units and 1 common standby for one phase.
	c) HCSD slurry Concentration	65:35 % by weight
	d) Each HCSD pump capacity	Contractor to indicate during DBR
	e) HCSD pump discharge pressure	Contractor to indicate during DBR
	f) Type of HCSD pump	Piston diaphragm or equivalent type with proven design and performance record.
	g) HCSD disposal pipe size	To be designed for about 1.8 m/s velocity
	h) Water consumption in HCSD system	Contractor to indicate

SL NO.	ITEM	CRITERIA
	i) Instrument air requirement	Contractor to indicate
	j) Bottom Ash preparation for HCSD system(not applicable)	
11.	**Ash conveying pipes**	
	Piping/Fittings material	Seamless carbon steel pipes shall be provided. Material shall be ASTM A-106 Gr-B or better, abrasion resistant properties. The fittings shall be of hardness 400 BHN minimum, Piping with minimum 7 mm thickness shall be provided for pipes having diameter less than200 NB, For 200 NB and above it shall be minimum 9.5 mm thickness.
12.	Number of ash slurry disposal pipe lines to ash dump area	One (1) from the discharge of each HCSD pump.
13.	Materials of the following miscellaneous items to be equivalent or superior to :	
	a) B.A hopper feed gate	/ Suitable for dry bottom ash with better, abrasion resistant materials..
	b) B.A hopper nozzle tips (not applicable)	Anti-Corrosive tool steel/S.S of min. 550 BHN.
	c) B.A hopper lining	One self supported type bottom ash hopper (SS plate or equivalent not less than 10mm) with cast-able ,refractory lining with SS anchors etc to withstand radiant heat and ash heat around 800-900 degree. All other accessories including, poke holes, bottom gate with hydraulic system/pneumatic system, inspection door etc. shall be provided..
14.	Ash Water Pumps	1 working, 1 standby for ash water pumps for flushing purpose of HCSD system for both phase.. 2 working, 1 standby for ash water pumps for each phase for making of slurry 2 working, 1 standby for Seal Water pumps for each phase
O.	**RAW WATER SYSTEM**	
1.	Location of Raw Water Pump House	Raw Water Reservoir at site

SL NO.	ITEM	CRITERIA
2.	Raw Water pumps	
	a) Number	Equal to the number of generating units plus one standby.
	b) Type	Vertical wet pit
	c) Material of Construction	
	Casing	C.I
	Impeller	SS
	Shaft Sleeve	AISI – 410
	Shaft	AISI – 410
	Fasteners	SS - 304
3.	Applicable Codes / Standards	Hydraulic institute standards of USA, equivalent
4.	Not used	
5.	Not used	
6.	Raw water Reservoir (within plant boundary)	
a)	Number	One (1) in two compartments
b)	Capacity	600,000 cub m
c)	Service	Storing of raw water for the whole station
d)	Material	As per civil part.
P	**RAW WATER TREATMENT & DRINKING WATER SYSTEM**	
1.	General	The water analysis to be adopted for the design of Raw Water Treatment Plant has been enclosed along with this specification.
2.	Type	Complete clarifier unit shall be over ground as much as possible so that sludge draining arrangement becomes underground to the minimum extent. Sludge blow off shall be by gravity.

SL NO.	ITEM	CRITERIA
3.	**Clarified Water Reservoir**	
	a) Number	One (1) in two (2) compartments
	b) Capacity	4 hours make-up water requirement
	c) Service	Storing of clarified water for supply of fire water, cooling water make-up, ash plant seal water and service water, supply to filtration unit & DM Plant.
	d) Material	R.C.C. (partly over ground & partly underground).
4.	**Drinking Water System**	
	a) No. of Units	Two (2) nos., One for Plant and other for Colony.
	b) Capacity at outlet	150 m^3/hr for each
	c) Turbidity at outlet	1 ppm
Q.	**DEMINERALISATION PLANT**	
	1. Number of streams and Period between two (2) successive regenerations	Eighteen (18) hours. Minimum two or three operating streams and one standby stream (3 x 240 TPH or 4 x 160 TPH).
	2. Regeneration Period	4 hours (maximum)
	3. Freeboard to be provided for all units and measuring/ storage tanks	(a) 300 mm (minimum) for measuring/storage tanks. (b) 80%-100% of resin bed depth for exchanger vessels.
	4. Material of all nuts, bolts, washers, etc. in submerged and corrosive application	SS 316
	5. Mode of operation of DM Plant	Fully automatic PLC based with provision for manual operation.
	6. Type of filters	Pressure Sand Filters and Activated Carbon Filters. Flow measurement with integration shall be provided at inlet header

SL NO.	ITEM	CRITERIA
7.	Type of Cation units	Strongly acidic.
8.	Regeneration of Cation Unit	Counter current regeneration by 30% HCl (IS-265 - Technical grade or equivalent).
9.	Interconnection of Cation exchanger units	The outlet of cation exchanger units shall be interconnected with isolation valves so that any of the exchangers can be used for any stream. Sodium Analyser at the outlet of Cation Exchangers shall be provided.
10.	**Type of Degasser Tower**	Forced draft type.
	- Maximum and minimum capacity	120% and 20% of normal capacity
	- CO_2 content in effluent	Not more than 5 ppm as CO_2
11.	**Degassed Water Storage Tank**	
a)	Number required & Type	Two (2), Horizontal cylindrical with dished ends.
12	**Anion Units**	
a)	Type	**Strongly Basic anion Type-1**
b)	Regeneration	Counter current by sodium hydroxide (IS-252 - Technical Grade or equivalent).
c)	Interconnection of Anion Exchanger Units	The outlet of the anion exchanger units shall be interconnected with isolation valve so that any of the anion units can be used for any stream.
13.	**Mixed Bed Units**	
a)	Type	Strongly acidic cation and strongly basic type-I anion.
b)	Regeneration	By HCl & NaOH (Technical Grade)
c)	pH Measurement required at	At Outlet Header of MB units.
d)	Silica & Conductivity Measurement	At outlet of each MB unit.
e)	Flow measurement	Flow measurement with integration shall be provided at the outlet header.

SL. NO.	ITEM	CRITERIA	
		Shall provide NRV in outlet of MB exchangers before DM tank inlet, DM tank feeding at top and DM tank discharge from bottom. DM Pump suctions shall be from DM tank only.	
14.	**Regeneration System**	**Acid**	**Alkali**
	a) **Unloading & Transfer Pumps**		
	- **Material of Construction**		
	i) Casing, impeller shaft sleeves & stuffing box	Polypropylene	Alkali unloading pump shall be of SS as per AISI-304 and Alkali transfer pump shall be poly- propylene.
	ii) Shaft	Hardened Carbon Steel En-8	
	iii) Packing	Mechanical Seal	
	b) **Alkaline Brine Preparation Tank**		
	- Useful capacity	Suitable to meet the requirement of five (5) bed volumes of SBA resin, plus 20% margin.	
	- Material of Construction	FRP with Bisphenol A Grade resin, conforming to the requirements of BS-4994.	
	c) **Measuring Tanks**	**Acid**	**Alkali**
	- Nos. required	Two (2) [One (1) for cation units and One (1) for MB Unit]	Two (2) [One (1) for anion units and One (1) for MB Unit]
	- Useful capacity of each	Double Regeneration requirement of one cation Unit + 20% margin and single regeneration requirement of MB unit + 20%margin.	Double Regeneration requirement of one SBA/WBA + 20% margin and single regeneration requirement of MB unit + 20%margin.

SL NO.	ITEM	CRITERIA	
	d) Storage Tanks	**Acid**	**Alkali**
	- Nos. required	Two Horizontal storage tanks	Two Horizontal storage tanks
	- Useful capacity of each	Total capacity suitable for 15 day's storage requirement.	Total capacity suitable for 15 day's storage requirement.
		Note : Acid and alkali measuring tanks for SAC & SBA/WBA respectively shall be adequate to carry out double regeneration as and when required.	
	- Material of construction	Carbon steel with corrosion resistant lining / FRP	
15.	**Neutralisation/Effluent Disposal System**		
	a) **Netralisation/Effluent Collection Pit**		
	- Number	Two (2) with common partition wall	
	-Material of construction lining	RCC with 3 mm thick PVC sheet /RCC with 3mm thick FRP	
	-Effective capacity (each)	Suitable for holding regeneration effluent generated from two (2) chains + 20% margin in each chamber.	
	-Special Feature	Necessary air grid arrangement of polypropylene construction shall be provided in each compartment for better mixing of effluent. Air for this will be taken from discharge header of mixed bed air blower. Minimum free board over water level in each pit - 500 mm.	
R.	**WATER SUPPLY AND STORAGE**		
1.	Design requirement of pump house accommodating vertical wet pit pumps	Sumps in pump house shall be designed in strict conformance to the recommendations/ standards of Hydraulic Institute USA,or approved equivalent.	

SL NO.	ITEM	CRITERIA
2.	**Design and Constructional Features of Vertical Wet Pit Pumps**	
	a) Design standard	Hydraulic Institute Standard/IS-1710/IS-5120 or equivalent
	b) Pump type	Non pull out/pull out
	c) Material of Construction	To be selected by the Contractor subject to the owner's approval.
3.	**Horizontal Centrifugal Pumps**	
	a) Design standard	Hydraulic Institute Standard/ IS-1520/ Equivalent Standard.
	b) Material of Construction	To be selected by the Contractor subject to the owner's approval.

4. **Miscellaneous tanks in the Plant**

	Tanks Designation	Number	Capacity	Type
a)	Filter water tank	1	8 hrs requirement	Vertical RCC Tank
b)	Drinking water tank in power house	2	each 50 m^3	
c)	Service water tank in power house	0	- -	- -
d)	DM Water storage tank	4	1600 m^3 each	Vertical Cylindri- storage cal steel tanks

		Number	Capacity	Type
e)	Condensate storage tank	1	800 m^3 each for each unit	--do --
f)	Condensate surge tank		contractor to decide	
g)	Closed cycle cooling water tank	1	- do -	Cylindrical steel tank

SL NO.	ITEM		CRITERIA
h)	Service water tank to be provided in other auxiliary building including:	One (1) minimum in each building	Contractor to decide
	i) Canteen		
	ii) CHP control room		
	iii) DM Plant building		
	iv) Administrative building and other buildings as found necessary within the SEPCO's Scope		
i)	Drinking water tanks to be provided in all the above mentioned auxiliary building in above item (h) and other buildings as necessary	Minimum one (1) no. in each building	Contractor to decide
j)	Construction code for Steel Storage tanks	IS-803 ; tanks shall be plate thickness 6 mm (minimum) for shell, with corrosion allowance of 1.0 mm	
k)	Applicable Codes and Standards for steel storage tanks.	IS-803, IS-804, IS-805, , IS-10987, API-120, API-12F, API-620, BS-2594	
5.	**Protection and Painting of Tanks**	**Surface Preparation :** Internal and blasting and external wire brushing if necessary. Inside - rubber lined (4.5 mm, 3 layers) for all tanks storing DM water. **Internal :** Asphalthene or equal for all tank except DM water tanks	

SL NO.	ITEM	CRITERIA
		External : Red lead primer followed by 2 coats of synthetic enamel paint. Bottom surface shall have 3 coats of Bitumastic paints.
S.	**CIRCULATING WATER, AUXILIARY COOLING WATER & DM CLOSED CYCLE COOLING WATER SYSTEM**	
1.	Demineralised water closed cycle cooling water (DMCW) working pressure	Working pressure in lube oil coolers of Boiler and TG island shall be less than the oil pressure in the above coolers and less than the hydrogen pressure in the H_2 coolers （Hydrogen used for generator rotor and core in closed circuit cooling will be cooled by ACW water）.
2.	Drive motor power rating	For ACW system capacity margin of 10% and head margin of 20% should be available. i) Shall consider at least 15% margin over the pump shaft input power at the rated duty point. ii) At least 5% margin over the maximum shaft input power required within the entire range of operation, also including the case of overloading of the pump assuming single pump operation in the event of tripping of one or more pumps working in parallel.
3.	**Vertical Pumps - Intake, CW & ACW System (where applicable)**	
	a) Applicable codes and standards for pumps and pump sump	Hydraulic Institute Standards of USA, IS-1710, IS-5120, IS-5659, BS-5316 PTC 8.2 English translation of relevant Chinese code to be supplied for review and acceptance.
	b) Pump Number and type	2 x 50% % CW pumps for each unit with one common standby for three units, and 2 x 100 % ACW pumps for each unit. Single or multistage centrifugal, mixed flow or axial flow type with discharge co-axial with shaft. Pumps shall be `Non

SL NO.	ITEM	CRITERIA
		pull-out' type and pump & drive motor shall have single foundation. Each CW pumps shall meet 60% load requirement. Head Margin of 5% will be provided for CW pumps to meet under frequency.
	c) Impeller adjustment	Provision shall be kept for adjustment of impellers in vertical direction from an accessible location, preferably at the housing (where separate thrust bearing for the pump is provided). To be finalised during DBR.
	d) Reverse flow through pump to be considered for pump/motor design	Reverse rotation arrestor to be included.
	e) Location of thrust bearing	Separate for pump and motor or one common with the motor
	f) Material of construction	
	1. Casing	Cast Iron.
	2. Impeller	SS
	3. Shaft sleeve	AISI-410 (Hardened) or equivalent
	4. Line shaft	AISI-410 or equivalent
	5. Impeller shaft	AISI-410 or equivalent
	6. Shaft coupling	AISI-410 (Hardened) or equivalent
	7. Fasteners	SS-304
4.	**Cooling Tower**	
	a) Type	Induced draught with film or splash type fill material, as per supplier's proven design.
	b) No.	IDCT will be provided with Back to back arrangement (with one stand by cell).
	c) Codes and Standards	BS-4485, CTI , PTC-23,

SL NO.	ITEM	CRITERIA
e)	Whether fills are removable type	Yes
f)	Design wet bulb and relative humidity to be considered	28°C/ 60%
g)	Range and approach	≤ 8: 8 Deg C and 5 Deg C, to be further optimised during detailed Engineering
h)	**Cold water basin details**	
	1. Storage capacity between normal to lowest water level	Shall be sufficient to fill the entire CW system (including condenser water space) from empty condition.
	2. Partitions	N/A
	3. Minimum permissible slope of basin floor towards sludge pit	1:150
i)	Hot Water Supply Header & Distribution System	Entire water distribution system shall be self-draining and non clogging type, with provision for isolating each cell/ compartment to facilitate maintenance work.
j)	Material of Construction	
	1. Basins, walls, structures, roof, fan stack, staircase, louvers	RCC
	2. Hot water distribution nozzles	Polypropylene/Approved Equal PVC
	3. Fills & drift eliminators	FRP
	4. Fill Support	FRP blades and Hot dipped galvanised steel/ Cast Al. Alloy fan hub.

SL NO.	ITEM	CRITERIA
	5. Valves	
	i) Body	CI: IS-210, FG-260
	ii) Spindle & Trim	Aluminium Bronze
5.	**DMCW Pump**	
	a) Codes & Standards	IS-1520, IS-5120, IS-5639, IS-9137, BS-5316, PTC 8.2, Hydraulic Institute (USA) standard, equivalent.
	b) Mode of Pump Starting	Discharge Valve Fully Closed
	c) **Material of Construction**	
	- Casing, liner, diffuser and impeller	ASTM-A743 Gr. CF8
	- Shaft	Stainless Steel SS-410
6.	**Heat Exchangers**	
	a) Design Standard	ASME Section-III & VIII/ Equivalent Standard
	b) Material of Construction of Plate/tube	Stainless steel, AISI-316
	c) Capacity	2 X 100 % for each unit
7.	**Circulating Water Chlorination and Conditioning Plant**	
	a) Chlorine absorption system	Chlorine concentration in air at absorber outlet shall be not more than 0.1 ppm as Cl_2 in any condition.
	b) Pump used in Antiscalant/ Corrosion inhibitor biocide dosing system	Suitably selected so that the required capacity can be delivered even at 50% stroke; however, stroke adjustment will be 0%-100%.
	1. Type	Positive displacement simplex, constant speed, variable stroke, manual stroke adjustment and arranged to operate under flooded suction.

SL. NO.	ITEM	CRITERIA
	2. Material of construction	SS-304
c)	**Chlorine Container**	
	i) Number	To be decided by the Contractor during DDE subject to a minimum of 40 nos..
	ii) Capacity	Not less than 900 kg each
T.	**FUEL OIL SYSTEM**	
1.	Type of HFO and LDO	See Annexure-II of this technical document (Vol-II)
2.	Codes to be followed for the complete system	Indian explosives Act/Indian petroleum code/ Recommendations and Regulations of the Tariff Advisory committee/IBR (where applicable).
3.	Unloading Pumps	
	a) Type	Screw / centrifugal
	b) capacity	2x100% (For both LDO &HFO)
	c) **Material of Construction**	
	Casing	CI as per BS-1452 Gr.14/ IS 210 Gr. FG260 or equivalent
	Rotor	AISI 431 or equivalent
4.	**Storage Tanks**	
	a) Type	Vertical cylindrical type. Shall be constructed to IS 803/API 650. Steel shall conform to IS 2062/ASTM A-285 Gr-C/ equivalent.
	b) Storage capacity	4 nos. 2000 m^3 HFO tanks, 2 nos. 1000 m^3 LDO tanks and one HFO day oil tank for each phase
	c) Floor heater	Shall be provided for HFO tank to maintain the oil temp. i.e. compensate heat loss from the unlagged

SL NO.	ITEM	CRITERIA
		tank completely filled with oil and also to meet performance requirement stipulated in Section-V.
	d) Suction heater	To be provided in HFO tank, shell & tube type, with steam heating.
	e) Inside painting	Coated with double boiled linseed oil.
5.	**Pressurising pumps**	
	a) Type	Horizontal screw type.
	b) **Materials**	
	- Casing and rotor housing	Cast Steel
	- Rotor and Shaft	13% Cr. Steel
6.	**HFO Heaters**	
	Type	Steam heated Shell and tube type heat exchanger designed as per TEMA-C.
7.	Strainers	Strainer (2 x 100% simplex/duplex) shall have screen of Stainless steel (AISI-304) construction and body of mild steel.
8.	Requirement of Hoses	For steam heating and unloading of HFO wagons and tankers.
9.	Hoses in oil lines	As per BS-1435 or equivalent, wire reinforced type S, smooth bore along with quick acting coupling fitting standard oil tankers.
10.	Other auxiliary equipment required	Drain oil tank, heater and pumps; sump pumps, oil water separator unit, flash tank etc. Steam tracing to be provided for all HFO line including return oil line, unloading system.
U.	**COMPRESSED AIR SYSTEM**	(Separate system for CHP, AHP and Rest of the plant- For each system following specification shall be followed)
1.	Compressors	Shall conform to international design standard and testing as per ASME PTC- 10 or equivalent

SL NO.	ITEM	CRITERIA
2.	Type of Compressors	For service air, the oil lubricated screws type , 2 stage water cooled air compressor will be provided and all instrument air compressor will be 2 stage water cooled oil free screw type Suction filters shall be located outside the building with weather hood, rain hood and bird screen. Separate compressor system for Instrument air and service air application All the Instrument and service air compressors required for one phase will be placed in one building There should be one standby compressor for IA and one standby for SA system for each phase 10% volumetric design margin over design requirement of compressed air shall be provided
3.	System design condition	Design maximum intake air temperature shall be taken as 45 Deg.C and the maximum relative humidity shall be considered as 100%. IA & SA compressors should be interchangeable and shall be interconnected on the upstream side of the Air Dryers. Separate air seal and oil seal shall be provided avoiding entry of oil into air side.
4.	**Compressor Material**	
	a) Casing	C.I., IS-210 Grade FG 260/ ASTM-A 278 Cl 25 or Equivalent/ Cast steel A-216 Gr WCB or equivalent.
	b) Impeller	Cast Stainless Steel ASTM-A-351-CF8 or Equivalent
	c) Intercooler, After cooler, Lube oil cooler	Admiralty brass tubes (ASTM-B-111/ equivalent); Admiralty tube sheet (ASTM-B 171/ equivalent)
	d) Suction and delivery valve	S.S. as per BS-970 EN-56D or Equivalent.
	e) Compressor Chamber	Cast Iron coated with corrosion resistant material
	f) Rotor	Forged Carbon Steel coated with corrosion resistant material
	g) Timing Gear and Shaft Seals	Alloy Steel

SL NO.	ITEM		CRITERIA
5.	**Air Receiver**		
	a)	Design	In accordance with ASME section-VIII Div.1/ equivalent.
	b)	Material of Shell, End plates (dished ends) & Flanges	IS-2062, IS-2002 grade 2/ ASTM-A-285 Gr-C/ A-516 Gr 70 or Equivalent.
	c)	Storage volume	To meet the requirement of all air users for five (5) minutes at their highest operating pressure to avoid excessive starting duty of the compressor.
6.	**Air Drying Plant**		
	a)	Installation	Indoor, Skid-Mounted, with 100% standby
	b)	Type of Drying	Adsorption
	c)	Dew point of dried air	-40°C max.
	d)	Type of Reactivation	Heat of compression type
	e)	Type of Change-over from drying duty to reactivation	Automatic with provision of manual operation.
	f)	Drying Cycle	8 hours.
	g)	**Supply of Accessories**	
		i) Prefilter	One (1) working + one (1) Stand-by for each ADP
		ii) After filter	One (1) working + one (1) Stand-by for each ADP
		iii) Control panel	One/drier.
7.	Compressed Air system capacity		To meet the performance and the redundancy requirements of Section-V & VII of this specification.
8	Automatic drain traps		To provide automatic sensing type drains all along compressed air line

V. AIRCONDITIONING SYSTEM

1. Air conditioning system shall be designed based on the following requirements:

Areas	System	Remarks
Power House Bldg./Control Bldg. areas. (including central control room, U.P.S. room, AVR room, shift charge engineer's room etc.), ESP control building	Central CHW (- Chilled Water) Plant 3 x 50 % ; the chillers shall be vapor absorption type using steam from turbine extraction/ auxiliary boiler at less than 10 bar pressure	One module of packaged chiller shall be kept as stand-by. Additionally, a separate package air conditioner; with provision to draw power from the plant's DG set, for microprocessor equipment rooms.
All control rooms like-, switchyard control room, DM plant control room CHP control rooms, AHP control rooms etc. as also C & I laboratory & stores, Electrical Instrument room, relay testing room etc.	Split type DX (Direct Expansion) Chiller plant with water cooled condenser for a cooling requirement of more than 25 TR;	One module of condensing unit shall be kept as stand-by with at least two nos. AHUs.
	Water and air-cooled Packaged air conditioners for a cooling requirement of less than & including 25 TR.	At least one module of packaged unit shall be kept as stand-by.
For other non-plant bldgs. like, Administrative bldg., Technical bldg., Telephone exchange, medical centre etc.	Generally by water-cooled packaged air conditioners/ and for small cubicles/ special room, air-cooled split air conditioners may also be used.	No stand-by capacity is required except for telephone exchange where at least one module of packaged or split units shall be kept as stand by.

Note : 1. Contractor will establish the cooling load of each area to justify his selection of equipment.

2. Induced draft FRP (Fibre Reinforced Plastic) cooling tower provided with water cooled AC System shall have at least one cell as standby.

3. All supply and return air ducts of AC System shall be thermally insulated. Additional acoustic insulation shall also be provided inside the SA Duct up to a distance of 6 m from the outlet of AHU/Packaged unit.

4. Air velocity in AC Duct shall not exceed 8m/sec. and the same in ventilation duct shall not exceed 12 m/sec.

5. AC duct shall be made of Galvanized steel sheets GI and its thickness shall conform to IS-655/equivalent

6. Solenoid operated fire dampers shall be provided at all such places where the duct works pass through fire barrier walls or floor slabs. The fire rating of fire dampers shall be minimum 60 minutes

7. All AHU/packaged air conditioner casings shall be thermally insulated to prevent condensation.

8. The fresh air quantity for AC areas shall be decided on the basis of about 1.0 air change/ hr or 0.45 Cu.m/min per person whichever is higher and maximum recirculated air shall be used.

9. High efficiency filters having an efficiency of 99.97% down to 0.3 microns size particles shall be provided with the supply air duct for all the micro processor areas, control rooms, computer rooms, control equipment rooms etc.

W. VENTILATION SYSTEM AND DE/DS SYSTEM

W/1 Ventilation System

1. All ventilation system shall operate on 100% fresh air. Ventilation system shall be designed based on the following requirements:

Areas	System	Remarks
a) Power House Building		
i) General areas		
TG building, MCC/ switchgear rooms cable spreader room, coal mill areas, Boiler platform, PRDS Stn.etc.	Air supply through evaporative cooling units & exhaust through roof extractors (for TG Bldg.) and wall mounted exhaust fans with back draft dampers as may be applicable for other areas	Module size of the evaporative cooling unit shall be limited to a capacity of 2,50,000 CMH (max.) Module size of roof extractors shall be limited to a capacity of 50,000 CMH (max.)
ii) De-aerator heater area (if located inside a room)	Air supply from common evapo-rative cooling units of power house bldg. & exhaust through roof/wall exhausters	Module size of wall exhauster shall be limited to a capacity of 10,000 CMH (max.) for proper air distribution

	Areas	System	Remarks
iii)	Coal conveyor tripper floor(bunker top floor)	Air exhaust through roof exhausters and entry through air intake louvers provided at the bottom side of the walls.	Module size limitation shall be as above
iv)	Battery/Battery charger room	Exhaust through centrifugal fan and ducting (air entry to battery charger room from common evaporative cooling unit of Power House Bldg.)	100% stand-by fan-motor sets to be provided
v)	Elevator M/c. room	Fresh air supply thru' wall mounted fan filter unit & exhaust thru' back draft damper	Module size shall be selected to provide more than one number of fan-filter unit for proper distribution
vi)	Valve room & oil room if any	Air exhaust thru' wall mounted exhaust fan & air entry from general areas of PH Bldg. thru' louvers. (Fire dampers to be provided both at air entry & exhaust for oil room & flame proof motor shall be used for oil room fan)	Module size shall be selected to provide more than on number of fan for proper distribution
vii)	Excitation cubicles	Hot air from excitation panels shall be exhausted to atmosphere by exhaust fans, air supply from common evaporative cooling units of PH Bldg.	- Do -
viii)	Toilets	Air exhaust through wall mounted exhaust fans	
ix)	Chiller room and condensing unit room	Air exhaust through wall mounted exhaust fan and air entry through air intake louvers	Module size shall be selected to provide more than one fan for proper distribution
b)	Pump/compressor rooms & houses	Fresh air supply by means of wall mounted supply fans and exhaust through openings and louvers	Module size shall be selected to provide more than one number fan for proper air distribution

Areas	System	Remarks
c) ESP control Building	Air supply through Unitary air filtration unit, ducting and supply air grilles and exhaust through back draft damper	- Do -
d) MCC/Switch gear rooms of control building, if any e) DM Plant, chemical rooms/houses	Air exhaust by means of wall mounted type exhaust fans and air entry through openings and intake louvers	Module size of fan shall be selected to provide more than one number fan for proper air distribution
f) Tunnels of CHP	Fresh air to be supplied by fan-filter unit through ducting and supply air grilles	
g) Crusher houses	Natural ventilation with adequate openings and louvres shall be provided. Filtered fresh air supply by means of wall mounted fans for the basement portion, if any with proper evacuation arrangement	Module size of fan shall be selected to provide more than one number fan for proper air distribution
h) Transfer points	Natural ventilation by providing adequate openings and louvres	
i) Maintenance Workshop and stores	Natural ventilation with adequate openings and louvres	
j) Toilets	Exhaust ventilation by wall mounted exhaust fans.	

2. Evaporative cooling unit shall be provided with double bank spray header, one will spray water over the stainless steel mesh filter in the direction of airflow and the other opposing the airflow. Evaporative cooling unit shall have a saturation efficiency of 90%. Moisture eliminators shall be of PVC/FRP. Nozzles shall be of polypropylene with Stainless steel tip.
3. UAF (Unitary Air Filter) unit shall be provided with single bank spray header spraying water over stainless steel mesh filter. UAF unit shall have a saturation efficiency of 60% and shall be incorporated with moisture eliminator of PVC/FRP make. Nozzles shall be polypropylene with stainless steel tip.
4. Ventilation duct carrying evaporatively cooled air, shall be thermally insulated and covered with sand-cement plaster and GI cladding wherever exposed to atmosphere.

Areas	System	Remarks
c) ESP control Building	Air supply through Unitary air filtration unit, ducting and supply air grilles and exhaust through back draft damper	- Do -
d) MCC/Switch gear rooms of control building, if any e) DM Plant, chemical rooms/houses	Air exhaust by means of wall mounted type exhaust fans and air entry through openings and intake louvers	Module size of fan shall be selected to provide more than one number fan for proper air distribution
f) Tunnels of CHP	Fresh air to be supplied by fan-filter unit through ducting and supply air grilles	
g) Crusher houses	Natural ventilation with adequate openings and louvres shall be provided. Filtered fresh air supply by means of wall mounted fans for the basement portion, if any with proper evacuation arrangement	Module size of fan shall be selected to provide more than one number fan for proper air distribution
h) Transfer points	Natural ventilation by providing adequate openings and louvres	
i) Maintenance Workshop and stores	Natural ventilation with adequate openings and louvres	
j) Toilets	Exhaust ventilation by wall mounted exhaust fans.	

2. Evaporative cooling unit shall be provided with double bank spray header, one will spray water over the stainless steel mesh filter in the direction of airflow and the other opposing the airflow. Evaporative cooling unit shall have a saturation efficiency of 90%. Moisture eliminators shall be of PVC/FRP. Nozzles shall be of polypropylene with Stainless steel tip.
3. UAF (Unitary Air Filter) unit shall be provided with single bank spray header spraying water over stainless steel mesh filter. UAF unit shall have a saturation efficiency of 60% and shall be incorporated with moisture eliminator of PVC/FRP make. Nozzles shall be polypropylene with stainless steel tip.
4. Ventilation duct carrying evaporatively cooled air, shall be thermally insulated and covered with sand-cement plaster and GI cladding wherever exposed to atmosphere.

5. Ventilation duct shall be made of 1 mm thick GI sheets for size less than or equal to 1200 mm larger side/dia. For higher sizes it shall be of 1.25 mm thick. This point shall be designed according to applicable international codes/ equivalent or superior Chinese codes.

6. All axial flow fans shall have cast aluminium alloy impeller (LM-6) .

7. Solenoid operated fire dampers shall be provided with all ventilation duct/fans connected with electrical areas, Fuel oil pump house, Oil room and other fire-prone areas.

8. All parts of the battery room exhaust system and any other ducting surface coming in contact with acid fumes any corrosive gases shall be epoxy painted suitably lined. Exhaust duct of battery room shall be of MS with epoxy painting.

9. All fans connected with evaporative cooling units and UAF units shall be spray galvanised (both inside and outside) and shaft shall be epoxy painted as per the international standard.

10. The ventilation air quantity for the different areas shall be decided on the following basis :

Sl.No.	Areas	Basis
a)	P.H. Building general areas :	Inside heat load and a temperature rise to maintain inside DB Temperature equal to the design summer outside conditions. However a minimum air change rate of 2 per hr. shall be maintained
b)	All electrical premises/ areas except cable spreader room	An air change rate of 15 per hr. (min.) and for cable spreader room an air change rate of 5 per hr. (minimum)
c)	Coal conveyor tripper floor	An air change rate of 6 per hr. (min.)
d)	Battery room	An air change rate of 20 per hr. (min.)
e)	Toilets	An air change rate of 10 per hr. (min.)
f)	Elevator M/c. room	An air change rate of 20 per hr. (min.)
g)	Chiller and condensing unit room	Inside heat load and a temperature rise of 3°C
h)	Excitation cubicle	Inside heat load and a temperature rise to maintain inside DB temperature 1°C less than design summer outside condition

i)	Pump Houses	Inside heat load and a temperature rise of 3°C
j)	DM Plant	An air change rate of 15 per hr. (min.)
k)	Tunnels of CHP(under Ground portion)	An air change rate of 10 per hr. (min.)
l)	Crusher houses (under Ground portion)	An air change rate of 10 per hr. (min.)

11. The UAF unit casing shall be made of at least 2 mm thick GI Sheet and the sump shall be made of at least 3 mm thick GI sheet.

W/2. **DE/DS System (For CHP & AHP)**

1. DE/DS system shall be designed based on the following requirements:

Areas	System	Remarks
Stock pile	Water spraying system with swiveling nozzles shall be provided for wetting of the coal stock pile and for any dry ash dump area	
Track hopper	Water spray arrangement for wetting the coal on wagon(i.e. near track hopper) shall be provided. DS system with pump, tank, spray header & nozzles flexible hoseshall be provided with paddle feeder and shall be mounted over paddle feeder assembly. Water header with socket outlets at regular interval shall be kept inside track hopper tunnel. Such outlets shall be provided with valves & quick coupling arrangement.	}
	Water spray system over the track hopper shall also be pro-vided from both the sides.	(Such spray system }shall be energised }during unloading coal }only)
Crusher houses	Dust extraction system with pulse jet/reverse jet type bag filter, fan duct, hood and stack shall be provided to extract dust laden air from all the dust generating	Arrested dust in the bag filter shall be dislodged and transferred to the nearest conveyor by means of rotary feeder

Areas	System	Remarks
	points, crushers, vibrating screens/feeders etc.	and screw conveyor as applicable
All transfer points	Dust extraction system with pulse jet/reverse jet type bag filter, fan duct, hood & stack shall be provided to extract dust laden air from all the dust generating points. Dust suppression system with water spray by means of spray nozzles shall also be provided for some dust generation points as applicable, including dry ash unloading area.	Arrested dust in the bag filter shall be dislodged and transferred to the nearest conveyor by means of rotary feeder and screw conveyor as applicable
	D.E. System with bag filter, fan, extraction hoods, duct and stack shall be provided for the bunkers	
Bunker		Dust laden air shall be extracted from the top cover of the bunkers. Arrested dust in the bag filter shall be dislodged and transferred to the nearest conveyor by means of rotary feeder and screw conveyor as applicable.

2. All design and construction of DE System shall be done generally in conformity with the recommendation of American Conference Governmental Industrial Hygienist/equivalent or superior Chinese design code.

3. The flexible connection used for DE System shall be made of EPDM/equivalent or superior Chinese design code.

4. All extraction points shall be provided with butterfly type dampers as per equivalent or superior Chinese design code.

5. The DE fans shall have straight but backwardly inclined blades be provided as per equivalent or superior Chinese design code.

6. The bag material shall be fire proof with antistatic property.

7. The air to cloth ratio of the bag filter shall not exceed 150 cum per hr. per sq.m.

8. The water spraying nozzles of DS System shall be made of stainless steel (designed as per equivalent or superior Chinese design code).

9. Solenoid operated fire damper shall be provided at inlet of each bag filter and the DE fans should be tripped off incase of fire in any part of the concerned area as per equivalent or superior Chinese design code.

10. Each water spray header in DS System shall be provided with a solenoid valve to stop the water spray when the concerned plant & equipment of coal handling and ash handling system does not operate.

General

The following General Design requirements shall also be considered for AC, Ventilation and DE/DS System:

1.	Design outside conditions:	Summer :	Dry Bulb Temp.	: 45°C
			Wet Bulb Temp.	: 30°C
		Monsoon :	DB Temp.	: 30°C
			WB Temp.	: 28°C
		Winter :	DB Temp.	: 10°C
			WB Temp.	: 6°C

2. All fans shall be interlocked with smoke/fire detectors of corresponding area.

3. Rubber in shear type vibration isolators/resilient mounting shall be provided with all reciprocating and rotating machines.

4. All supply air diffusers/grilles shall be provided with volume control dampers.

5. All duct connections with the fans/AHU/packaged air conditioners shall be provided with rubber impregnated canvas flexible connection.

6. All motors shall have at least 15% margin over driven equipment power and all fan-motors shall be rated over limit load power, if applicable.

7. All pumps shall have bronze impeller with CI casing as per equivalent or superior Chinese design code.

8. All centrifugal fans shall be provided with outlet dampers.

9. Module size of all filters of AC & ventilation system shall be limited to 610 mm x 610 mm as per equivalent or superior Chinese design code.

10. Latest edition of the following codes and standards are to be followed:

11. **Codes and Standards**

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below:

IS-659	:	Safety code for air conditioning
IS-660	:	Safety code for mechanical refrigeration
IS-524	:	Standard for positive displacement refrigeration compressors.
IS-5111	:	Code of Practice and measurement for testing refrigerant compressors.
ASHRAE-23 (67 Standards)	:	Standard method of testing and rating air conditioner.
AR1-450-6	:	Standards for water cooled refrigerant condenser.
IS-2825	:	Unfired pressure vessels.
ASME Sec. VIII	:	Unfired pressure vessels.
TEMA-C	:	Shell and tube type heat exchanger.
ASHRAE 22-72	:	Method of testing for rating water cooled refrigerant condenser.
ASHRAE-23-67	:	Methods of testing for rating positive displacement refrigerant compressor.
ANSI-B-31.5	:	Refrigeration piping.
ANSI-B-9.1	:	Safety code for mechanical refrigeration.
ARI-410	:	Standard for air cooling and air heating coils.
ARI-210	:	Standard for unitary air conditioning equipment.
ARI:520	:	Standard for positive Displacement Refrigeration Compressor & Condensing Units

IS-3588	:	Specification for electrical axial flow fans.
IS-848	:	Methods of performance test for fans.
BS-2831	:	Methods of test for air filters used in AC and general ventilation.
IS-4671	:	Expanded polystyrene foam for thermal insulation purpose.
IS-8183	:	Bonded universal wool
IS-702	:	Industrial bitumen
IS-1239/ASTM A-53	:	ERW Steel pipes
IS-8188	:	For Water conditioning
IS-325	:	3 phase induction motors
IS-4029	:	Guide line for testing 3 phase induction motor
IS210	:	Specification grey iron casting
IS-2062/ ASTM A-36	:	Structural steel
IS-227	:	Specification for GI Sheets

Standard code testing centrifugal and axial flow fans.

AMCA	:	Bulletin No. 210
IS-2676	:	Dimensions for wrought aluminium and aluminium alloy sheets and strips.

Relevant AFT Code for various filters.

IS-655 : Specification for metal air ducts

Pump design and testing should correspond to the procedure mentioned in IS-1520/ recommendations of Hydraulics Institute Standard.

The refrigerant shall be refrigerant 22 for reciprocating compressor and R-11/R-123 for centrifugal compressors as per ARI designation.
Relevant equivalent or international design code.

SL. NO.	ITEM	CRITERIA
X.	**FIRE FIGHTING SYSTEM**	
1.	General	The entire fire fighting system shall be as per recommendations of TAC/ NFPA. In addition the following design criteria/data specification for the system/ equipment shall also be applicable.
2.	**Hydrant system**	Entire hydrant system both external and internal hydrant/landing valves shall be designed as per the recommendations of TAC/ NFPA
	a) Spacing of hydrant	
	i) Outdoor	45 m in general
	ii) Internal hydrant/ landing valves	30 m (maximum)
	b) Pressure at each hydrant point (both outdoor and indoor)	3.5 kg/Sq.cm(g) Pressure break-down orifice, as necessary to restrict pressure of all hydrant point at said value.
	c) Water monitors	To be provided in fuel oil dyke area, coal stockpile and conveyors in CHP, which are in elevated position.
3.	**Spray Water System (HVW & MVW system)**	Entire spray water system shall be designed generally as per the guidelines given in the relevant sections of NFPA/ TAC.
	a) Nozzle arrangement	i) In the form of ring to all transformers.
		ii) Conveyor belt, cable vaults and cable spreader rooms shall be suitably zoned. Length of each zone shall be so selected that water requirement of each zone limited to one third of the capacity of each spray water pump.
		iii) Placing shall be such that spray cones

overlap each other.

SL. NO.	ITEM		CRITERIA
4.	**Foam System**		Fuel oil storage tanks shall be protected with manually operated fixed foam injection system.
5.	**Inert Gas Flooding system**		Control room, Control Equipment room and Computer room shall be protected with automatically operated modular Inert Gas injection system. The system design shall be as per NFPA 2001 guidelines.
6.	**Detection System**		
	a)	Coverage of Fusible bulb type detector, IC type heat detector. Optical and ionisation type smoke detector.	Shall be considered as 50 sq.m at a height of 7m (maximum.)
	b)	Infra red type detector	3 nos. for each coal conveyor: one each at a distance of 1-2 m from tail end and head end and one at the middle.
	c)	Linear heat sensing cable	Shall be provided along the entire length of each coal conveyor idler frames and bearings for pulleys of driving and non-driving ends.
7.	**Fire Water pumps**		
	a)	Design	To meet TAC recommendations/ NFPA guidelines. (Hydraulic Institute Standard for hydraulic design)
	b)	Number	Separate sets of pumps shall be provided for hydrant system and spray system. The number of pumps and capacity shall be governed by the applicable guidelines and recommendations. Diesel engine driven fire water pumps shall be provided as back-up to the motor driven pumps.
	c)	**Material of Construction**	
		i) Casing/bowl/ Suction bell	C.I as per IS-Gr. FG 260/ BS-1452 Gr 14 or equivalent.

SL. NO.	ITEM		CRITERIA
	ii)	Impeller	Bronze, IS-318 or equivalent.
	iii)	Shaft sleeve	SS ASTM A 276 Type 410
	iv)	Line shaft & Pump shaft	SS AISI Type 410
8.	**Diesel Engine**		
	a)	Type	Compression ignition, mechanical (air-less) direct injection, multi-cylinder, 4-stroke cycle and cold starting type.
	b)	Starting	Shall be capable of both automatic and manual start. Automatic cranking by a battery driven DC motor having high starting torque. Starting power shall be supplied by two sets of battery - one set for automatic starting and the other for manual.
9.	**Fire Tender**		Four tanker type fire tenders, each with 3000 litre water tank, one centrifugal pump of 2250 lit/min capacity and 7 bar head, monitor with 2250 lit/min capacity straight/ fog nozzle and hose, breathing apparatus and all standard accessories.
Y.	**CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS**		**Refer to Section-XVII**
Z.	**ELECTRICAL SYSTEM**		**Refer to Section-XVIII**
ZA.	**CONTROL & INSTRUMENTATION**		**Refer to Section-XIX**
ZB.	**ENVIRONMENTAL CONDITIONS**		**Refer to Section-XX**
ZC.	**THERMAL AND ACOUSTIC INSULATION**		a) To suit performance requirement as indicated in Section-V. b) Bonded type material shall be provided. Bonding material property should not deteriorate at working metal temperature. c) Insulation surface protection against all weather conditions and mechanical damage is required.

SL. NO.	ITEM	CRITERIA
		Also insulated metal surface shall be protected against corrosion.
ZD.	**E.O.T. Cranes**	
	Crane structure, main hoist, aux. hoist, cross travel and long travel	Shall conforms to Class-M5 of IS: 3177 and IS: 807 / equivalent or superior Chinese standard (latest editions).
		Three no of EOT cranes to cater to the requirement of 6 units in TG building.
	Crane Hooks	
	• Main Hook	Ramshorn type as per IS: 5749
	• Aux. Hook	Shank type as per IS: 3815
	Wire ropes	As per IS: 2266
	All brakes	Electro-magnetic thruster type with 100% electro-hydraulic thruster type back-up.
	Creep speed arrangement	Required for inching (at about 10% speed) of main& aux. hoisting motions, long travel and cross travel.
ZE	**HYDROGEN GENERATION PLANT**	
	Capacity of Hydrogen Generation	Highest of - a) 150% of maximum leakage rate from all Generators. b) As required to fill one Generator every month. c) 10 Nm^3/hr.
	Purity of Hydrogen	99.9% pure at gas manifolds with moisture content not more than 0.05 gm/m^3.
	Minimum number of Electrolyser streams (as modules)	Two (2), with one separate rectifier unit for each.
	Storage	Adequate cylinders shall be provided for storage, along with manifolds for charging

SL. NO.	ITEM	CRITERIA
ZF	**LIQUID EFFLUENT TREATMENT**	**As per designing requirement to meet zero discharge**

The desired scheme of the effluent collection and treatment are highlighted below. The Contractor shall offer his scheme meeting these basic requirements.

1. **WASTE WATER COLLECTION AND EQUALIZING TANK**

a)	Number	:	One (1)
b)	Capacity	:	One day's storage of effluent, in two compartments.
c)	Material of Construction	:	RCC, with anti-corrosion lining

2. **WASTE TRANSFER PUMPS TO SOLIDS CONTACT CLARIFIER**

a)	Number	:	Three (3) [2 working + 1 standby]
b)	Type	:	Horizontal, Centrifugal, Non-Clog open impeller
c)	Capacity	:	Based on daily waste generation and 16 hours operation per day
d)	Material of Construction	:	SS-316 Casing and impeller, impeller shaft, shaft sleeve

3. **BLOWERS FOR WASTE COLLECTION/ EQUALISING TANK**

a)	Number	:	Three (3) [2 working + 1 standby]
b)	Type	:	Horizontal, Centrifugal
c)	Material of Construction	:	C.I. – IS: 210 FG 260/ BS-1452 Gr.14/ equivalent

5. **SOLIDS CONTACT CLARIFIER**

a)	Number	:	Three (including one standby)
b)	Type	:	High Rate Solids contact
c)	Material of Construction	:	RCC
d)	Internals	:	MS with Epoxy paint for Wetted Part
e)	Drive type	:	Centrally Driven with Internal Sludge Recirculation

6.	**CENTRIFUGE FEED PUMPS**		
	a) Number	:	Three (3) [2 working + 1 standby]
	b) Type	:	Horizontal Centrifugal, Non-Clog
	c) Material of Construction	:	C.I. (IS-210 FG 260) casing and impeller
7.	**CLARIFIED WATER TANK**		
	a) Number	:	One (1) in two compartments
	b) Capacity	:	2 hours storage
	c) Material of Construction	:	RCC with protective lining
8.	**CENTRIFUGE**		
	a) Number	:	To suit overall capacity, including one standby
	b) Type	:	Rotating Bowl type; suitable for concentrating sludge to at least 25% solids
	c) Material of Construction:		
	Wetted Parts	:	SS 316
	Other parts	:	Mild steel / Cast Iron with Epoxy paint
	d) Drive	:	V-belt pulley
	e) Dewatered sludge (Cake)	:	Minimum 25% solids by weight
9.	**MULTI-GRADE FILTERS FEED PUMPS**		
	a) Number	:	Three (3) [2 working + 1 standby]
	b) Type	:	Horizontal Centrifugal
	c) Material of Construction	:	SS-316 Casing, impeller, shaft, sleeve
10.	**MULTI-GRADE FILTERS**		
	a) Number of units	:	To suit overall capacity, including one standby
	b) Type	:	Multi-Grade with anthracite and graded sand.
	c) Filtered water quality	:	Suitable for treatment in UF Modules. (Shall

filter out particles higher than 100 micron)

11. **ULTRAFILTRATION (UF) PLANT**

a)	Number of Modules	:	To suit the plant capacity with required number (minimum six) of parallel streams
b)	Type	:	Hollow Fibre

12. **UF FLUSH PUMPS**

a)	Number	:	Three (3) [2 working + 1 standby] for fast flush, As well as for back flush
b)	Type	:	Horizontal Centrifugal
c)	Material of Construction	:	SS Casing impeller, shaft, sleeve

13. **RO FEED TANK**

a)	Number	:	One (1) in two compartments
b)	Material of Construction	:	RCC, with acid proof lining

14. **CARTRIDGE FEED PUMPS (FOR MCF)**

a)	Number	:	Three (3) [2 working + 1 standby]
b)	Type	:	Horizontal Centrifugal
c)	Material of Construction	:	SS

15. **MICRON CARTRIDGE FILTERS (MCF)**

a)	Number	:	To suit overall capacity, including one standby
b)	Material of Construction	:	SS

16. **HIGH PRESSURE PUMPS FOR RO**

a)	Quantity	:	Three (3) [2 working + 1 standby]
b)	Type	:	Horizontal Centrifugal
c)	Material of Construction	:	SS

17. **REVERSE OSMOSIS SYSTEM (RO)**

a)	Number	:	One (1) set for each stage, with required number (minimum three for each phase) of

parallel streams

b) Number of stages : Two (2)

c) Water Recovery (overall) : 75% minimum

18. **RO CLEANING SYSTEM**

a) Pumps

- Number : One (1) working. One (1) standby
- Type : Horizontal, Centrifugal
- Material of Construction : SS

b) Cartridge Filter

- Number : To suit required capacity, including one standby
- Material of Construction : SS

c) Cleaning Solution Tank

- Number : One
- Material of Construction : MSRL

d) Agitator

- Number : One
- Material of Construction : SS

19. **CHEMICAL DOSING SYSTEM**

a) Coagulant Dosing System

i) Location of Dosing : Prior to clarifier

ii) Dosing Tank

- Quantity : One
- Material of Construction : MSRL

iii) Dosing Pumps

- Number : Two (2) [1 working + 1 standby]
- Type : Plunger

- Material of Construction : SS

iv) Agitator

- Number : One (1)
- Material of Construction : SS

b) Coagulant Aid Dosing System

i) Location : Prior to clarifier

ii) Dosing Tank:

- Quantity : One (1)
- Material of Construction : MSRL

iii) Dosing Pumps:

- Quantity : Two (2) [1 working + 1 standby]
- Type : Horizontal Centrifugal
- Material of Construction : SS-304

iv) Agitator

- Number : One
- Material of Construction : SS-304

c) Dewatering Poly electrolyte Dosing System

i) Dosing Tank:

- Location : Prior to centrifuge
- Number : One (1)
- Material of Construction : MSRL

ii) Dosing Pumps

- Number : Two (2) [1 working + 1 standby]
- Material of Construction : PP
- Type : Electronic Magnetic Diaphragm

iii) Agitator

- Number : One (1)
- Material of Construction : SS-304

d) Acid (HCl) Dosing System

i) Location of Dosing : Prior to Micron cartridge filter

ii) Dosing Tank:

- Number : One (1)
- Material of Construction : FRP

iii) Dosing Pumps

- Number : Two (2) [1 working + 1 standby]
- Material of Construction : PP
- Type : Electronic Magnetic Diaphragm

iv) Transfer Pumps:

- Number : Two (2) [1 working + 1 standby]
- Material of Construction : PP
- Type : Horizontal Centrifugal

e) Sodium Bisulphite Dosing System:

i) Dosing Tank:

- Number : One (1)
- Material of Construction : FRP

ii) Dosing Pumps

- Number : Two (2) [1 working + 1 standby]
- Material of Construction : PP head, hypalon diaphragm
- Type : Electronic Magnetic Diaphragm

iii) Agitator

- Number : One (1)
- Speed : 950 rpm

- Material of Construction : SS-304

f) Antiscalant Dosing System:

i) Dosing Tank:

- Number : One (1)
- Material of Construction : FRP

ii) Dosing Pumps

- Number : Two (2) [1 working + 1 standby]
- Type : Electronic Magnetic Diaphragm
- Material of Construction : FRP

iii) Agitator

- Number : One (1)
- Material of Construction : SS-304

g) pH Boosting System (Morpholine Dosing System)

i) Dosing Tank:

- Number : One (1)
- Material of Construction : MSRL

ii) Agitator

- Number : One (1)
- Material of Construction : SS-304

iii) Dosing Pumps

- Number : Two (2) [1 working + 1 standby]
- Type : Electronic Magnetic Diaphragm
- Material of Construction : PP

20. **TILTED PLATE INTERCEPTOR (FOR OILY WASTE)**

a) Number : To suit overall capacity,

b) Type of plates : Corrugated

c) Type of Oil skimmer : Slotted pipe

d) Material of Construction:

- Tank : MS Epoxy Painted
- Plates : FRP
- Oil Skimmer : MS Epoxy Painted

21. GUARANTEED PERFORMANCE PARAMETERS

a) Permeate Characteristics – from UF/ RO System

i) Output : As per final approved Water Balance; Minimum 200 m^3/hr for each stream

ii) TDS : < TDS of pre-treated water

iii) Total Alkalinity : < Total alkalinity of pre-treated water

iv) Total Hardness : < Total hardness of pre-treated water

v) Recovery : Minimum 90% after 2nd Stages of RO

vi) pH : 6.5 – 7.0 before pH boosting

b) Total power consumption & chemical consumptions shall be guaranteed.

22. EVAPORATION POND (IF REQUIRED)

a) Type of construction : Earthen reservoir with raised banks. Earth shall be compacted to minimum 95% Proctor Density.

b) Side slope : 1 : 2 (V:H)

b) Lining : Minimum 0.75 mm HDPE liner , protected by 100 mm PCC cover with chicken mesh.

c) Basis of Sizing : To evaporate total net excess liquid waste along with the average annual rainfall quantity, with evaporation rate 5 mm /day The effective depth shall be at least 2.5 m.

MOM on Specification of Major Pumps i.e. Boiler Feed Pump, Condensate Extraction Pump and Cooling Water Pumps between SEPCO and WPCPL on Dtd: 20-03-09 at KSK, Hyderabad

Members Present

WPCPL

1. Mr. N. S. Rao
2. Mr. G. P. Rao
3. Mr. Kiran Kumar Panda

SEPCO

1. Mr. Xue Li
2. Mr. Wang Zhao Bo

Points Discussed:

1. Based on the agreed technical specification in the contract, WPCPL discussed and sent a questionery for design details of these pumps. SEPCO sent replies to the same after discussing with their likely vendors (not yet finalised).
2. Further WPCPL commented on the replies sent by SEPCO. SEPCO handed over their further answer on 20-03-09 which is attached with this MOM.
3. Both WPCPL and SEPCO understood the criticality of these equipments. As till date order for these pumps are not finalised, WPCPL requested SEPCO to involve WPCPL in preparation of final specification to be used for procurement and also in finalisation of Vendor. SEPCO agreed.

(Kiran Panda)
WPCPL

(Wang Zhao bo)

WPCPL-3600 MW, POINTS ON PUMPS

Boiler Feed Pump (BFP)

a. Warm up Requirements.

WPCPL : Whether warm up is provided for standby pumps?
SEPCO answer : Normally, warm up system is not required for BFP; the pump can be started anytime under cold working condition. If required, the warm system will be provided along with pump.
WPCPL : Requirement or otherwise of warm up on a boiler feed pump depends on obtainable shaft deflection and extent of barrel hogging under the operating conditions. Usually it is a design requirement and not a client's choice.

SEPCO answer : The warm up system for BFP had been designed around 10 years before in China due to the shaft material problem. The BFP without warm up system will be provided from the manufacturer KSB Shanghai, SPEM, EBARA, Shenyang pump, etc. for the power plant which unit capacity is above 300MW, also the technology is very excellent now.

b. Rotor couplings

WPCPL : Whether flexible couplings are provided? Diaphragm type Flexible shaft couplings shall be provided to accommodate any misalignment in the shat & protect te pump.
SEPCO answer : Different type couplings will be provided for booster pump-motor, motor-hydraulic coupling, hydraulic coupling-main pump, and the flexible type shaft coupling will be selected properly for BFP set. The Diaphragm type Flexible shaft couplings will be provided for turbine driven boiler feed water pump.
WPCPL : For what reason, diaphragm couplings are not provided for motor driven boiler feed pumps?

SEPCO answer : According to the discussion with the manufacturer of BFP, the flexible type shaft coupling normally will be used for BFP set due to the shaft system balancing requirement.

c. Reverse rotation indicator.

WPCPL : Since BFPs are not supposed to be run in reverse direction, it is essential to provide reverse rotation indicators with sensors on the pump shaft which shall be integrated with DCS.
Specially, they are required for standby pumps when the NRV on discharge line passes.
SEPCO answer : The reverse rotation indicator can not be provided for BFP, but the alarm protection will be provided for it, also the alarm signal will be transmitted to DCS.

WPCPL : Ok.

d. Axial Shift indicator.

WPCPL :Since the Thrust pads of the pump have very little thickness of babbit metal, it is vital to monitor the axial shift of the shaft & protect the Thrust bearing pads.

SEPCO answer : The Axial shift indicator can not be provided for BFP. The Axial shift protection will be provided for thrust bearing of BFP, the signal will be transmitted to MTSI.

WPCPL :Axial shift indicator on rotor ,if provided will also indicate shift in rotor axial position as well as change in wearing ring axial clearances. Please confirm the above.

SEPCO answer : We have confirmed the above again; the axial shift indicator will be provided for the thrust bearing of BFT, the function is same with your opinion which provides the axial shift indicator on rotor, also the value of BFT axial shifting will be indicated in MTSI for protection purpose.

e. Mechanical seals

WPCPL :While mechanical seals are confirmed to be from Bergmann, Germany, it should be clarified why condensate injection sealing is not provided which is a standard feature for all BFPs of higher ratings.

SEPCO answer : According to the actual requirement of mechanical seal and the design of pump sealing, the cooled sealing water source will be confirmed for mechanical seals, the condensate water or DM water will be provided for mechanical seals.

WPCPL :Question is why not condensate injection sealing system in place of mechanical seals?

SEPCO answer : The condensate injection sealing system is unfamiliar for most BFP manufacturer, the excellent mechanical sealing type will be provided for BFP only.

f. Suction strainers

WPCPL :Both BFP and Booster pump shall be provided with suction strainers amply sized to prevent frequent choking and duplex type for easy maintenance. The strainers should have automatic backwash feature. The net free flow area of strainer shall be minimum 3 times the inlet pipe area.

SEPCO answer : The basket type strainers will be provided for inlet of booster pump and main pump, the drain line will be provided for each strainer and also the space of strainers installation will meet the requirement for maintenance.

WPCPL :Duplex strainers are required and simplex strainers are not. Acceptable.

SEPCO answer : We have discussed with the BFP manufacturer again, the duplex strainer can not be provided for BFP and booster pump due to the installation space and designing problems. As per your requirement, the different temporary commissioning filter and permanent operation filter for each strainer will be provided to meet the requirement of different operation condition.

g. Inter-stage tapping

WPCPL :Please reconfirm that inter-stage tapping for re-heater attemparation is being provided.
SEPCO answer : Yes, confirmed.
WPCPL :Ok.

h. Kicker stage

WPCPL :Why kicker stage for super heater attemperation is not provided? This is a standard feature on BFPs of 500 MW and above.
SEPCO answer : The tapping for super heater attemperation will be provided from the head line of HP feed water piping due to the high pressure requirement.
WPCPL :Provision of kicker stage saves power.

SEPCO answer : Yes, we also understand that kicker stage type will save some power, but it is very old technology, also kicker stage design will bring much bad influence for shaft system. If required, please contact with KSB pumps Germany for this technology comparison.

i. Dry Run capability

WPCPL :Please clarify whether BFPs are capable of dry running under transient operating conditions.
SEPCO answer : The BFP can not running under dry water condition.
WPCPL :Ok.

j. Journal bearings

WPCPL :Are the journal bearings of tilting pad design provided?
SEPCO answer : It is different type of journal bearings from different BFP manufacturer.
WPCPL :Ok, we shall discuss it at a later stage.

k. Low load recirculation

WPCPL :Please confirm that low load recirculation line is provided with recirculation valve of Masoneilnan make with 'Hush trim' design. Alternately, DRAG type valves of CCI, USA or Fisher valves of suitable design may be provided.

SEPCO answer : The imported good quality recirculation valve will be provided for BFP low load recirculation, the manufacturer can not be confirmed now.
WPCPL :OK. To be discussed later.

l. Type tests on BFPs

1. **WPCPL** :Thermal shock test
   SEPCO answer : This test has never be done in workshop.
   WPCPL :Not ok (This test shall be done at least on one pump)
   SEPCO answer : We have discussed with the manufacturer,they tell us they never do this test.
2. **WPCPL** :Full load test with contract motor
   SEPCO answer : Full load can be not done,part load test can be done in the workshop.
   WPCPL :Not ok (This test shall be done at least on one pump)
   SEPCO answer : Part load test can be done inwork shop on one pump.

3. **WPCPL** :Hot water test
   SEPCO answer : This test has never be done in workshop.
   WPCPL :Not ok
   SEPCO answer : We have discussed with the manufacturer,they tell us they never do this test.

4. **WPCPL** :NPSH test for 3% head drop
   SEPCO answer : This test can be done in workshop
   WPCPL :Ok.

Condensate Extraction Pump (CEP)

a. **WPCPL** :Is first stage impeller with enlarged eye / double suction?

   SEPCO answer : It is different type first stage impeller from different pump manufacturer.
   WPCPL :Ok at this stage.

b. **WPCPL** :Inter-stage tapping
   Whether inter-stage tapping is provided for providing condensate to regeneration of Condensate polishing unit
   SEPCO answer : Not provided. The tapping for providing water to CPU will be taken from the outlet line of CEP.
   WPCPL :Interstage tapping saves power. Hence please confirm the above.

   SEPCO answer : The reason is similar with BFP design, the inter-stage tapping will not be provided for advanced technology in China.

c. **WPCPL** :Pump/Motor couplings – Type/Make
   SEPCO answer : It can not be confirmed now.

WPCPL :Ok for now

d. **WPCPL** :Mechanical seals – Type/Make
SEPCO answer : It can not be confirmed now.
WPCPL :Ok for now.

e. **WPCPL** :Thrust bearing – Capacity/Make
SEPCO answer : It can not be confirmed now.
WPCPL :Ok for now.

f. **WPCPL** :Vacuum sealing arrangement
SEPCO answer : Air extraction will be provided for CEP.
WPCPL :Ok.

g. Tests
1. **WPCPL** :Full load test
SEPCO answer : Full load can be not done, part load test can be done in the workshop.
WPCPL :Not ok
SEPCO answer : Part load test can be done inwork shop on one pump.

2. **WPCPL** :NPSH test with 3% head drop
SEPCO answer : This test can be done in workshop.
WPCPL :Ok.

Cooling Water Pumps(CWP)

a. **WPCPL** :Type of impeller – specific speed
SEPCO answer : It can not be confirmed now.
WPCPL :Ok for now.

b. Type of lubrication
– **WPCPL** :Whether forced water lubrication is envisaged?
SEPCO answer : The forced water lubrication and self water lubrication system will be provided for rubber bearing. The forced water lubrication system is not required for Sailong bearing.
WPCPL :Ok.
– **WPCPL** :Whether bearings are of cutless rubber bearing type?
SEPCO answer : Rubber bearing or Sailong bearing can be provided for CWP.
WPCPL :Ok.

c. Runaway speeds
WPCPL :Please confirm that the pumps are designed for runaway speeds.
SEPCO answer : The runaway speed design will be considered for manufacturer.
WPCPL :To be discussed later.

d. Shaft sealing
WPCPL :Whether mechanical seals are provided?
SEPCO answer : No mechanical seals will be provided for CWP.
WPCPL :To be discussed later

e. **WPCPL** :Thrust bearing – Capacity/Make. WPCPL recommends Kingsbury, USA or Michell Bearings, UK. Thrust bearings shall have centrally pivoted pads.
SEPCO answer : The above manufacturer will be considered by us, it can not be confirmed now.

WPCPL :Ok for now

f. **WPCPL** :Sump model tests – CFD + Model tests
SEPCO answer : This test has never be done in workshop.
WPCPL :Ok. Discssed and settled elsewhere.

g. **WPCPL** :Water hammer analysis on discharge piping
SEPCO answer : Yes. The water hammer analysis will be considered by designer.
WPCPL :Ok

h. **WPCPL** :NPSH and Submergence requirement
SEPCO answer : To be provided after confirm the manufacturer of pump.
WPCPL :Ok for now

i. **WPCPL** :6 pumps running and 1 pump as standby – implications on run-out flow.
SEPCO answer : The design will meet the requirement of EPC contract.
WPCPL :To be discussed later

j. **WPCPL** :Method of axial thrust balancing
SEPCO answer : To be provided after confirm the manufacturer of pump.
WPCPL :OK

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SECTION-VII

REDUNDANCY REQUIREMENT

VOLUME-II

SECTION-VII

REDUNDANCY REQUIREMENT

The following plant and equipment shall be provided with such capacity and/or stand-by as to meet the specification requirements as listed here. Redundancy requirement indicated here is applicable for each unit separately unless mentioned otherwise :

SL.NO.	ITEM	SPECIFICATION REQUIREMENT
1.	I.D, F.D and P.A fans for	Minimum 60% BMCR generation on continuous boiler draft plant basis when one (1) set of fans are out of service. Also, all start-ups (Hot/Cold/Warm) shall be efficiently achievable with one (1) set of fans in operation.
2.	ESP + Fabric Filters	Particulate emission maintained within the specified/guaranteed limit on continuous basis when one field in each gas path is out of service.
3.	Coal mills (based on loading not to exceed 90% of the design load of mill) :	100% BMCR generation with the specified worst coal with one mill out of service; (Total 7 bowl mills - 6 Working+ 1 Standby)
4.	Boiler feed pumps	100% BMCR generation (with provision for maximum blow-down and surge flow) at maximum working pressure when one (1) pump is out of service. Two turbine driven and one motor driven pumps shall be provided, each of 50% capacity.
5.	Condensate extraction Pumps	Maximum possible condensate flow-rate and pumps pressure requirement, considering all eventualities (like turbine VWO operation, feed heater drains diverted to condenser, maximum LP bypass steam plus spray water flow to the condenser during HP-LP bypass operation etc. as applicable), maintained with one (1) pump out of service. 2 x 100% pumps shall be provided.

SL.NO.	ITEM		SPECIFICATION REQUIREMENT
6.	Raw Water pumps		Total make-up water requirement of the plant maintained when one (1) pump is out of service
7.	Circulating water pumps		2 x 50% pumps for each units, 1x50% common standby for three units.
8.	Auxiliary cooling water pumps/ DMCW system pumps		2 x 100% pumps for each unit
9.	Cooling Tower Cells		Back to back cells with 1 standby cell for each unit
9.	Demineralising Plant for Condensate make-up	a)	The specified/guaranteed output shall be maintained when one of the demineralising chains is out of service.
		b)	The specified/guaranteed output of each demineralising chain shall be maintained for a period of at least 20 hrs followed by regeneration for 4 hr.
10.	Water treatment Plants (for the supply of clarified item Is water, fire water, filtered water, potable water, etc.)		The required rate of water supply shall be maintained when any one (1) major plant out of service.
11.	Fire Water supply pumps, source of power and water		Stand-by requirements are as per the Fire insurer's recommendation/ NFPA guidelines.
12.	Coal Handling Plant		The guaranteed/specified rate of coal unloading, crushing, stacking/reclaiming and conveying shall be maintained when any one (1) conveyor or any one (1) equipment is out of service.
13.	Ash Handling Plant	a)	The guaranteed/specified rate of ash removal shall be maintained when any one Conveyor (Bottom ash intermediate silo to main ash silo),,Vacuum Pumps, clinker grinder, and pump or compressor/ blower is out of service. (Also refer Section-III and Section-VI.) The standby clinker crusher to be finalised based on feasibility.
		b)	For the High concentration slurry Disposal system, the failure of one pump set and one pipeline shall not affect the total ash disposal function for the station.

SL.NO.	ITEM	SPECIFICATION REQUIREMENT
14.	Fuel Oil System	HFO & LDO unloading, transfer, heating and pressurisation at the requisite rates shall be maintained when any one (1) pumping system (including pumps, strainers & filters in series) or any one (1) heating system is out of service.
15.	Compressed Air System	Each unit's maximum compressed air demand (both service air & instrument air) shall be maintained when any one compressor of each category is out of service. 100% stand-by Air drying unit to permit efficient drying and regeneration cycle. One Standby compressor for each phase shall be provided. Separate compressor and compressed air system shall be provided for Coal handling and Ash handling system.
16.	All other compressors, blowers, fans, pumps and including those for water systems, turbine/ In case of generator oil Systems etc.	At least one (1) standby for each equipment so that normal functioning is no way affected when any of heat exchangers/coolers, (1) pump is out of service. For Ash Handling system, 100% standby shall be provided for vacuum pumps and 50% air compressors for conveying fly ash
17.	Air pre-heater drive (for regenerative type)	Two AC motor and one DC Motor / Air motor shall be provided
18.	Condenser air extraction equipment	2 x 100% vacuum pumps shall be provided for each unit.
19.	Waste Water treatment (for the treatment of sewage, blowdown, regeneration, Waste water, etc.)	The required rate of water supply shall be maintained when any one (1) major plant out of service.
20.	Demineralising Plant for Condensate make-up	The specified/guaranteed output shall be maintained when one of the demineralising chain is out of service.
21.	Aeration Blowers for AHP	(1+1) for Hoppers of ESPs and Buffer Hoppers of each unit (2+1) for fly ash silos of one phase,
22.	Pumps for Ash handling	HCSD System: One working for each silo and One (1) standby for one phase. (2 + 1 or 1 +1) Seal Water Pumps for each Phase

23	Dry Bottom ash conveyor	100% for each unit, no standby – metallic conveyor 2 x 100% for total plant – for belt conveyor from intermediate silo to main silos with option to choose any Main silo
24.	Electrical system	Refer to relevant Electrical Part
25.	Control and Instrumentation	Refer to relevant C&I Part
26.	All control valves, filters, strainers, traps and such other auxiliary items	Necessary standby so that normal functioning is in no way affected when any one items is taken out for maintenance.
27.	Turbine Lube Oil system	Shaft driven Main oil pump with 1 x 100% AC Standby + One DC Emergency Oil Pump, 1 x 100% AC and 1 x 100% DC jacking Oil Pump
28.	Mill Lub oil pumps, Filter,	One Working + One Standby
28.	Mill Lub oil Coolers	One Working (No Standby)
29.	ID, FD, PA Fan - Lub oil pumps, Filters	One Working + One Standby
30.	ID, FD, PA Fan -Lub oil Coolers	One Working (No Standby)

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SECTION-VIII

OPERATION, CONTROL AND PROTECTION FEATURES

26.03.2009
(KIRAN PANDA)
WPCPL

(XUE LI)
2009.02.26

SECTION-VIII

OPERATION, CONTROL AND PROTECTION FEATURES

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3.00.00	UNIT OPERATION PHILOSOPHY	V.II/S-VIII : 7

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SECTION-VIII

OPERATION, CONTROL AND PROTECTION FEATURES

1.00.00 GENERAL

The units shall be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand. The units shall be suitable for shutdown on every weekend, if required. Moreover the units should be capable to operate frequently down to 40% load.

The Plant Control shall be configured to provide distributed control for safe, reliable and efficient operation. There shall be two Central Control Rooms each one catering for operation of three units. Central Control Room#1 for operation of Unit#1, Unit#2 and Unit#3 and Central Control Room#2 for operation of Unit#4,Unit#5 and Unit#6. Common and Offsite equipment monitoring shall be possible from both Central Control Rooms. Centralized control from Central Control Room shall cover main plant i.e Boiler, Turbine, Generator and their auxiliaries, (except ESP), and part of the balance of plant, namely DM Cycle Make Up Pumps, Condenser Circulating Water Pumps, Auxiliary Cooling Water Pumps, Closed Cycle Cooling Water Pumps, Fuel Oil Pressuring Pumps, Compressor Air System. The rest of the parts viz. ESP, Coal Handling Plant, Ash Handling Plant, DM Plant, Air compressor system(AHP), Dosing system etc. should be controlled from Local Control Rooms to be provided close to individual Plant, with redundant communication interfaces to DCS in the central control Room (CCR).

All the necessary process & equipment parameters shall be measured and processed to enable operator to control plant and equipment and also for generating various Interlock, Protection, Alarms, Data Logging etc.

1.01.00 Drive Control Philosophy

All the electrical drives should have following Control Philosophy.

a) Breaker testing facility from switchgear through test position of the selector switch of item (b).

b) Selector Switches (SS) for TEST - Local - Remote selection at Switchgear , Local - Remote selection at MCC. The switches are to be lockable at each selected position.

c) Provision for Emergency stopping from local to equipment. This facility is to be lockable at stop position.

d) Start/stop facility from local with all safety interlocks & motor protection remain active through Local position of SS of item (b). However, Local selection must not impair any safety function. The local start shall be wired through DCS/PLC to MCC to interlock Start permissives.

e) Start/stop facility from remote (Control Room) with all Protection & Process interlocks remain active through Remote position of SS of item (b).

f) Provision of auto, sequential start/stop.

g) Bi-directional drives to have torque and limit switches both in open & close positions for protection & interlocking purposes.

h) Interface between Switchgear/ MCC/ Actuator and DCS shall be as per enclosed Table.

2.00.00 OPERATION & CONTROL CRITERIA

2.01.00 Steam Turbine & its auxiliaries

a) Governing System : Digital Electro hydraulic Governing system with back up. Bumpless transfer from active to backup & vice-versa.

b) Droop : 0 to 10%.

c) Control : Also refer to Clause No. 3.01.00 to 3.05.00 of "Unit Operation Philosophy" of this section.

d) Start up/Shutdown : Automatic optimised start-up, synchronisation and initial loading (soaking). Provision of manual interruption at any point of start/stop programme.

e) Turbine Stress Evaluator : Turbine stress to be computed continuously for display and interlocked with Turbine start up, shutdown and Machine loading and unloading.

f) Load Rejection from full load or any load level to house load. :

i) Machine speed rise shall be below overspeed trip set point.

ii) SEPCO will prove the plant for at most 15 minutes of House load operation after PG test.

	g)	Turbine Protections	:	i) Provision of automatic tripping for all faults & abnormal conditions.
				ii) Provision of direct tripping (Mechanical or Hydraulic) for critical faults like overspeed, low lub oil pressure etc.
				iii) Provision of minimum independent trip channels as indicated in XIXA and XIXB1 specification for faults activated electrically.
				iv) All faults should have pre trip & trip alarms.
	h)	Turbine Protection testing	:	Automatic & Sequential testing of Turbine Protection to be provided.
	i)	Emergency DC Lub Oil Pump	:	Auto cut in of DC Emergency lub oil pump in case of total power failure. Should have redundant hardware, independent of central computer.
	j)	Testing of Turbine stop Valves	:	Provision to be there for testing Turbine Stop Valves while Turbine in operation.

2.02.00 **Steam Generator & its Auxiliaries**

a)	Air & Fuel	:	Boiler air & fuel management shall be functionally achieved Management through well versed Burner Management System.
b)	Boiler Protections	:	trip channels as indicated in XIXA and XIXB1 to be provided for Boiler Protections.

c) Control : i) Automatic Control to be provided for :

- Boiler Combustion
- Drum level
- Draft
- Steam temperature

Also refer to clause no. 3.06.00 to 3.08.00 of "Unit Operation Philosophy", of this section.

d) Cut back : Provision shall be there to reduce the boiler load according to new load demand (max. variation down to 60 percent TMCR) in the event of :

i) Load Rejection

ii) Auxiliary equipment failure.

e) ESP : Control & Monitoring from ESP Control Room with provision of status feed back to CCR.

2.03.00 **Boiler-Turbo-Generator (BTG)**

a) Mode of Operation : Constant Pressure/ Modified Sliding Pressure / Both Constant / Pressure / & /Sliding pressure

b) Operational Frequency : Capability for sustained operation of main plant and all auxiliary with system frequency variation from 47.5 Hz to 51.5 Hz. However, under exceptional circumstances excursions between 52 hz. & 47 hz. must be accommodated without tripping.

c) Part load operation : Capability for both constant and sliding pressure operation during varying load demand including house load operation following sudden load rejection from maximum load, without tripping.

d) Co-ordinated Control : Steam Generator & Turbo-Generator to be controlled automatically by unit Load Control depending on load demand.

e) Unit Protection Scheme : The scheme shall comprise of :

i) Unit Lock out Relay

ii) Turbine Lock out Relay

iii) Generator lock out Relay

iv) Master Fuel Trip Relay

Class-'A' tripping covers electrical faults in Generator, Generator Transformer, Unit Auxiliary transformer, and Turbine fault that require instantaneous and simultaneous tripping of Turbine & Generator.

Class-'B' tripping generally mechanical faults of Turbine shall first trip Turbine and then trip unit through either Reverse Power or Low Forward Power Relay or both.

Class-'C' this is valid only if HP LP Bypass System is there. Generally electrical faults that can be cleared by tripping Generator Transformer circuit breaker & Machine can continue to run in house load for at most 15 minutes thereafter.

f) H.P & L.P Bypass :

i) Remote/Manual operational facility from CCR

ii) Automatic quick opening of the valve in case of

- Turbine Tripped.
- Upstream rate of rise of pressure exceeding preset value.
- GCB opening.
-
- Large load (50% or more load) throw-off.

iii) Automatic Control of down stream steam temperature.

iv) LP Bypass valve to maintain up stream steam pressure. The steam pressure set point to be generated automatically as per system requirement with manual overriding facility.

2.04.00 **Balance of Plant Control Philosophy**

a) Coal Handling Plant : Fully automatic PLC based control with provision for manual operation from CHP Control Room and with provision for monitoring from CCR, except Wagon unloading system and Stacker-Reclaimer, which are to be controlled from the Track hopper Control Room & S/R control cabin respectively.

b) Ash Handling Plant : PLC based control from AHP Control Room with provision for monitoring from CCR.

c) D.M Plant : PLC based control from DM Plant Control Room with provision for monitoring from CCR.

d)	CW Pumps, ACW pumps, F.O. P&H Unit, D.M CCC Water Pumps, Cycle Make-up Pumps, C.T. Fans	:	Controlled from Central Control Room.
e)	Rest of pumps & equipment	:	From Local Control Room with PLC/Relay whichever suitable depending on location & service.

2.05.00 The plant should also be designed for the following operational requirements :

2.05.01 Capability for operation at VWO condition for at least eight (8) hours in a day [four (4) hours in the morning shift and four (4) hours in the evening shift].

2.05.02 Capability for intermittent emergency operation at valve wide open condition with all HP Heaters out of service.

2.05.03 Capability for continuous and stable part load operation in the range of 40 to 100 percent TMCR.

2.05.04 Capability for responding to the changed load demand in 5 minutes.

2.05.05 Boiler shall be able to achieve a stable flame without oil support down to 40% TMCR, unless otherwise stated in Section-V of this specification.

2.05.06 No limitation on generated output arising from isolation of any single feed water heater except deaerator.

2.05.07 Average minimum plant load factor of 80.0 percent.

2.05.08 Capability for shutdown with or without automatic controls, in the event of an emergency trip, in a manner which avoids damage to plant and equipment and risk to health and safety of personnel.

3.00.00 UNIT OPERATION PHILOSOPHY

3.01.00 Units should normally operate on a fixed load setting in MW, from the Station, with a common target load set point for both boiler and turbine taking into restrictions, if any, in the respective boiler and turbine systems.

3.02.00 Units would be loaded or unloaded on pre-set ramp rate. Facility should be available for adjusting this ramp rate between 1% MCR per minute and 5% MCR per minute.

3.03.00 The Unit would continue to operate on pre-set load within an adjustable dead band of frequency during which TG will not respond to frequency variation. Outside the dead band, governor responds as normal. The maximum higher side frequency setting and the minimum lower side frequency setting would be 51.5 HZ and 47.5 HZ respectively. The operator would have the facility to adjust both top and bottom limits independently.

3.04.00 If and when the frequency crosses the manually set higher side value, the unit would shed load on P & I mode at a fixed ramp rate. Likewise, if the frequency drops below the set minimum limit, the unit would raise load in the above ramp rate. The ramp rate should be adjustable in the range between 2.5% and 5.0% in commensurate with the governor droop.

3.05.00 Governing system of the turbine shall be such as to be responsive for the following modes of operation:

a) Co-ordinated control.

b) Turbine following Boiler control.

c) Boiler following Turbine control.

3.06.00 For every operating regime the operator would be able to set a high level generation limit and a low level generation limit. This will be dictated by the number of mills in services, quality of station coal on that date, disposition of burners and other allied factors.

3.07.00 During loading/unloading, when the machine load reaches the upper/lower limit, "Boiler Capability Reached" alarm would be annunciated. At this point the operator will have to change the number of mills in services so as to raise/lower the unit load.

3.08.00 In the event of large load throw-off (about 50% MCR or more), HPLP bypass system would come into service and the boiler will be driven down to 60% BMCR flow. A mill may be tripped to ensure boiler stability during this period.

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SECTION-IX

PLOT PLAN
LAYOUT REQUIREMENTS

WPCPL
(Kiran Panda)

(Wang Heng)

VOLUME-II
SECTION-IX

PLOT PLAN
LAYOUT REQUIREMENTS

	ITEM	SPECIFICATION REQUIREMENT
A.	**Site conditions to be considered**	
1.	Prevalent wind direction (for deciding cooling tower orientation and for deciding the location of coal stock pile and ash dump/unloading areas, minimising the pollution effect due to dust)	Refer plot Plan
2.	**Location of**	See enclosed area map
	a) Water treatment plant.	
	b) Water discharge point.	
	c) Plant drainage outfall point(s).	
	d) Railway entries & exits.	
	e) Road entries & exits.	
	i) Switch yard & Transformer Yard	
3.	**Mode of transportation & unloading**	
	a) Coal	Railway & track hopper
	b) Heavy fuel oil	Railway/Road tanker
	c) Light fuel oil	Railway/Road tanker

	ITEM	SPECIFICATION REQUIREMENT
3.	**Elevation (above M.S.L.) at the top of**	To be finalized by Contractor (MSL already mentioned)
a)	Rail tracks at plant site entry & exit points.	
b)	Roads at plant site entry & exit points.	
B.	**Layout Requirements**	
1.	**Maximum permissible slope in**	
a)	Rail track	1 in 400
b)	Road	1 in 30
c)	Sides of unpaved embankment	1 in 2
2.	**Required road (All roads will be of concrete M-30 grade) width**	
a)	Plant Main roads	7.0 metres, with 1.5m wide shoulders on either sides. RCC storm water drain of adequate capacity shall be provided on eitherside.
b)	Auxiliary interconnections	4.0 metres, with 1.0m wide shoulders on either sides. RCC storm water drain of adequate capacity shall be provided on either side.
c)	Approach road from NH200 to Main power plant gate. (Approx length-600m)	carriage width of 14.0, meters with 2.0m wide. shoulders on either side. RCC storm water drain of adequate capacity shall be provided on either side.
d)	Road to the power house unloading bay :	

•	To enter and pass through the unloading bay	entering from A row

	ITEM		SPECIFICATION REQUIREMENT
3.	**Required minimum horizontal distance between the nearest points of**		
	a)	Plant boundary and the boundary of residential area	(Local municipality/factory rule)
	b)	Electrical transformer and any other building/facility	As per the Fire Insurer's Recommendations
	c)	Fire water supply installation and any building/facility subject to fire risk	As per the Fire Insurer's Recommendations
	d)	Inflammable liquid (fuel oil, etc.) storage & handling installation and	Rules of the Indian Explosive (Indian Explosives Act)
and		their fencing and other buildings/ facilities	Indian Petroleum Code
4.	**Required minimum vertical clearance**		
	a)	Under pipes/cable racks at road crossings	8.0 metres
	b)	Soil coverage over underground pipes	1.5 - 2.0 metres (to be decided by the bidder to meet his design requirements)
	c)	Pipe/Cable trench	Not Acceptable
5.	Railway Wagon clearance		Rules of the Indian Railways
6.	Minimum Clearance between any road edge and		3 metres

	ITEM	SPECIFICATION REQUIREMENT
	building/structure/ any fixed installation.	
7.	Minimum permissible distance of the ash unloading (to truck) installation and the ash dump area from any plant/equipment/building not directly associated with the ash unloading/dumping system (and its dust suppression/extraction plant).	100 metres
8.	Minimum permissible distance of the coal stock pile and the coal wagon unloading installation from any plant/equipment/building not directly associated with the coal stacking/reclaiming and unloading operation (and its dust extraction/ suppression plant).	50 metres
9.	Minimum rail track length required for coal wagon unloading	Railtrack by the Owner. Track hopper should be as per design requirements..
10.	Minimum rail track length required for fuel oil wagon movement	Railtrack by the Owner. One full rake of 650 m length shall be placed in a straight rail track during unloading. Railway Infrastructure will be executed by the Owner through IRCON International Ltd. /equivalent Necessary coordination for inserts, embedded plates of the rail tracks in the civil work shall be carried out by the Contractor. Railway Marshalling Yard will be designed by IRCON to meet the Indian Railways requirement.
11.	**Other rail track requirement**	

a) To power house unloading bay — no

b) For transformer yard — rails shall be provided for all the GT, UT&ST to main road and from main road to one STG maintenance bay for transportations.

12. **Minimum required capacity of**

	ITEM	SPECIFICATION REQUIREMENT
a)	Raw water reservoir	refer to design requirement
b)	Clarified water reservoir	refer to design requirement
c)	Filtered water reservoir	refer to design requirement
d)	Demineralised water tanks	refer to design requirement
e)	Fire water reservoir (may be clubbed with clarified water reservoir)	refer to design requirement
f)	Chlorination containers - (ton containers) :	
	• For CW system	Minimum 30 nos.
	• For clarification plant	Minimum 10 nos.
g)	Open yard crushed coal stockpile (density of coal specified elsewhere)	refer to design requirement
h)	HFO and LDO storage tanks	refer to design requirement
i)	HFO and LDO storage dyke	refer to design requirement

	ITEM		SPECIFICATION REQUIREMENT
13.	**Maximum permissible**		
	•	Width of coal stockpile	50 m
	•	Height of coal stockpile (subject to total height reclaiming)	13 m
14.	**Required level, above the local developed grade level, of**		
	a)	Top of all roads	150 mm
	b)	All outdoor paved areas	150 mm
15.	**Other requirements**		
	a)	All future extension buildings, plants, storage areas etc. as required/anticipated	No
	b)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes
	c)	Green belt around power plant area	As per environmental guidelines of MOEF, Govt.of India. Only leveling and grading of green belt in Contractor's scope

16. Contractor to note that 'Bore Hole Data', 'Geothermal Investigation' and 'Electrical Resistivity Report' is attached as Table-VIII, Table-IX, Table-X.

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SECTION-X

BUILDING/EQUIPMENT LAYOUT REQUIREMENTS

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SECTION-X

BUILDING/EQUIPMENT LAYOUT REQUIREMENTS

	ITEM	SPECIFICATION REQUIREMENT
A.	**Minimum clear space required at all working and walking areas for operating & maintenance personnel**	
1.	**Horizontal, in all directions**	
a)	Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/equipment of surface temperature exceeding 60□C.	1200 mm
b)	Adjacent to any other plant facilities (including walls/structures)	1000 mm
2.	**Vertical (head-room clearance)**	
a)	Under any pipe/equipment surface of temperature exceeding 60□C	3.0 meter
	any electrical cables or other electrical items.	2.2 metre
b)	Under any other plant facilities (including structures, pipes etc.)	3.0 metre
3.	**For all areas** where any equipment (including trucks, trolleys and other material handling equipment) will	Minimum 500 mm clear in all direction move or maneuver. from the outer edges of the equipment
4.	**Minimum clear hand space required for**	
a)	The application of thermal insulation	100 mm
b)	Welding work	150 mm
c)	Bolt tightening	150 mm

	ITEM	SPECIFICATION REQUIREMENT
B.	**Floors, platforms, staircase, ladders, walls, doors & windows**	
1.	**Statutory Requirement**	As per the recommendations of Fire Insurer, Indian National Building Code, Indian Factories Act, Local Municipal Rules, Tariff Advisory Committee(TAC) etc.
2.	**Operation & Maintenance Requirement**	
	a) Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
	b) Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, (including valves, instruments, otc.), to be operated and/or to be frequently (more than once a month) maintained.	Yes
3.	**Plinth level** of all buildings, above the local developed 500 grade level	300 mm, however, mm for power house building.
4.	**Minimum access** opening required (with rolling shutter) wherever entry of truck, for material transportation, is envisaged	3.5m wide x 4m high or, more depending upon the equipment size to be handled. Electrical operated rolling shutter.
C.	**Other Maintenance Requirement**	
1.	**Generator stator handling**	
	Two (2) nos. EOT cranes shall be used to lift Generator Stator. SEPCO will supply one Lifting Beam to facilitate lifting of Generator Stator by two EOT cranes in tandem.	Yes

Further, SEPCO shall design the TG building structure based on above requirement.

	ITEM	SPECIFICATION REQUIREMENT
2.	**Maintenance** of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, coal crushers, air compressors, blowers, heat exchangers, fuel oil pumps, filters etc.	Shall be possible without disconnecting or dismantling any piping/ducting
3.	**Overhauling and handling** of the casings for the above items	Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4.	**Crane Approach**	
	Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.	Yes
D.	**Central Control Room**	
	All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room.	Yes
	The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomical consideration.	
	However, as a guideline, following features are given:	
	a) False ceiling and flooring shall be provided:	Refer Civil discussion. control room flooring shall be of Granite make
	b) Uniform height, colouring schemes for cabinets etc. shall be available.	
	c) The total area of floor space covered by Control Consoles/Panels in the Control Room shall not	

exceed 15% of floor area.

d) No opening shall be provided from Boiler side.

ITEM	SPECIFICATION REQUIREMENT
e) Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor	
f) Cable entry for the panels/consoles shall be from bottom and suitable openings shall be provided	
g) The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX	
h) Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.	
i) Basic amenities like toilet, tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room	
E. **Toilet and drinking water facility**	Required in all buildings and on all floors wherever operating personnel are to be deployed. Ladies toilet facility to be provided additionally.

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SECTION-XI

TESTING AND COMMISSIONING

VOLUME-II

SECTION-XI

TESTING AND COMMISSIONING

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Attachment – I Joint Protocol for commencement of the Reliability Run of the - Unit and/ or the Plant

VOLUME-II

SECTION-XI

TESTING AND COMMISSIONING

1.00.00GENERAL REQUIREMENT

1.01.00The Contractor shall provide sufficient number of competent commissioning & start-up personnel, specially identified, for the period commencing with start-up, extending through initial & trial operations, all testing, to placing the plant to full commercial operation upto the issue of Taking Over certificates. During this period, the Contractor shall provide all the consumable materials, tools and tackles, temporary equipment, tapping points, calibration devices, special test instruments etc. necessary for start-up, commissioning, trial and initial operation and testing. The Owner will associate his operators in shifts, as required, for commissioning & testing under the supervision and work instructions of Contractor's commissioning & start-up personnel. All other labours, fitters etc. for starting, trial operation, initial operation, testing, repairs and adjustments shall be supplied by the Contractor.

1.02.00The Contractor shall start training the Owner's personnel sufficiently in advance of commissioning process and during the commissioning & start-up period to make them familiar with the Plant and intended operation techniques and to ensure safe and efficient operation & maintenance of the New Plant after the issue of Taking-over Certificate.

1.03.00The Contractor shall inform the Owner about his programme of conducting commissioning and operator training well in advance and this has to be agreed by the Owner at least three (3) months in advance of the commencement of the Commissioning Process of the Plant.

2.00.00SHOP TEST

The Contractor shall indicate the Plant items to be tested at works in the presence of the owner or his representative prior to dispatch to site along with the references to the relevant test standards. The individual shop tests for Plant Component shall be as per the approved International Codes and Standards as applicable for each item.

3.00.00START-UP AND TRIAL RUN

3.01.00The check outs during the pre-commissioning period should be programmed to follow the construction completion schedule. On completion of inspection, checking, cleaning and after the pre-commissioning tests are satisfactorily conducted, the complete equipment shall be placed on Trial Run during which period the complete equipment shall be operated integral with sub-systems and supporting equipment as a complete plant.

3.02.00During this period all adjustments and repairs, as required, shall be made by the Contractor. The Plant may be shutdown, if necessary, to carry out such adjustments and repairs. On completion of satisfactory Trial Run, the Plant will be placed under initial operation.

3.03.00When the equipment is operating satisfactorily, its characteristics shall be recorded on the start-up report sheets. Copies of typical start-up report shall be given to the Owner. Start-up reports for all equipment shall be completed before the start of the Initial Operation period.

3.04.00A protocol will be signed by contractor and owner/owner's representative that all systems commissioning has been checked and satisfactory and that unit is ready for initial operation.

A punch list will be prepared and jointly signed by contractor and owner/owner's representative with the indication of the completion date for the same. The punch list items are the items pending for total completion but are not affecting the unit operation as identified for reliability test and thereafter.

4.00.00INITIAL OPERATION

4.01.00Each unit of the Plant shall be on Initial Operation during which period all necessary adjustments and final testing of all controls and protections shall be made which operating over the full load range enabling the plant to be made ready for Reliability Run and subsequently for Performance Guarantee Tests.

4.02.00During this initial operation period, the operational requirements, as mentioned elsewhere in the specification, are to be demonstrated to the full satisfaction of the Owner.

4.03.00All the necessary data, adjustments, repairs etc. made during this operation are to be recorded properly by the Contractor and submitted to the Owner for his verification prior to Reliability Run and Performance Guarantee Tests.

4.04.00This initial operation is aimed to establish the performance of the Unit steady-state operation at a required load level and to provide base-line operating data.

5.00.00RELIABILITY RUN TEST(RRT)

5.01.00RRT of unit-1 shall start not later than 37.5 months from NTP (Notice To Proceed) date. RRT of subsequent units shall start at 4 months gap (like 41.5 m for unit-2, 45.5 m for unit-3 ... etc)

5.02.00Each unit RRT shall be conducted with 14 days of operation. Each RRT shall consist of 72 hours of continuous operation at full load (or any other load at owner's discretion) and further demonstrate operation at various other loads like 80%, 60%, 40% or any other load mutually agreed. Any minor failure of aux. equipment (which shall be set right immediately), which does not force the unit shut down, will not be treated as failure of RRT.

Each RRT may have max. two shut downs of unit with total hours of interruption not exceeding 8 hours.

In case total No. of hours of interruption of operation exceed 8 hours, such RRT shall be treated as unsuccessful.

5.03.00If RRT of any unit is not successful based on above criteria, SEPCO shall repeat the RRT. In case SEPCO could not conduct RRT successfully within 38 months, SEPCO shall be liable for LD on account of delay.

However, in case SEPCO could not conduct RRT successfully within 38 months, Owner would permit one additional RRT without levying LD. In case of major shut down due to 'Boiler tube leakage' in any unit, the repeat RRT shall start immediately after repair but not later than 36 hours from the time of unit shut down.

In the event such repeat RRT is also not successful, Owner may permit one more additional RRT without levying LD. In case of major shut down due to 'Boiler tube leakage' in any unit, provided the repeat RRT starts immediately after repair but not later than 36 hours from the time of unit shut down. But, in any unit not more than two additional RRTs are permitted.

In any case, all the additional RRTs for the total six units shall not exceed 8 tests. The cost of consumables in such additional tests shall be borne by Owner.

5.04.00The unit will be put on reliability run when the Owner is fully satisfied that the offered unit/ Plant has been fully proven with regard to its safety and operability. A 15 days notice will be issued by the Contractor to the Owner about the completion of the Plant /Unit being ready for the Reliability Run. A joint protocol will be signed before the commencement of the Reliability Run by the Owner, the Contractor and any appointed /authorized agency of the Owner. This protocol will confirm the acceptance of the participating parties that all the Plant/ unit systems have been completed and are put in auto operation with all necessary adjustments and final testing of all controls and protections are made for operating over the full load range and the Plant/ Unit is ready for the Reliability run. A Punch List, [that is a list

of items not completed, the lack of which or failure of completion of which (considered individually or in aggregate) will not affect the performance and safety of the Plant /Unit or ability of the Owner to safely and efficiently operate and maintain], along with a Schedule for completion of the same will be submitted by the Contractor and agreed to by the Owner and jointly signed as a part of the protocol for commencing the Reliability Run. By way of example, Punch List may include final grading, clean up, final painting etc.
At any time prior to the Handing Over date, the Owner or the Appointed agency by the Owner has the right to add to Punch List Items if the same are found to be deficient. All the items which Owner and Lender believe to be deficient after the Plant Handing Over Date but with the Warranty Period, as applicable, shall be submitted to the Contractor as warranty work.

By approving the Punch List or acknowledging the Plant readiness for Reliability Run by the Owner or his appointed /authorized agency shall not forfeit their respective right to add to Punch List (prior to Handing Over Date) or to make claim for warranty work for those items which prove to be deficient after such acknowledgement or which were overlooked by the Owner or his appointed /authorized agency prior to such approval or acknowledgement .

A joint protocol format to be signed before the Reliability Run is enclosed as an Attachment to this Section.

5.05.00 During the Reliability Run Test period no equipment shall be allowed to be adjusted except the shutdowns agreed in clause no. 5.02.00 & 5.03.00. All the systems shall run in Auto mode.

5.06.00 Contractor shall include all the consumables till completion of Reliability tests in their scope. Except for the following four (4) inputs from the Owner which shall be supplied free subjected to guaranteed cap (for quantities).

- Coal in MT
- LDO/HFO in kilo litres
- Raw Water in cu.m
- Start up power in kWh and peak in kVA.

For the agreed guaranteed cap values and recovery rate for any excess consumption beyond guaranteed cap, refer the commercial contract.

6.00.00PERFORMANCE GUARANTEE TESTS

6.01.00Acceptance Tests consist of Reliability Run and Performance Guarantee Test. The unit is taken over based on successful completion of Reliability Run (part of Acceptance Test). PG Test is performed within 60 days of Reliability Run when the unit is being operated by the Owner.

After completion of satisfactory Reliability Run, the Contractor shall prepare the units for Performance Guarantee Test. The PG test shall be carried out within 60 days of Reliability test when the unit is being operated by the Owner.Within this period no derating of the equipment performance will be permitted.

6.02.00These tests shall be carried out by the Contractor to the requirements of the Owner. The Owner will provide the requisite load and fuel for the test.

6.03.00In case of delay in carrying out the Performance/Acceptance Test for reasons not attributable to the Owner, the Contractor shall be required to prove the specified performance guarantee without any derating/ageing factor.

6.04.00The Performance Tests will be conducted in accordance with internationally recognised codes preferably ISO/ASME PTC Code, which is to be highlighted by the Contractor in his offer. The Contractor shall submit the test procedure for Owner's approval within twelve (12) months from the date of "Letter of Award" of the contract or any time frame mutually agreed between Owner and Contractor. This procedure shall indicate the tentative date & program, the arrangement & form of the tests, log sheets, duration, control periods, readings to be taken, number of observers required etc. and any other requirements in accordance with applied test code. The test shall be carried out by the test grade instruments as stipulated in the applicable test code. These instruments shall be calibrated by the Contractor in a recognised laboratory not exceeding three (3) months prior to the date of test and shall furnish the certified calibration curves. Batch calibration will not be acceptable. The class of accuracy of the instruments shall be as specified in the code. All flow measuring devices (for fuel, water or steam) and thermocouples with their indication shall be certified by an approved independent authority. The tests will be conducted at the specified load points, and as near the specified cycle conditions as practicable. Proper corrections in calculations to take into account the condition which do not correspond to the specified conditions will be applied in the test report as per stipulations to be decided before finalisation of the procedures. All the correction curves are to be submitted along with the Performance Test Procedures.

6.05.00All special test grade instruments including Power meter with 0.2 % accuracy with printer, equipment, tools and tackle, required for the successful completion of the Performance Tests shall be brought for the purpose of the test, free of cost by the Contractor.

6.06.00Should the plant or any portion thereof fail under these tests to give the performance required, then any further tests which may be considered necessary by the Owner shall be considered in a similar manner.

6.07.00The guaranteed performance figures of the equipment shall be proved by the Contractor during these tests. The Contractor shall submit a detailed test report in the manner, already agreed to within one (1) month time of completion of the test, for Owner's approval. Should the Owner's assessment of these tests show any deterioration from the guaranteed values, the Contractor shall modify the equipment as required

at no extra cost to enable it to meet the guarantees. In such case Performance/Acceptance Tests shall be repeated after the equipment is ready for retest.

The Heat rate test to be demonstrated for the following conditions, though the Contractor will guarantee heat rate for full load condition.

- Turbine VWO
- 100% TMCR (Guarantee condition)
- 80% TMCR
- 60% TMCR
- 40% TMCR without oil support
- Maximum power generation when all H.P heater out
- 60% HP –LP bypass condition and without turbine on house load

6.08.00 Requisite no. of copies of the test reports as mutually agreed upon, are to be furnished by the Contractor to the Owner backed up with jointly signed data sheets recorded during the test period.

6.09.00 Whenever it is not practicable to conduct the performance guarantee test at site, and an accurate test to prove the guaranteed parameters have already been conducted in the shop test, such a test may not be repeated, if so agreed by the Owner.

6.10.00 The tests to be carried shall include but not limited to the following:

i) Turbine Heat Rate. (latest ASME PTC 6.0)

ii) Boiler efficiency (ASME PTC 4.0 Dtd: 1998 - Fuel efficiency)

iii) Piping Efficiency

SEPCO guaranteed Turbine cycle Heat Rate as 1950 kcal/kWh. SEPCO agreed to guarantee Gross Unit Heat Rate as 2239.77 kcal/kWh, considering (minimum) 99.5% piping efficiency. However improved piping efficiency shall be considered later based on the actual Main steam parameters measured during PG Test. Formula to be used for calculating piping efficiency shall be $\{ 1 - ((i_B - i_T)/i_B \times 100) \}$, where i_B, i_T are values of enthalpy of main steam at Boiler outlet & Turbine inlet respectively. SEPCO indicated that piping loss is not considered on BE calculation. The unit heat rate shall be calculated by the formula, UHR=THR/BE/PE.

iii) Plant Heat Rate.

iv) Cooling Tower Performance.

v) DM Plant Performance.

vi) 50 mg/Nm^3 Particulate emissions at MCR with any one field in each gas path out of service.

vii) Gaseous emissions at MCR.

viii) Steam Purity.

ix) Bottom & Fly Ash handling system and HCSD Performance.

x) Coal handling Plant Performance.

xi) Electrical Power output (Gross) at Generator Terminals with excitation losses deducted.

xii) Electrical Power output (net) at TMCR as would be measured at the high voltage side of the main transformer assuming all electrical loads, or, losses associated with the units electrical ancillary equipment normally in service, plus associated station loads.

Duration : 120 hours of continuous uninterrupted plant operation.

Demonstrate 15 mins house load operation after PG test

xiii) Heat Rate (Gross) at MCR on H.H.V. of Fuels and 0% Make-up basis.

xiv) Heat Rate (Net) at MCR on H.H.V of Fuels and 0% Make-up basis.

Duration: Same as item (xii) above. Test periods shall be subject to the Owner's approval to prove the guaranteed performance.

xv) Deaerator Performance.

xvi) Testing of Generator as per IEC/equivalent.

xvii) Performance of the Effluent Treatment Plant components, including the systems for achieving zero discharge

xviii) Auxiliary Power Consumption including transformer and electrical losses.

xix) Unburnt carbon losses in fly ash less than 1%.
Unburnt carbon loss shall be calculated only as per method as explained hereafter. " Sample of fly ash will be taken from fly ash silo. This sample will be passed through 200 mesh size screen. This screen material will be heated upto 105 Deg.C. Then, Weight (W1) will be taken. This sample will be further heated upto 815 Deg.C and will be kept at the same temp. for 1 hour. Weight (W2) will be taken. Afterwords, unburnt carbon loss will be calculated as follows:

Unburnt Carbon loss (%) =100 x (W1 – W2)/W1

6.11.00 Extended Performance Tests

An extended performance period will be required to demonstrate the compliance with the required availability for the duration of the Defects Liability Period. This period will commence following takeover of the plant.

The Contractor shall specify the information required, in addition to that available on the SCADA system, to demonstrate compliance with the availability requirement.

The extended period to prove availability shall be one (1) year from the taking over of the plant. During this period the responsibility of supervision of any major repair, maintenance or overhaul will be that of the Contractor while the operation and normal maintenance is carried out by the Owner.

ATTACHMENT TO VOLUME-II - SECTION-XI

TESTING AND COMMISSIONING

(Plant Name with the mention of the concerned Unit /Plant)

Joint Protocol for commencement of the Reliability Run of the --Unit and/ or the Plant:

Following the notice given by the Contractor vide ref no. dtd. that the Unit No --- and/ or the Plant is ready for the Reliability Run as per the Contract Vol-II, Section XI, and after due joint examination by the Contractor, Owner and his Authorized /Appointed Agency it has been agreed to commence the 14 days Reliability Run from ------(date) . The Contractor also has provided a Punch List as per the above Contract Section, consisting of a list of items not completed, the lack of which or failure of which to complete (considered individually or in aggregate) will not affect the performance and safety of the Plant /Unit or ability of the Owner to safely and efficiently operate and maintain along with a time schedule for completion of the same. This list also has been reviewed by the Owner and his Authorized /Appointed Agency and signed.

Signed by:

Contractor Owner Owner's Appointed /Authorized Agency

Date

Place

28.03.09
CKIRAN PANDA
WPLPL

薛利
(XUE LI)
2009.03.28

VOLUME - II

SECTION - XX

ENVIRONMENTAL CONSIDERATIONS

26.03.09 (KIRAN PANDA) WPCPL

(XUE LI) 2009.03.26

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SECTION - XX

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VOLUME - II

SECTION - XX

ENVIRONMENTAL CONSIDERATIONS

1.00.00 GENERAL REQUIREMENT

The Contractor shall design and develop the Water Balance Diagram adopting the philosophy of maximum recycling and reuse of treated waste water within the plant to minimise consumptive water requirements as well as to minimise the quantum of effluent discharged from the plant. Each identified waste water stream of the plant shall be subjected to suitable treatment to ensure that quality of treated effluent from each stream meets the standards stipulated by Statutory Authority as well as specified elsewhere in this section. SEPCO shall submit Water balance diagram for WPCPL approval post contract and shall carry out necessary changes without any commercial implication.

Apart from ESP, which is covered elsewhere in the specification all other sources of emission (including fugitive emission) shall be taken care of by providing dust extraction (DE) or dust suppression (DS) systems as per technological requirement and the emissions there from shall meet the stipulated requirements as well as conform to the requirement laid down in Factories Act of India as amended from time to time.

2.00.00 ENVIRONMENTAL STIPULATIONS

2.01.00 Emissions and discharges of solid, liquid and gaseous effluents from the Thermal Power Plant shall fully comply with all requirements and limits specified in Environmental (Protection) Act, 1986, Minimal National Standards (MINAS), along with all latest amendments to all of the above, requirements and stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF) and State Pollution Control Board (SPCB) for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement.

The basic requirements for this project are indicated below for reference of the Bidder. However, it shall be the Bidder's / Contractor's responsibility to ensure full compliance with the latest amendments of all applicable regulations.

Relevant conditions of the permits already obtained for the project shall be passed on to the Contractor. Contractor shall ensure full compliance with the same. The

Contractor shall be responsible for obtaining all other necessary consents, licenses and permissions which are related to design, construction, installation and operation of the plant. These shall be obtained in sufficient time to ensure that the construction and commissioning programme can be achieved.

2.01.01 **Gaseous and Particulate Emissions**

For the complete range of fuels specified, including fuel oil, the gaseous and particulate emissions from the stack shall comply with the following requirement :

a) Emissions of nitrogen oxides (expressed as NO_2) shall be limited to the minimum that can be reasonably achieved using established abatement techniques. In all cases these emissions shall comply with the limit stipulated in Section-V as a monthly average and no more than 5% of all 48 hour averages in a calendar year, shall exceed 110% of monthly average estimated at 273°K, a pressure of 101.3 kPa, dry with 6% oxygen content.

b) The emissions of carbon monoxide (CO) shall not exceed to the limit specified in Section-V under any of the defined operating conditions.

c) Emissions during normal operation, start-up and shut-down, but excluding start-up from cold, shall not exceed shade 1 on the Ringelmann scale (see note below) or equivalent 1 for more than 15 minutes in any period of 2 hours.

d) Emissions during start-up from cold shall not exceed Ringelmann shade 2 or equivalent.

e) There shall be no emissions of acid soots at any time, including start-up from cold.

f) Particulate emissions shall not exceed the limit specified in Section-V as a calendar monthly average, and no more than 3% of all 48 hr. averages in a calendar year shall exceed 110% of monthly average estimated at 273°K, a pressure of 101.3 kPa, dry with 6% oxygen content.

The Bidder shall provide in the appropriate schedules in the Bid Proposal Sheets predicted emission levels for various firing cases:

The Contractor shall provide continuous monitoring equipment to measure particulate matter (e.g. cross-stack optical density or equivalent), carbon monoxide, sulphur dioxide, nitrogen oxides, temperature and oxygen content of the stack gases. The monitoring instruments must be carefully located to ensure that representative sampling is obtained and sampling should be to a recognised standard.

The monitoring systems should incorporate the means to record various time-averaged values as required by the performance requirements noted above. Monitoring data should be displayed in the control room, with provision of alarms to notify the operator of any deviation from the specified ranges. The Bidder shall state what monitoring equipment he intends to provide, its location on the plant and its cost.

Note :

Ringelmann Shade numbers refer to an assessment made with either the Ringelmann Chart or Miniature Smoke Chart, in accordance with BS 2742

Dust Control

Control of dust matter to the air from the site, including coal stocking area, roadway, etc. shall be controlled by means of a permanently mounted water sprinkler system.

Coal crushing and screening plant and coal transfer points shall be contained and ducted to suitable dust arrestment equipment, so that an emission limit specified in Section-V.

3.00.00 **NOISE CONTROL**

3.01.00 An integrated approach shall be taken by the Contractor to control noise emission which shall include but not be limited to :

a) Design and layout of building to minimise transmission of noise, segregation of particular items of plant and to avoid reverberant areas.

b) Specification of permissible noise levels for bought out items.

c) Choice of materials for civil construction

d) Acoustic design of building

e) Use of lagging with attenuation properties on plant components.

3.02.00 **Noise Levels Local to Plant**

Following criteria shall apply during all continuous operating conditions of the plant.

3.02.01 **Maximum Surface Noise Level - Plant**

The maximum surface noise level of any item of plant, including valves, piping,

vessels and ducting, shall not exceed 85 dB(A) measured at a distance of 1 metre from any point on the surface of the item, under any operating condition with the exceptions indicated in Section-V.

3.02.02 **Maximum Noise Level - Plant Rooms/Buildings/corridors**

The plant rooms and buildings must be designed so that noise levels shall be less than the value specified in Section-V at any point within the building, subject to not being closer than 1 metre to any item of plant. The effect of the reverberant acoustic field shall be considered. It may prove necessary, in achieving the specified level, whilst allowing for the number, size and spacing of plant items, that a maximum surface noise level of less that 85 dB(A) be required for some plant components.

3.02.03 **Noise Control**

Where the requirements stated above are not met within the basic design of the plant they shall be achieved by the supply under the contract of suitable means of noise control, which shall conform to the following requirements :

a) The noise control system shall, as far as possible, be designed to form an integral part of the plant.

b) The abatement system shall, wherever practicable, be applied to the source of excessive noise rather than to the entire item or component.

c) If above means are not adequate and enclosures are used for noise abatement, close fitting enclosures, which do not require or allow personnel access are preferred. The maximum surface noise level of these enclosures shall not exceed 85 dB(A).

d) Noise abatement measures shall be such as to ensure that safety, operation and maintenance of the treated item or component are not impeded.

3.03.00 **Noise in Control Areas**

3.03.01 **Control Rooms**

The noise levels in control rooms must be such that intelligible speech communication is always possible and mental concentration is not hindered. The background noise level in control rooms and the Speech Interference Level (SIL) shall not exceed the values specified in Section-V.

3.03.02 **Other Control Areas**

The noise levels in other control areas must be such that intelligible conversation (telephone and person-to-person) is possible and operator fatigue is minimised.

The background noise level in these areas and the Speech Interference Level (SIL) shall not exceed the values specified in Section-V.

3.04.00 **Station Noise Criterion**

The criterion for environmental noise is that the design of the station and its components shall not exceed, in any continuous mode of operation, the level specified in Section-V at any point on the site boundary adjoining local residential areas located at the site boundary. These levels are designed to prevent any significant local community annoyance in accordance with World Health Organisation criteria and the Bidder's attention is drawn to the important further conditions regarding octave band levels given in the table in Cl. 3.06.00.

In connection with the above the Contractor's attention is drawn to the guidance given in BS4142and/or ISO 1996:parts 1 to 3. The methods of measurement and measurement conditions shall be noted and particular attentions is drawn to the need to apply an additional 5 dB(A) reduction to noise sources containing a distinguishable, discrete, continuous tone or distinct impulses. Such sources shall also be required to meet octave band noise levels 5 dB below the limits given in the table.

The Bidder shall furnish sufficient evidence that the above noise levels shall be within allowable limits by reference to plant data, calculation and modeling, and show that allowance has been made for tonal and impulsive components.

3.05.00 **Other Plant Noise Criteria**

3.05.01 **All plant components**

It will be required that the Contractor provide sound power level (PWL) data, in both octave band and dB(A) units, for all plant components which produce surface noise levels in excess of 75 dB(A) or contribute measurably to off-site noise levels.

3.05.02 **Stack radiated noise**

The stack efflux noise levels when measured in accordance with ISO 10494:1993(E) shall not exceed a calculated equivalent power level of 105 dB(A) PWL(re 10^{-12} watts). In addition, the octave band power levels specified in Cl. 3.06.00 shall not be exceeded.

3.05.03 **Safety Valves, Power Operated Relief Valves, Other Vent Systems & Plant Intermittent Operation**

The first valves to lift in any safety valve or power operated relief valve system shall be fitted with silencers designed to ensure that the noise emitted shall not exceed 75 dB(A) at 400 m from any side of the plant house containing the valves.
The remaining valves in the safety valve or power operated relief valve system shall be fitted with silencers designed to ensure that the noise emitted shall not exceed 80 dB(A) at 400 m from any side of the plant containing the valves.

The noise emitted during plant intermittent operation or by any other atmospheric vent system, including drains and other systems operated during turbine or boiler start-up, shall be controlled so as not to exceed 60 dB(A) at 400 m from any side of the plant containing the vents.

The noise emitted by any of the systems referred to above also shall not exceed a level of 105 dB(A) at 15 m from the vent at 1.5 m above roof level.

In addition, the octave band power levels specified in clause 3.06.00 shall not be exceeded.

3.06.00 **Octave Band Sound Power Levels**

The following Octave band power levels shall not be exceeded in the different areas as mentioned in the following Table:

Octave Band Centre frequency (Hz)	Octave Band Sound Power Level (dB)					
	Control Rooms	Other Control Areas	Station Noise Criteria	Stack Radiated Noise	Safety Valves & Power Operated Relief Valves	Other Vent Systems and Plant Intermittent Operation
31.5	-	-	-	124	-	-
63	67	82	72	117	94	79
125	60	75	62	112	85	70
250	53	68	54	108	78	63
500	49	64	49	104	73	58
1K	45	60	45	100	70	55

2K	41	56	42	97	67	52
4K	33	48	40	95	65	50
8K	25	40	38	93	64	49

Note : For measurement of noise levels refer Section-V of this Volume (Volume : II).

4.00.00 **DISCHARGE OF LIQUID EFFLUENTS**

Clear water drains and treated effluent streams excepting cooling tower blow down will be taken to a central effluent monitoring basin to be located suitably within the plant boundary. Treated effluent from each individual stream will conform to the tolerance limit furnished after Clause no. 4.00.00 of this section. The central effluent monitoring basin shall be adequately sized to ensure 48 hours holding basin at maximum throughput from each stream. This basin will serve the basic purpose of equalisation as well as a facultative pond. Equalised effluent from this guard pond shall be recycled and reuse COMPLETELY within the plan for systems like dust suppression etc.

The Bidder would suggest schemes following the philosophy of water consumption and treatment delineated hereinbefore while the quality of treatment effluent shall conform to the stipulated limits.

Complete waste water reuse philosophy i.e. ZERO DISCHARGE shall be adopted. RO Plant of suitable capacity shall be provided for meeting Zero discharge norms. Permeate (Clear) Water from RO Plant shall be fed to cooling tower basin and reject water shall be utilised for HCSD system, road wetting, dust suppression etc.

STANDARD FOR TREATED EFFLUENTS FROM EACH STREAM

General Standards for discharge of environmental pollutants Part-A : Effluents
[Environmental (Protection) Act, 1986]

Sl. No.	Parameter	Standards Inland surface water
1.	Colour and odour	All efforts should be made to remove colour and odour as far as practicable
2.	Suspended solids mg/l, Max.	100
3.	Particle size of suspended solids	shall pass 850 micron IS Sieve
4.	Dissolved solids (inorganic) mg/l max.	2100
5.	pH value	5.5 to 9.0
6.	Temperature	shall not exceed 5°C above the receiving water temperature
7.	Oil and grease mg/l max.	10
8.	Total residual chlorine mg/l max.	1.0
9.	Ammonical nitrogen (as N) mg/l max.	50
10.	Total Kjeldahl nitrogen (as NH_3). mg/l max.	100

11.	Free ammonia as NH_3 mg/l max.	5.0
12.	Biochemical oxygen demand (5 days at 20°C), mg/l, max.	30
13.	Chemical Oxygen demand, mg/l, max.	250
14.	Arsenic (as). mg/l, max.	0.2
15.	Mercury (as Hg), mg/l, max.	0.01
16.	Lead (as Pb) mg/l, max.	0.1
17.	Cadmium (as Cd)	2.0
18.	Hexavalent chromium (as Cr+6), mg/l, max.	0.1
19.	Total chromium (as Cr), mg/l, max.	2.0
20.	Copper (as Cu) mg/l, max.	3.0
21.	Zinc (as Zn) mg/l, max.	5.0
22.	Selenium (as Se) mg/l, max.	0.05
23.	Nickel (as Ni) mg/l, max.	3.0
24.	Cyanide (as CN) mg/l, max.	0.2

25.	Fluoride (as F) mg/l, max.	2.0
26.	Dissolved Phosphates (as P) mg/l, max.	5.0
27.	Sulphide (as S) mg/l max.	2.0
28.	Phenolic compounds (as C_6H_5OH) mg/l, max.	1.0
29.	Radioactive materials :	
	a) Alpha emitters micro curie/ml max.	10^{-7}
	b) Beta emitters micro curie/ml max.	10^{-6}
30.	Bio-assay test	90% survival of fish after 96 hours in 100% effluent
31.	Manganese (as Mn)	2 mg/l
32.	Iron (as Fe)	3 mg/l
33.	Vanadium (as V)	0.2 mg/l
34.	Nitrate Nitrogen	10 mg/l

4.01.00 Recommended systems for Treatment of different Liquid Effluents are given below:

4.01.01 **Oil Water Waste**

Oily water wastes from fuel oil handling and storage area shall be treated in suitable API oil separators. Wash water from other areas handling oil and grease will be led to above separators or will be treated in separate plate separators.

4.01.02 **Coal Handling Plant Waste**

Waste Water from coal handling plant area would be led to coal settling ponds of adequate storage located near the coal stock.

4.01.03 **DM Regeneration Waste**

Regeneration waste shall be collected and treated in neutralising pit as indicated in Section-VI.

4.01.04 **Service Water System Waste**

Service Water Waste from various building shall be treated to remove suspended solids and oil contents. For treatment of these effluents side stream treatment by using tube settler/plate separators shall be adopted. Service Waste water shall include floor wash water from Main plant, CHP, AHP.

5.00.00 TREATMENT OF BOILER CLEANING EFFLUENT

To take care of the effluent generated due to chemical cleaning of boiler and auxiliaries during pre-commissioning and post-commissioning stages, an impervious solar pond will have to be provided having adequate size and facilities to retrieve the solids and use/disposal of the same in environment friendly manner.

6.00.00 MONITORING REQUIREMENTS

Apart from the continuous monitoring requirements indicated in Clause no. 2.01.01 of this section, the Bidder has to provide the following:

a) Continuous ambient air quality monitoring system for suspended particulate matter, respirable particulate matter, SO_2, NO_x, and CO - three (3) sets. Provision shall be kept for installation of these beyond plant boundary also.

b) For manual monitoring of ambient air quality - High Volume Sampler with attachment for gaseous sampling and particulate matter sampler - four (4) sets.

c) Stack monitoring kit complete with all accessories as well as NO_x sampling assembly for manual monitoring of stack gases conforming to the requirements laid down by CPCB and/or USEPA.

d) One completely automatic micro-meteorological data collection and recording station comprising wind-vane, anemometer, thermometer, Hygrometer, sunshine recorder, evaporimeter, rainfall recorder etc. The station shall be equipped with arrangement for measurement of ground-based inversions using techno-commercially acceptable methods. Alternative means can be proposed for the method of measurement of inversions on hourly basis.

The entire station shall be of automatic recording type connected with logic controller and programmable microprocessor. Continuous recording system with provision for instantaneous display of different parameters including the wind rose shall be there.

e) On line monitoring equipment for continuous monitoring of temperature and other salient parameters like TSS, free chlorine, pH, oil and grease, DO and heavy metals of treated effluent before disposal shall be provided.

f) A full-fledged and well-equipped modern laboratory with all necessary instrument and facilities shall be provided. The Bidder shall furnish the list of Laboratory Equipment and Appliances including specification and make. The Laboratory shall be adequately equipped to test and analyse all parameters laid down in the Standards of Discharge of Liquid Effluents, Air Emissions, Ambient air quantity as well as solid wastes applicable in India. All chemicals and consumables shall be supplied by the Bidder for one year's plant operation from the date of commissioning of the plant in totality, as would be necessary for the various testing and analyses.

g) Necessary Borewells evenly spaced all around ash dyke area shall be provided for monitoring ground water quality.

7.00.00 GREEN BELT

Green Belt of around 100 M width shall be provided by planting trees of local species around the power plant boundary, around coal handling area and on the surroundings of ash dump area and emergency ash pond area. The number of trees shall not be less than 250 per Hectare. Arrangement should be kept for provision of reusing water from guard pond etc. to the green belt area and horticulture elsewhere within the plant boundary.

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CHEMICAL LABORATORY EQUIPMENT

26.03.09
(KIRAN PANDA)
WPCPL

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(XUE LI)
2009.03.28

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SECTION - XXI

CHEMICAL LABORATORY EQUIPMENTS

1.00.00 GENERAL INFORMATION

1.01.00 Chemical laboratory equipment shall be provided for the environmental aspects testing / measuring, coal analysis, flue gas analysis, oil analysis and water analysis work. The laboratory shall be fully equipped for all standard analysing equipment.

2.00.00 CODES AND STANDARDS

The design, manufacture, fabrication, installation and testing of equipment covered by this specification shall comply with latest edition of the appropriate equivalent international standards, all currently applicable statutes, regulations and safety codes in the locality where the equipment shall be installed.

3.00.00 SCOPE OF SUPPLY / SERVICES

Chemical laboratory equipment is to be supplied for shall include but not limited to Annexure-IX.

3.01.00 One lot of Chemical laboratory glassware's and miscellaneous apparatus as necessary.

3.02.00 One lot of initial stock of reagents, chemicals and supplies.

3.03.00 Installation of equipment in laboratory and demonstration of operation of equipment.

4.00.00 TECHNICAL SPECIFICATION

4.01.00 <u>Air Oven</u>

Iso-temperature, double walled, forced draught, blower at the bottom type air oven, complete with thermometer. The entire chamber is accessible when the full width door is opened. The door shall be insulated. The heater and the thermometer are on the outside of the chamber where they cannot obstruct the working space. The door shall be tightly shut against silicon rubber gasket. The oven shall be properly insulated.

Specification:

Outside body	:	Well finished Mild Steel
Inside body	:	Stainless Steel
Insulation	:	70mm glass wool insulation in between these two walls
Door	:	Front open flush type door with auto lock
Trays	:	Perforated 2 removable trays at a fixed distance, made of stainless steel inside body
Circulation	:	Constant speed ducting type circulation from the bottom, for uniform temperature
Temperature range	:	50° C to 200° C, accuracy, ± 1° C
Heating	:	Using long lasting strip heaters on the backside wall with ventilation cover, to avoid failure by liquid dripping or moisture
Temperature indicator	:	Digital readout having 0.1° C resolution
Temperature control	:	Fully automatic solid state electronic controller with PT-100 sensor
Control panel	:	At front top with all pilot lamps for every switch and contact Digital Readout Temperature indicator and setting
Moisture outlet	:	At top side with ventilation control
Working chamber	:	90H x 60W x 60L cms
Supply voltage	:	230 Volts A.C. single phase 50 Hz

4.02.00 Muffle Furnace

Specification:

Type	:	Thermolyne automatic furnace Model No: 10-555 or its equivalent
Temperature Range	:	50° C to 1100° C
		Temperature shall be controlled by solid state controller with silicon controlled rectifier
		Temperature shall be set once and it shall work automatically for ± 25° C
		Red control light cycles shall show heating or resting phase
Insulation	:	Properly insulated by insullight moulded ceramic fibre insulation
Voltage and Power	:	240V 50 / 60 Hz, 7 amp, 1680 W
Chamber	:	Inner – 14W x 92H x 17 cm Outer – 31W x 46H x 37 cm
Spares	:	Replacement heating element – 1 No. Pyrometer – 1 no. Thermocouple – 1 no.

4.03.00 Analytical Balance – Equal Arm, Chain Weight Type

Two pan equal arm analytical balance with rider chain weight device shall be provided.

The combination of the chain weight and notched beam mechanizes the transfer of all fractional weights. The capacity of the balance shall be 200 gms and its sensitivity shall be 0.05 milligrams. The aluminum alloy beam shall be 6 inches long and shall be notched and numbered from 0 to 1 gram. All bright metal parts shall be rhodium plated. The knife-edges and planes shall be hard Brazilian agate. One end of the chain shall be connected to balance and the other end to a sliding vernier.

The balance shall be housed properly in glass case with sliding door, etc. Each balance shall be supplied with weight loss, as mentioned below:

Construction	:	Shall be made of Plastic / Wood
Nos. of Weights	:	One 10 mg, two 20 mg, one 50 mg, one 100 mg, two 200 mg and one 500 mg fractional, one 1 gram, two 2 gram, one 5 gram, one 10 gram, Two 20 gram weights
Material of weights	:	Shall be made of Brass/Bronze and rhodium plated

4.04.00 Balance Harvard Trip

Balance shall have double beam with stainless steel plates, complete with weight box. The beam is made of stainless steel. The knife-edges are made of hardened steel and the self-aligning bearings are agate. The bearings are in full contact over the entire knife-edge at all times. Each bearing has a dust-proof, self-locking cover.

The upper beam is graduated from 0 to 10 gms in 0.1 gm division. The lower beam is graduated from 0 to 200 gms in 10 gms division. The capacity of the balance is 2000 gms and the sensitivity is 0.1 gm.

4.05.00 Balance – Barranger

The balance shall be barranger type with 2 nos., 8 inch diameter stainless steel pans. It shall be complete with a set of weights in a box.

Technical Data

Capacity	:	5 Kgs
Sensitivity	:	0.2 gm

4.06.00 Bomb Calorimeter (Isothermal)

Bomb Calorimeter shall be suitable for determination of calorific value of liquid hydrocarbons, as per IS Specification. The said calorimeter should be complete with the following items:

a) Double valve, self-sealing oxygen bomb made of stainless steel. Capacity approx 300 cc. Works Test Certificate is necessary for this item.

b) Double walled insulated jacket.

c) Chrome plated brass bucket suitable to hold oxygen bomb plus 2000 gms water.

d) Ignition unit suitable for 220V, 50 Hz.

e) Stainless steel fuel capsules – 6 Nos.

f) Oxygen filling connection, complete with valves and pressure gauge

g) Support stand for bomb lid

h) Sealing "O" rings – each type 3 Nos.

i) Thermometers:

i) Low range for jacket temperature range – 0° C to 110° C.

ii) Beckman differential thermometer, zero at the bottom, reads upward. Range covers 5° C in 0.01 divisions. Auxiliary scale shall be in 2° C divisions with dropping chamber below. Milk While differential scale sealed in thermometer Nickel-plated cap, with ring. Total length shall be suitable for the calorimeter. Requirement – 2 Nos.

NPL Certificate shall accompany with each Beckman thermometer.

j) Suitable eyepiece for thermometer reading.

k) Suitable stirring arrangement complete with motor 220V 50 Hz

l) Suitable calorimeter cover

m) Ignition wire and cotton reel

n) Gelatine capsules – 100 nos.

o) Pellet press

p) Benzoic acid table – 10 nos.

q) Other items required for operation, such as spanner, hook for lifting the bomb, etc.

4.07.00 Conductivity Meters

Digital type equipment shall be having:

a)	Range	:	2 micro mhos/cm full scale to 2000 micromho/cm full scale in different range
b)	Accuracy	:	± 0.5% of full scale
c)	Least Count	:	0.1 micro mho/cm
d)	Conductivity Cell	:	Immersion type, having cell constant 0.1 or very near 0.1
e)	Power	:	240V, 50 Hz

Equipment shall be complete with cell constant compensation, manual temperature compensation, stand and holder for conductivity cell.

One spare conductivity cell as per (d) above, for each meter shall be provided

4.08.00 Cloud & Pour Point Apparatus

The apparatus shall be used for determining cloud and pour points of petroleum oil as per ASTM 097. The apparatus shall consist of test jar, thermometer (-38° C to 50° C) cork, jacket, disc, gasket, bath along with all other accessories. The temperature shall be controlled by solid-state temperature indicator-cum-controller. Hermetically sealed air-cooled refrigeration system shall be provided for cooling purpose.

4.09.00 Dean & Strarker Distilling Trap

Dean & Strarker Distilling Trap – This trap shall be used to determine water in a sample of petroleum product of bituminous material by distilling the sample with a volatile solvent. The graduated portion of the trap shall be calibrated from 0-2 ml. In 0.1 ml and from 2 to 10 ml in 0.2 ml division.

4.10.00 Disc Comparator

Lovibond or Hellige disc comparator for determination of silica, phosphate hydrazine, chlorine and pH. Each disc should be provided with 9 or 10 non-fading colour standard in 0.2 steps. The comparator and the discs shall be of the same brand and as per the following details:

Comparator	:	12 Nos. Required
Disc	:	2 Nos. for each range, as described below
- pH range	:	2.8 to 4.4 Bromophenol Blue

4.4 to 6.4 Methyl Red
6.0 to 7.6 Bromomethyl Blue
7.2 to 8.8 Cresol Red
8.0 to 9.6 Thymal Blue
4.0 to 11.0 Universal Indicators

- Chlorine in water	:	0.0 to 1.0 ppm
- Chlorine in water	:	0.0 to 5.0 ppm
- Phosphate	:	0.0 to 8.0 ppm
- Phosphate	:	0.0 to 80.0 ppm
- Hydrazine	:	0.0 to 0.1 ppm
- Silica	:	0.0 to 2.2 ppm
- Silica	:	0.0 to 10.0 ppm
- Copper	:	0.0 to 0.05 ppm
- Iron	:	0.0 to 3.0 ppm

4.11.00 Digital pH Meter

Mains operated, direct reading instrument for rapid and accurate pH with the following particulars:

a) pH range 0.00 to 14.00

b) Accuracy pH $\pm$ 0.01

c) Temperature control 0°C to 100°C manual

d) 3 digit LCD display with automatic polarity and decimal point indication

e) Combined electrode (0-12 pH), electrode stand and holder, pH buffer solution of 4, 7 and 9 pH, Potassium Chloride solution.

f) Power 240V, 50 Hz.

4.12.00 Dissolved Oxygen Test Kit

Suitable to determine dissolved oxygen in condensate and feed water by indigo carmine method. The apparatus shall be complete with stoppered Nessler tubes

(3 Nos.), glass beads, sampling container, Nessler tube comparator, standard colour disc or Nessler tube colour standard, having values of 0, 5, 10, 15, 25, 50 ppb oxygen, rubber tubing (black neoprene 3/16 inch ID x 1/16 inch wall) carrying case, etc., and its literature.

4.13.00 Dry - Wet Thermometer

One dry bulb and one wet bulb thermometer with glass reservoir shall be mounted on a wooden board. The reading scale range shall be 0°C – 100°C.

4.14.00 Electric Bunsen

The apparatus shall consist of one fire clay crucible of holding one 30 cc porcelain crucible, which shall be heated by a 500 watt heating element on 230 volts AC line controlled by an energy regulator. The maximum temperature attainable shall be 900°C. (min.)

4.15.00 Electric Stirrer

Capable of stirring 5 – 7 litres of low viscosity liquid electric stirrer shall comprise of motor, stirring shaft, coupling and speed controller with following specification:

a) Stirrer shaft : 6 mm diameter, 250 mm long with single 3.5 mm sweep, 3 bladed propeller both made of AISI 316 Stainless Steel

b) Speed control : Continuously variable electronic controller directly mounted on stand speed range 2-200 rpm approximately

c) Motor : Continuous duty, fan cooled drip proof universal winding

d) Main supply : 240V, 50 Hz

4.16.00 Electronic Analytical Balance:

Readability	mg	0.01
Weighing Range	gm	0-205
Tarring range (by subtraction)	gm	0 – 205
Reproducibility (Standard deviation)	mg	0.1

	Linearity	mg	± 0.3
	Linearity relative to 10 g	mg	± 0.1
	Stabilization time (typical)	ς	5
	Integration time (adjustable)	ς	1.5/3/6
	Stability detector (Sensitivity adjustable in 3 steps)		1/2/off
	Sensitivity drift (10-30° C)		± 2 x 10^{-6}
	Calibration weight (built-in)	gm	100

4.17.01 Electronic Analytical Balance – Semi Micro, Top Loading Type (Mettler PM 100 or Equivalent)

	Readability	gm	0.001
	Weighing range	gm	0-110
	Reproducibility (ς)	gm	0.0005
	Linearity	gm	± 0.002
	Sensitivity drift (10-30° C.)	° C	± 4 x 10^{-6}
	Result deviation with balance Inclined by 1:1000	gm	± 0.005
	Stabilization time (typical)	ς	Approx. 2
	Accessories:		
	Calibration weights (Accuracy class OIML F1)	gm	100

4.17.02 Electronic Analytical Balance – Semi Micro, Top Loading Type

	Readability	mg	0.1
	Weighing Range	gm	0 – 55
	Reproducibility (Standard Deviation)	mg	0.1

Linearity	mg	± 0.2
Linearity relative to 10 gm	mg	± 0.1
Stabilization time (typical)		5
Integration time (adjustable)	ç	1.5 / 3 / 6
Stability detector (Sensitivity adjustable in 3 steps)		1 / 2 / off
Sensitivity drift (10 – 30°C)	° C	$\pm 2 \times 10^{-6}$
Calibration weight (built-in)	gm	50
Power Supply		220 V, 50 Hz

4.18.00 Flash Point Apparatus

Pensky Martens apparatus conforming to IP / 34 / 67 and IS 1448 (Part-I), IS 1209 Method A & B for the determination of (closed up) flash point of fuel oils having flash point above 49° C. The apparatus should be an electrically heated model, complete with a brass cup, lid with spring operated shutter, oil test jet, temperature controller, a clip to convert the apparatus into (open) test model, as per IP 35 / 42 and IS 1209 Method C, and thermometers, as mentioned below:

IP 15C Low range thermometer (–7°C to 110°C) – 2 Nos.

IP High range thermometer (–90°C to 370°C) – 2 Nos.

4.19.00 Fortins Barometer

The barometer shall have full-scale reading range of 675 – 820 mm with graduations of 1 mm and vernier reading of 0.5 mm. It shall be complete with attached thermometer, having °C scale on polished board, with reflector. The bore of the barometer tube shall be 7 mm minimum.

4.20.00 Hardgrove Grindability Apparatus

The equipment shall consist of ring ball type pulveriser, suitable for determination of Grind ability Index of coal, as per ASTM D 409 and IS: 4433. The equipment shall be complete with standard weights, automatic revolution counter which shuts off the machine after 60 revolutions, drive motor, receptacles, etc.

Following items shall be supplied with the equipment:

a) 1 Kg. Coal sample of standard HGI (passing through 16 mesh ASTM and retained on 30 mesh).
b) Sieve, 20.3 cm (8") dia and 5.1 cm (2") height

ASTM – 16	:	1 No.
ASTM – 30	:	1 No.
ASTM – 200	:	1 No.
Receiver & Cover	:	1 set suitable for sieve shaker

4.21.00 Heating Mantles

To be used for fractional digestion, distillation and extraction, particularly suitable for boiling volatile liquids, which cannot be heated with, exposed glowing wires. The mantles are knitted with layers of glass fabric, with nickel/chrome heating element, with adjustable energy regulator. Five (5) different capacity flasks (500, 300, 1000, 2000 & 3000 ml) operated on 240 V, single phase 60 Hz, wattage 0.4-0.7 kW, shall be provided).

4.22.00 Hot Plates

The hot plates shall be made of stainless steel and of size 18 inches x 24 inches and capacity of 3 to 4 kW. It shall have rotary switch with settings for high, medium and low heat.

4.23.00 Humidity Cabinet

Specification:

Working chamber	:	70H x 50W x 50D cms
Temperature Range	:	10° C to 110° C
Accuracy	:	± 0.5° C
Inside chamber	:	Made of Stainless Steel
Total load	:	8 Amps
Phase	:	Single
Tray	:	Stainless Steel perforated two removable trays at a fixed place, with 3 separate doors for 3 compartments.

Insulation	:	70 mm glass wool insulation in between these two walls from all sides
Door	:	Front open single door flush type with viewing glass window at the center, with low voltage heater in between double glass, which shall eliminate mist on the glass, to have a clear vision of the chamber for inspection. Door shall be fitted with lock and key system and leak-proof gasket.
Circulation	:	Ducting type air circulation shall be provided using constant speed A.C. Motor at top for uniform gradient temperature and humidity accuracy.
Heating	:	Chamber heating shall be done by long lasting strip heaters to eliminate the failure of heater by moisture drip and boiler heating is by immersion heater connected to low liquid level heater cut off circuit with indication lamp on the front panel.
Cooling	:	Using hermetically sealed compressor coupled with evaporation coil and fan cooled condenser using Freon-12 as refrigerant in a removable tray at the bottom for easy servicing.
Indicator	:	Digital display having 0.1° C resolution for both dry and wet bulb.
Controller	:	Fully automatic solid-state electronic controller with Pt-100 as sensor for both dry and wet bulb control.
Humidity	:	By steam injection near the duct from a boiler connected to water tank fitted with float level control at the top compartment. Boiler is with low liquid level heater cut off circuit, with a pilot lamp indication in the front panel. Humidity set on derived by dry and wet bulb principles by the provided depression chart.

Other Features	:	Control panel at the front top with pilot lamps for all switches and controls. Voltmeter and ampere for indication of main voltage and total load of unit. Cable wheels for easy mobility.
Supply Voltage	:	230 Volts AC Single phase 50 Hz.

4.24.00 Karl Fischer Apparatus

The equipment shall be suitable for measurement of very minute traces of moisture in transformer oil.

The instrument shall work on volumetric principle. The instrument shall be equipped with a generator, which shall generate the KF reagent in the titration cell, to react with the moisture present in the sample.

The instrument shall display moisture in a sample in milligrams, which can be calculated in percentage / ppm.

Range	:	0.00 mg to 9.99 mg
Accuracy	:	0.01 mg

The apparatus shall be supplied complete with main unit, amber coloured titration vessel, dual platinum sensing electrode, generator, magnetic stirrer rotor, suitable syringes, six vessel charges, six generator solution samples, ampoules, six neutralizing solution vials, jar of sealant and manual of instruction.

4.25.00 Laboratory Centrifuge & Accessories

Laboratory centrifuge, having step less electronic speed regulator, continuous indicating speed meter safety, fuse, automatic timer and with following features:

Bowl & cover	:	Stainless Steel
Maximum speed	:	5000 rpm
Maximum tube RCF	:	3250 g
Maximum tube size	:	100 ml
Interior & exterior	:	
Surface	:	Anti-corrosive painting

Voltage : 240V, 50 Hz

Essential accessories:

a) 6 x 50 ml swing out head complete with metal tubes and 50 ml graduated tubes corning tubes.

b) 16 x 15 ml swing out head complete with metal tubes and 15 ml graduated tubes corning glass.

Additional accessories:

a) 50 ml corning glass tubes : 20 numbers

b) 15 ml corning glass tubes : 45 numbers

4.26.00 Laboratory Flocculator

The laboratory flocculator shall be provided for coagulation, flocculation and other tests, where simultaneous stirring of six (6) samples are required. It shall have a shelf containing six (6) openings, each large enough to hold a one (1) liter beaker. The shelf shall be high enough to enable a burner to be placed beneath it. It shall also have a chemical adder which holds two (2) nos. 10 ml. Test tubes over each beaker for simultaneous addition of two (2) separate chemicals. The chemicals are added by tilting a handle attached to the bar. A motor with worm gear speed reduction and suitable speed control device shall drive the agitators associated with flocculator. The agitator rod & paddles shall be of stainless steel. The unit shall not be less than 36 inches long and 6 inches wide and 18 inches high.

4.27.00 Laboratory Disc Mill

Disc pulverizer type, complete with motor, starter, V-belt. Equipment shall be as per the following specifications:

Feed : Coal, HGI 45 to 60

Feed Size : 0.5 inch maximum

Grinding rate : 1 kg / hr

Output Size : 99% passing through BS 72 mesh

Material of disc : Manganese - Steel

Suitable hopper for feeding and receiver to collect 1 Kg. Fine sample should be provided.

4.28.00 Magnetic Stirrer with Hot Plate

Hot plate with built-in variable speed magnetic stirrer. Separate controls for independent heating/stirring or simultaneous operations. Top plate shall be stainless steel. Arrangements shall be provided to protect motor and controls from heat. The stirring speed and heating energy shall be controlled by step less speed controller and energy regulator.

Maximum Speed	:	1200 rpm
Stirring Capacity (Water)	:	5 litres
Heating Capacity	:	500 Watts
Width	:	180 mm
Depth	:	180 mm
Height	:	165 mm
Mains	:	220 Volts, 50Hz
Accessories for each instruments	:	Teflon coated magnetized stirring paddle – 4 Nos. (9mm dia x 35 mm length)

4.29.00 Microscope – Binocular

The microscope shall be provided with slip catch, to prevent microscope and slide damage. Detailed specification is as follows:

1. Eyepiece: Locked in 10x wide-field eyepiece with built-in pointer
2. Heads: 360o rotatable, 45o inclined, with 160 mm tube length. Binocular head is adjustable for interpupillary distance and dioptric difference.
3. Objectives: 4 x (0.10NA), 10x(0.25NA), 40 x (0.65NA, re-traceable) achromatic, par focal, color-coded anti-reflection objectives are standard 100 x (1.25 NA retraceable) oil immersion objectives is also standard.
4. Nosepiece: quadruple nosepiece standard.

5. Condenser: Fixed helicord motioned 1.25 NA Abbe condenser is suitable for oil immersion work. Condenser contains continuously variable iris diaphragm and filter holder. Blue filter and frosted white filter are to be provided.

6. Slip Clutch: Coarse-focus-adjustment slip clutch engages at full travel end points to prevent focusing gear damage and destruction of specimen slides.

7. Focus Controls: Separate, dual-knob coarse and fine-focus controls. Tension control ring allows adjustment of rack and pinion movement. In addition to slip clutch feature and adjustable safety stop limits upward travel to stage to help further minimize possible breakage of specimen slides.

8. Illumination 30W tungsten sub stage illuminator with integral on/off switch. Mains – 220V 50 Hz.

8. Finish: Reagent resistant suitable enamel.

9. Instrument shall be provided with eyepiece dust cap, vinyl dust cover, spare lamp and a bottle of immersion oil.

4.30.00 Orsat Gas Analyzer

For determination of CO_2, O_2 and approximate estimation of CO in flue gases shall be complete with the following:

i) Handy portable model with metallic case.

ii) SS manifold with SS needle valve connected with the absorption pipette with transparent PVC pipe.

iii) 50 ml capacity gas burette enclosed in water jacket. Lower part graduated to read directly in percentage from 0-20% with graduation of 0.5%.

iv) The entire apparatus shall be complete with leveling bottle absorption pipettes, etc., are to be enclosed in a polished metallic case opening at both faces.

4.31.00 Photoelectric Calorimeter

Double beam model, suitable to accommodate 1 cm and 4 cm/5 cm optical path length cuvettes for analysis of drak and pale solution, complete with tungsten lamp, cuvettes, filters, frictionless taut band meter, etc., as mentioned below:

a) Filters:

Colour	Peak Transmission	For Sample Absorbance	Number Required
Red	650 mm	625 – 675 nm	1
Green	525 mm	500 – 550 nm	1
Blue	425 mm	400 – 475 nm	1
Yellow	585 mm	575 – 595 mm	1
Blue – Green	470 mm	460 – 480 nm	1

b) Cuvettes for each instruments Nos. required

1 cm optical path 4
4 cm/5 cm optical path 4

c) Operating characteristics of the instrument should be based on the following principle:

Light from tungsten source lamp is projected through filter to isolate wavelength that shall be absorbed by sample. Filtered beam is split. One beam passes through sample to photocell. Other passes through reference solution to another photocell. Null balance potentiometer measures difference in output of cells. The meter should be so sensitive that difference of 1% I produces a deflection of 1 mm on the null meter.

d) The dial should read directly absorbance and % transmittance reading should be reproducible to ± 0.5% T.

Spare for each instrument:

i) Tungsten lamp – 1 No.

e) Power 240V, 50 Hz.

4.32.00 Platinum Ware

1. Platinum dish with crucible type lid – 3 Nos.

a) Capacity : 100 ml

Depth : 29 mm

Inside Diameter	:	75 mm
b) Approximate weight	:	
Dish with rim reinforced	:	41.5 g
Crucible type lid	:	21.5 g

2. Platinum crucible with lid: 3 nos.

a) Capacity	:	30 ml
Depth	:	41 mm
Inside Diameter	:	37.5 mm
b) Approximate weight	:	
Crucible with rim reinforced	:	27 gm
Lid	:	5.6 gm

All items shall be manufactured out of platinum 99.95% min.

Unit price of Platinum shall be quoted.

4.33.00 Refrigerator

Capacity – 165 liters, complete with thermostat, magnetic sealed door with locking arrangements, adjustable shelves, etc.,

4.34.00 Sieve Shaker & Sieves

a) Sieve Shaker : One (1) no. RO-Tap model, complete with time switch, motor, etc.

i) Suitable to accommodate six number sieves (20.3 cms 8") dia 5.1 cm (2" height), US/BS/IS standard and one receiver of same dimension.

ii) Number of revolution : 250 rpm (minimum)

iii) Number of tapings : 150 per minute (approx.)

iv) Mains : 240 V, 50 Hz

v) Time switch : 0 – 60 min.

b) Sieves : Diameter 20.3 cm (8"), height 5.1 cm (2") seamless brass frame, ASTM Standard. Each sieve should be marked with the size of opening and mesh no.

Sieve opening (mm)	Wire Cloth	Quantity
4.00	Stainless Steel	2
2.36	Stainless Steel	2
1.18	Stainless Steel	2
0.600	Stainless Steel	2
0.300	Stainless Steel	2
0.212	Stainless Steel	2
0.150	Stainless Steel	2
0.075	Stainless Steel	2
0.045	Stainless Steel	2

Receiver and cover : Stainless Steel, suitable to fit in RO-Tap sieve shaker and above mentioned sieves

Receiver : 2 nos.

Cover : 2 nos.

4.35.00 Silica Crucibles

a) Translucent glazed silica crucibles, complete with lid, for the determination of V.M. of coal, as per IS Specification – 12 nos.

b) Translucent glazed silica Moisture Dish of circular type, having dia 48 mm and height 15 mm, as per IS Specification – 12 nos.

c) Translucent glazed silica Ash Dish of circular type, having dia 48 mm and height 15 mm, as per IS Specification – 12 nos.

4.36.00 Spectrophotometer

Single beam, digital read out, built-in fan to keep the instrument cool, complete with suitable sample holder to accommodate cuvettes/cylindrical cells of different optical path.

Detailed specifications are given as follows:

1. Principle : Single beam

2. Wave length range : 200 to 1000 nm

3. Spectral slit width : 10 mm

4. Readout : Digital

5. Photometric presentation : 0 – 100.0% Transmittance
   0 – 2.000 Absorbance
   0 – 2000 Concentration as absorbance multiplied by a continuously adjustable expansion

   Over and under range indicator.

   A four-position, push-button decimal selector which, in the concentration mode, provides a display of concentration values with correct decimal placement wave length accuracy ± 2 mm.

6. Photometric linearity : ± 0.2 T
   ± 0.002 A
   @ 0.4 A

7. Photometric accuracy : ± 0.3% T
   ± 0.003 A
   @ 0.4 A

8. Stray light : <0.3% T
   @ 220 mm

9. Grating : 1200 lines per mm

10. Source lamp : Tungsten
    Deuterium

11. Detector type : Wide range

12. Line voltage : 240 V, 50 Hz

13. The instrument shall be provided with arrangements, to carry out analysis with universal test tube (10 mm light path), rectangle cuvette (10 mm light path) cylindrical cell 50 mm and 100 mm light path.

14. Universal Test Tube

1 cm optical path length : 12 Nos.

15. Spares :

Tungsten lamp : 1 No.
Deuterium lamp : 1 No.
Thermo regulated cuvette
Holder fuse

16. Accessories for each spectrophotometer:

a) Semi-micro uv cell, (rectangular, 10 mm light path) – 2 Nos.
b) Optical glass, cell (rectangular, 10 mm light path) – 6 Nos.
c) Cylindrical glass cell (20 mm light path) – 2 Nos.
d) Cylindrical glass cell (50 mm light path) – 2 Nos.
e) Cylindrical glass cell (100 mm light path) – 2 Nos.

4.37.00 Steel Cabinet

Height – 78", Width – 36", Depth – 20" to afford storage space for apparatus, accessories, platinum wares and deadly poisonous chemicals. There shall be three adjustable shelves. Shelves are adjustable in ½" steps. The steel cabinet shall also include a shelve with locker facility. Thickness of steel shall be 18 gauge.

4.38.00 Stop Watch

The stopwatch shall have jewel movement and be non-magnetic. The watch should have a large split-second hand making one revolution in 60 seconds, with a dial having 1/5 seconds graduations. The other hand shall record on a small dial with full scale of 30 minutes, having 1-minute graduation. The case shall be of black metal and the movement shall have 7 jewels with incablock shock protection.

4.39.00 Vacuum Pump

Suitable for vacuum drying, freeze-drying, backing diffusion, vacuum distillation, etc. The pump shall be provided with vented exhaust through a valve, which admits atmospheric air to the pump in its exhaust cycle. The pump shall be complete with steel base, motor, pulley, V-belt, starter, pump oil, belt guard, moisture trap, vacuum gauge, NVR regulator, etc.

Capacity, free air displacement
Displacement : 200 liters/min.

Guaranteed vacuum : 0.1 micron (0.0001 mm Hg) with vent closed

4.40.00 Viscometer : Red Wood No : 1 & Red Wood No : 2

a) Viscometer, Red Wood No : 1

For determination of viscosity (not exceeding 2000 seconds) of oil as per IS:1449 and IP 70. This shall have the following essential features:

i) Oil cup : Heavily silver plated brass oil cup with precision stainless steel jet having standard hole at the bottom.

ii) Bath : Bath filled with stirring arrangement, thermometer mounting drain cock, heater, etc. Bath, stirrer, thermometer and clip, etc., should be chrome plated.

iii) Ball Valve : Silver plated

iv) Cup Cover: Should fit properly

v) Spirit Level: Should be provided

vi) Stand : Suitable iron stand for mounting the bath, stand should be properly painted

vii) Temperature Controller : Sunvic energy regulator U.K.

viii) Case : Teak wood case

b) Viscometer Red Wood No : 2

For determining viscosity (exceeding 2000 secs.) of oil as per IS: 1449 and IO 70.

Essential features similar to viscometer for Red Wood No : 1 above.

Essential accessories for both types of viscometers (for Red Wood No : 1 and Red Wood No : 2) are as follows :

i) IP 8C Thermometer : 2 Nos.
ii) IP 9C Thermometers : 2 Nos.
iii) IP 10C Thermometers : 2 Nos.

iv) Flask receiver 50 ml capacity : 4 Nos.
v) Viscosity Chart : from Red Wood second to other units

4.41.00 Water Bath

Electrically heated concentric ring water bath suitable for evaporating liquids, solvents, etc. Concentric rings can be removed (in sequence from inner cover to out most ring) to accommodate containers of all sizes. Rings shall be flanged-formed stainless steel. Fit flush with top plane of bath and with other rings. Center ring cover shall be 25 mm dia. Rings progress out from cover in 25 mm increments. Water bath shall be stainless steel construction, complete with constant water level device (with 6 mm inlet for water supply), adjustable drain tube, arrangement for thermometer insertion and support frame for the said bath.

Capacity	:	7.5 liters
Time to 100° C	:	45 mins.
Number of Hole	:	4
Hole dia	:	4 x 13.5 cms.
Number of rings/hole	:	5
Heating Arrangements	:	Suitable immersion heater controlled 3-position heater switch
Mains	:	220 V, 50 Hz

4.42.00 Water Still

The water still shall be of stokes type operating on efficient counter current principle where feed water is pre-heated by condensing distillate. The dissolved gases shall be released before it enters the boiling chamber made of stainless steel. The apparatus shall be equipped with rugged immersion type heaters, which shall be easily replaceable.

Technical Data:

Capacity	:	2 gallons/hour
Wattage	:	6000 W
Voltage	:	240 V AC

4.43.00 Turbidity Meter (Photo Nephelometer)

For determining turbidities in 0.025 to 15 ml. samples, including electronic photometer, multiplier tube and amplifier transformer, range switch, search unit, mercury vapour lamp, quartz, filter holder, stabilizing transformers and all other accessories, as required. The instrument shall be indicating type with direct acting graduated multiple scale, with manual selector 0-30 NTU sensitivity 0.05 NTU shall be provided.

4.44.00 High Volume Sampler

High volume sampler shall be housed in a sturdy aluminum cabinet and consists of a blower, filter holder assembly, voltage stabilizer, time totaliser timer, flow controller, flow measurement device, needle valves, flow meter and set of 4 impingers.

Filter holder assembly	:	SS-304 with rubber gaskets
Filter paper size	:	Overall 25 x 20 cms, effective 23 x 18 cms
Heavy duty blower	:	1.5 Cu.m/min (without resistance)
Blower duty cycle	:	Continuous
Voltage Stabilizer	:	Input 170-270 VAC standard 140-270 VAC optional. Output 230 ± 10 VAC
Auto shut-off timer	:	0-24 hours
Time totaliser	:	0-0000 minutes
Flow controller	:	Solid state continuously variable
Flow measurement	:	Glass U-tube manometer
Particulate sampling	:	From 100 micron down to 0.01 micron, depending on type of filter used
Gaseous sampling	:	
Impinger tubes	:	4 Nos., 35 ml capacity
Needle valves	:	4 Nos., SS for fine control
Rotameter	:	Acrylic 3 lpm capacity
Toggle valve	:	For snap action shut-off of suction port

Dimensions :

Control module: Size 70 (H) x 36 (W) x 29 (D) cms (excluding gable roof)

Stand : Size 80 (H) x 36 (W) x 29 (D) cms on castors

4.45.00 Stack Monitoring Kits

Control module shall consist of the following:

i) Digital temperature display: 3 digit LCD readout for stack gas and dry gas temperature with a range of 0-600° C and a resolution of 1° C (battery operated).

ii) Digital stopwatch: LCD stopwatch for 120 min. with one-second resolution (battery operated).

ii) Inclined manometer: Fabricated from acrylic block for a range of 0-2" of water with a resolution of 0.01" . Spirit level for leveling and spill proof arrangement for water or oil.

iii) Vacuum Gauge: 0-30" of Hg

v) Flow totaliser (Dry Gas Meter): Capacity to measure total flow with resolution of 1 liter. Facilities for measurement of dry gas temperature and pressure.

iv) (L.H.) Rotameter : 100 lpm with coarse control valve for particulate sampling.

v) (R.H.) Rotameter : 3 lpm with fine control valve for gaseous sampling.

Sampling Accessories

1. SS braided Teflon hoses with SS end fittings in standard lengths of 2 metres (other sizes optional).

2. S-type pitot tube standard length 1 meter (other sizes optional).

3. SS thimble holder with unique tapered design for leak-proof collection. Choice of cellulose, glass fiber and alundum thimble holders. Thimble pipe standard length 1 meter (other sizes optional). Set of 3 nozzles : size ¼", 3/8" and ½" bore.

4. SS thermocouple with standard length of 1 meter (other sizes optional).

Tip of S-type Pitot Tube

S-type pitot tube shall be individually calibrated from SS-304, as per EPA regulations.

4.46.00 Impinger Tube Box

Set of 4 glass impinger tubes with 100 ml. Capacity and 2 glass impinger tubes with 300 ml. Capacity in double walled container and thermacole insulation. Ball and cup joints for leak-proof sample connection.

4.47.00 B.O.D. Cabinet

Suitable to store B.O.D. bottles for B.O.D. determination of industrial waste, sewage, as per A.P.H.A.

1. Working cabin capacity : 170 to 180 liters
2. Temperature : 5°C to 50°C
3. Temperature accuracy : ± 0.5° C
4. Temperature controller : Automatic solid state electronic temperature controller
5. Air Circulator : Forced air circulation fan
6. Shelves : Adjustable shelves. Each shelf shall be perforated and removable
7. Inner door : Glass
8. Outer door : With magnetic seal
9. Water collector : External condensed water collector
10. Material of construction of wall and shelves : Aluminum
11. Shall be provided with : Illuminator
12. Safety switch : Safety switch should cut-off the heater in the event of failure of automatic heat control device

4.48.00 Jaw Crusher

Jaw Crusher shall be of single togel type complete with motor, starter, v-belt, fly wheel adjustment plate and other standard accessories.

Specification

Feed	:	Coal
Jaw Crusher size	:	125 mm x 225 mm
Output rate	:	1500 kg/h
Output size	:	3 mm
Power	:	240V, 50 Hz
Material of Jaw	:	Manganese steel

Suitable hopper for feeding material shall be provided.

Civil assignment drawing indicating load, location and size of holding down bolts, shall be furnished.

4.49.00 Glassware & Accessories

Glassware, including sampling bottles, burettes, pipettes, flask, beakers, etc.

1. Burettes – Straight bore stopcock (Class A of IS: 1997)

Capacity (ml)	Graduation interval	Tolerance ± ml	Approximate Total Height (mm)	Quantity (Nos.)
100	0.2	0.10	830	6
50	0.1	0.05	780	12
25	0.1	0.05	530	12
10	0.05	0.02	530	12
5	0.02	0.01	590	12

2. Burettes, Automatic Zero adjustment, mounted on reservoir (Reservoir Capacity 2000 ml)

Capacity (ml)	Graduation interval	Tolerance ± ml	Quantity (Nos.)
100	0.2	0.2	6
50	0.1	0.1	6
25	0.1	0.1	6
10	0.05	0.05	6

3. Pipettes, Transfer volumetric, Accuracy as per Class A of IS: 1117

Capacity (ml)	Tolerance ± ml	Quantity (Nos.)
100	0.08	6
50	0.05	12
25	0.03	12
20	0.03	12
10	0.02	12
5	0.015	12
2	0.010	12
1	0.007	12

4. Pipettes (Mohr type). Accuracy as per Class A of IS: 4162

Capacity (ml)	Graduation interval	Tolerance ± ml	Quantity (Nos.)
10	0.1	0.05	12
5	0.1	0.05	12
5	0.02	0.01	12
2	0.1	0.01	12
1	0.1	0.006	12
1	0.01	0.006	6

5. Volumetric flasks with stopper, Accuracy as per Class A of IS: 915

Capacity (ml)	Tolerance ± ml	Interchangeable Stopper size	Quantity (Nos.)
50	0.06	10/15	12
25	0.04	10/15	12

6. Graduated cylinders single Metric scale

Capacity (ml)	Graduation interval	Tolerance ± ml	Quantity (Nos.)
2000	20	10	2
1000	10	5	6
500	5	2.50	4
250	2.5	1.00	4
100	1.0	0.50	4
50	1.0	0.50	12
25	0.5	0.25	24
10	0.2	0.10	24

7. Flasks, Erlenmeyer, Conical Narrow mouth

Capacity (ml)	Approximate O.D. x Height mm x mm	Approximate Neck O.D. mm	Quantity (Nos.)
1000	131 x 220	42	6
250	85 x 140	34	24
150	72 x 124	24	24
100	64 x 105	25	24

8. Beakers, Griffin Low Form with spout

Capacity (ml)	Approximate O.D. x Height mm x mm	Quantity (Nos.)
2000	131 x 190	6
1000	105 x 148	12
600	90 x 120	12
400	77 x 105	24

9. Flasks Boiling Round Bottom, Short Neck

Capacity (ml)	Approximate O.D. x Height mm x mm	Approximate Neck O.D. mm	Quantity (Nos.)
1000	188	24/29	6
500	160	24/29	4
250	140	24/29	4

10. Flask, distilling with side arm

Capacity (ml)	Approximate O.D. x Height mm x mm	Approximate Neck O.D. mm	Quantity (Nos.)
1000	130 x 305	31	6
500	110 x 250	28	6
250	88 x 226	25	12

11 (a) Funnels, Plain 60° Long Stem

Diameter (mm)	Quantity (Nos.)
50	12
75	12
100	12

11 (b) Funnels, Separating, with Stopcock and Interchangeable Stopper

Capacity (ml)	Stopper Size	Quantity	
		Globe Shape (Nos.)	Conical Shape (Nos.)
1000	29/25	3	3
500	24/25	3	3
250	19/20	3	3

12. Bottles, Reagent, Plain Narrow Mouth with interchangeable flat head stopper

Capacity (ml)	Approximate O.D. x Height both only (mm)	Size of Inter-changeable Stopper	Quantity (Nos.)
2000	129 x 265	34/35	12
1000	104 x 200	29/32	48
500	80 x 172	24/29	96
250	64 x 147	19/26	48
125	54 x 120	19/26	48

13. Bottles, Reagent Amber, Narrow Mouth with interchangeable Flat Head Stopper:

Capacity (ml)	Total Height (mm)	Quantity (Nos.)
1000	200	12
500	172	12
250	147	12

14. a) Dropping Bottles

Dropping bottles with 0.5 ml dropper :

Capacity (ml)	Quantity (Nos.)
100	12

Dropping bottles, Clear Glass, T.K. pattern with slotted ground glass stopper:

Capacity (ml)	Quantity (Nos.)
100	12

Dropping bottles, Amber Glass, T.K. pattern with slotted ground glass stopper:

Capacity (ml)	Quantity (Nos.)
100	12

b) Bottle, Winchester:

Capacity (lit.)	Quantity (Nos.)
2.5	12

15. a) Glass Wool – (E Merck) : 500 gm

b) Glass Bead - : 500 gm

16. Bottles, Aspirator, with tubulature at bottom and connection designed with flexible tubing

Capacity (lit.)	Quantity (Nos.)
5	2
10	2

17. Bottles, wash, complete with interchangeable stopper

Capacity (ml.)	Quantity (Nos.)
1000	6

18. Bottles, weighing, with interchangeable stopper

Diameter (mm)	Body Height (mm)	Quantity (Nos.)
20	40	12
30	60	12
40	80	12
50	25	12

19. Bottles, Gas Washing complete, with interchangeable stopper

Capacity (mm)	Size of Interchange-able Stopper	Quantity (Nos.)
500	29/32	6
250	29/32	6
125	29/32	6

20. Watch glasses

Diameter (cm.)	Quantity (Nos.)
2.5	12
4.0	12
5.0	12
7.5	12
10.0	12

21. Petri Dishes, Crystallizing

O.D. x Height (mm x mm)	Quantity (Nos.)
50 x 40	6
75 x 50	6
100 x 50	6

22. Petri Dishes, Culture

O.D. x Height (mm x mm)	Quantity (Nos.)
50 x 17	12
80 x 17	12
100 x 17	12

23. Dishes, Evaporating, Flat Bottom, with pour out

O.D. x Height (mm x mm)	Quantity (Nos.)
80 x 45	6

24. Desiccators, with knob top

Approx. ID of Ground Flange (mm)	Approx. Overall Height(mm)	Approx. Chamber Depth (mm)	Quantity (Nos.)
110	150	50	3
160	255	95	3

25. Desiccators, Vacuum, with cover & sleeve

Approx. ID of Ground Flange (mm)	Approx. Overall Height (mm)	Approx. Chamber Depth (mm)	Quantity (Nos.)
160	255	95	2

26. Cylinders, colour comparison, Nessler, Flat Bottom Graduated, as per IS:4161 – 1967 Corning ®/Borosil ® :

Capacity (ml.)	Approx. O.D. x Height (mm)	Quantity (Nos.)
100	34 x 180	12
50	26 x 150	12

100 ml cylinder is marked at 50 ml & 100 ml
50 ml cylinder is marked at 25 ml & 50 ml

27. Distilling Apparatus with Graham Condenser, Interchangeable Joints, Interchangeable Stopper

Capacity (ml.)	Condenser Jacket (mm)	Interchangeable Joint	Quantity (Nos.)
500	200	19/26	1

28. Funnels Buchner Type with sintered disc

Capacity (ml.)	Porosity Grade	Disc Dia (mm)	Approx. Height (mm)	Stem Dia (mm)	Quantity
35	1 to 5	30	137	8	2 of each porosity
80	1 to 5	40	149	8	1 of each porosity

29. Crucibles, Gooch Type low form with sintered disc

Capacity (ml.)	Porosity Grade	Disc Dia (mm)	Approx. Height (mm)	Quantity
15	1 to 5	20	44	2 of each porosity
30	1 to 5	30	50	2 of each porosity

30. Tubes Filter, for Gooch Crucibles

Approx. O.D. x Length (mm)	Stem Dia. (mm)	Quantity (Nos.)
36 x 160	8	6
27 x 150	8	6

31. Gas Generator, Kipps

Capacity (ml.)	Quantity (Nos.)
500	1
1000	1

32. Splash Heads, Pear Shape, Sloping :

Flash Cone (Nos.)	Condenser Cone	Quantity
B 24/29	B 24/29	3

33. Splash Heads, Pear Shape, Vertical :

Flash Cone (Nos.)	Condenser Cone	Quantity
B 24/29	B 24/29	3

34. Steam Distillation Heads:

Flash Cone (Nos.)	Condenser Cone	Quantity
B - 24	B-19/26	3

35. Condenser Liebig, with sealed inner tube

Jacket Length (mm)	Quantity (Nos.)
200	2
300	2
400	2

36. Condenser Liebig, Drip tip interchangeable inner joint and interchangeable outer joint

Jacket Length (mm)	Joints (Nos.)	Quantity
200	19/26	2
300	24/29	2
400	24/29	2

37. Condenser Allihn, Drip tip interchangeable inner joint and interchangeable outer joint, Corning ® :

Jacket Length (mm)	Joints (Nos.)	Quantity
200	19/26	2
300	24/29	2
400	24/29	2

38. Condenser, Coiled Type, Grahem Drip tip interchangeable inner joint and interchangeable outer joint

Jacket Length (mm)	Joints (Nos.)	Quantity
200	19/26	2
300	24/29	2
400	24/29	2

39. Glass Tubing:

4 mm, 5 mm, 6 mm, 10 mm Bore - 2 kgs. each

Between 0.5 mm & 3 mm - 2 kgs.

Solid Glass Rod

3mm, 5 mm, 10 mm, Dia - 2 kgs.

41. Thermometers, general purpose -

Range - 0 to 110° C

Division 0.1° C - 6 Nos.

42. Thermometer 0 to 350° C - 6 Nos.

4.50.00 Laboratory Safety Equipment:

1.	Coat	: 6 Nos.
	Men's long coats size	
	Chest size	: 34"; 36"; 38"
2.	Rubberized cloth apron	: 114cm (L) x 86 cm (W)
3.	Asbestos gloves – 20 cml	: 2 Pairs
4.	Natural rubber gloves	
	Medium weight 33 cml size 7	: 3 Pairs
	Medium weight 33 cml size 8	: 3 Pairs
5.	Neoprene gloves size 7	: 4 Pairs
6.	Neoprene gloves size 8	: 4 Pairs
7.	Silicon rubber hand protector for griping hot beaker, bottles, etc., pockets for thumb and fingers to fit every hand size	: 6 Nos.

8.	Respirator for toxic dust complete with filter	:	4 Nos.
9.	Gas mask suitable against ammonia, chlorine, sulphur dioxide	:	3 Nos.
10.	Safety goggles to avoid chemical splash. Soft vinyl frame with plastic ventilators, Optical quality, distortion-free replaceable lens, with rubber head band	:	6 Nos.
11.	First Aid Cabinet similar to Fisher Catalogue 203 No. 10-020	:	4 Sets
12.	Toxic and Hazardous chemicals chart similar to Fisher catalogue 203 No. 10-027-1	:	2 Nos.
13.	Laboratory safety chart similar to Fisher Catalogue 203 No. 10-027-10	:	4 Nos.
14.	First-Aid chart similar to Fisher Catalogue 203 No. 10-026	:	4 Nos.
15.	Eye/Face wash wall mount similar to Fisher Catalogue 203 No. 91-572	:	4 Nos.
16.	Safety signs such as eye wash, exit, fire extinguisher, no smoking, first aid kit, each item acid, displayed in the laboratory	:	4 Nos.
17.	Safety tray for reagents light weight, fiber glass, resistance to acid, mild alkalies, most solvents size 30" x 20" x 2"	:	6 Nos.

4.51.00 General Laboratory Requisites

General Laboratory requisites, including polythene equipment, rubber products, porcelain ware and other miscellaneous items necessary for initial establishment of the chemical laboratory, are listed below:

1. Nickel plates steel tongs for handling crucibles length 50 cms. : 3 Nos.
2. Stainless steel tongs 25 cms long : 6 Nos.
3. Stainless steel beaker tongs 25 cms long : 4 Nos.
4. Stainless steel basin tongs 25 cms long : 4 Nos.
5. Stainless steel flask tongs 25 cms long : 4 Nos.
6. Pipette stand Fisher type : 6 Nos.
7. Test tube stand Fisher type : 6 Nos.
8. Fisher double filter stand : 6 Nos.
9. Double burette stand : 12 Nos.
10. a) Fisher type acid resisting finish cast iron rectanguiar retort stand bases 25 cms x 15 cms with retort stand rods, 60 cms long : 12 Nos.

    b) Assorted bass heads to fit above rods : 24 Nos.

    c) Assorted tommy bar clamps to fit above rods : 24 Nos.

    d) Assorted rings to fit above rods : 24 Nos.
11. Tripod stand, 20 cms high, triangular top 15 cms wire gauge 15 cms square : 112 Nos.
12. Steel spatulas with riveted handles 12.5 cms long : 12 Nos.
13. Stainless steel spatulas flask with spoon end : 12 Nos.
14. Scissors, stainless steel 15 cms long : 6 Nos.
15. Burette Brushes : 12 Nos.

16. Test rube brushes : 12 Nos.

17. Flask Brushes : 12 Nos.

18. Asbestos Mats

    150 mm square : 24 Nos.

    300 mm square : 24 Nos.

19. Mohr clips nickel plated, flat jaws, with rounded edges & finger plates

    5 cms : 12 Nos

    7 cms : 12 Nos

20. Screw clips, Bunsen type with hingec : 24 Nos.
    bottom bar Size 1.3 cms width betweer
    bar

21. Cork borer sets with borer sharpener : 3 Sets

22. Velvet corks (assorted size) : 100 Nos.

    Cork rubber (assorted size) : 100 Nos.

23. Mortar, porcelain with lip, fitted with : 2 Nos.
    wood handle dia 10 cms

24. Agate motor and pastel :

    a) Dia 5 cms : 2 Nos.

    b) Dia 7.5 cms : 2 Nos.

25. Crucibles, Porcelain with perforated bottom and complete with perforated discs

    4.5 cms x 4.2 cms : 6 Nos.

    4.9 cms x 3.6 cms : 6 Nos.

26. Combustion boats silica glazed

    50 ml : 6 Nos

	25 ml	:	6 Nos
27.	Pipe clay triangles iron wire with pipe Clay stalks for holding the above boats	:	24 Nos.
28.	Glass cutting knives	:	3 Nos.
29.	Bunsen Burner	:	12 Nos.
30.	Rubber gloves assorted size	:	12 Pairs
31.	Rubber tubing assorted size (13 mm x 2.5 mm to 5 mm x 1 mm, 10 meters each)	:	12 Pairs
32.	Polythene bottle	:	

Capacity		Quantity
1000 ml	:	12 nos.
500 ml	:	12 nos.
250 ml	:	12 nos.
100 ml	:	12 nos.

33.	Bottle trays for acid bottles	:	6 Nos.
34.	Magnets with keepers 10 cms. Long	:	2 Nos.
35.	Magnifying glass with handle	:	2 nos.
36.	Wash bottle polythene 1000 ml. capacity		12 Nos.

4.52.00 Jar Test Apparatus

For flow formation tests in Water Treatment Plant, it is designed for uniform stirring upto six samples of 1000 ml simultaneously.

A variable transformer provides speed from 10 – 150 rpm. Stirrers are driven by brushless motor with gear train. Entire unit is to be mounted in elongated cast aluminium housing.

Stainless steel stirring paddles of about 25 x 75 mm are attached to rods 25 x 60 mm diameter with lifting knob at top. Locking collars on stirring rods permit adjustment of paddle height. A spacing of about 150 mm provided between rods to permit use of 1000 ml breakers, which rest directly on bench. Complete with On-Off switch, 3 wire cord and plug for use at 220 V AC, 50 Hz supply.

4.53.00 Hot Air Dryer

Electrically operated and portable type hot air dryer for general drying purpose.

It comprises of electric motor and about 500 W heaters and enclosed in light, but high impact thermoplastic.

Shall be Provided with 3 way switch (off, cool, hot),
Maximum air flow temperature : 70^0 C,
Air delivery : 3-4 $feet^3$ / min,
Supplied with 7 feet, 3 conductor cord & 3 prong plug for use at 220 V AC 50 Hz.

4.54.00 Hydrometers (Density)

Hydrometer of glass, graduate in units of Density conforming to ASTM Specification M-50 SP and calibrated at 15^0 C suitable for determination of Density of hydrocarbons.
Range :
0.70 to 0.75
0.75 to 0.80
0.80 to 0.85
0.85 to 0.90
0.90 to 0.95
0.95 to 1.00

4.55.00 Wet & Dry Bulb Hygrometer

Wet & Dry Bulb Hygrometers on polished zinc scale in polypropylene frame with reservoir and spare wicks.

Thermometer Range : 0^0C – 50^0C

Thermometer graduation : 0.5^0C

There shall be Provision for wall mounting.

Two Conversion charts provided.

4.56.00 Digestion Apparatus

Digestion Apparatus shall be suitable to digest many organic and mineral Samples for subsequent analysis by spectrophotometric, titrimetric or turbidimetric methods. This apparatus shall be suitable for wide range of samples like water, wastewater, mineralores, sludges, plating bath Solutions Oil and coal samples.

Apparatus shall have detailed procedures to determine parameters like Kjeldahl Nitrogen, Phosphorus, Calcium, Potassium, Iron, Copper, Silver, Aluminium, Nickel, Cobalt, Magnesium, Zinc, Lead, cadmium, chromium in variety of solid and liquid samples and total sulphur, total iron and silica in coal samples.

Digestion Apparatus shall use concentrated Sulphuric acid & hydrogen Peroxide as digestion chemicals without adding any metal catalysts. Digestion Apparatus shall have a facility for controlled addition of Hydrogen Peroxide for effective digestion.

Typically complete sample digestion shall be achieved within 15-20 minutes and after digestion sample shall be as a clear liquid solution and shall be ready for instrumental analysis without any ashing.

Digestion Apparatus shall have a mechanism to remove fumes generated during the digestion process through a water aspirator. Digestion apparatus shall have a heat shield assembly.

Digestion Apparatus shall meet the following functional specifications:

Temperature Control	:	Adjustable from 100^{0}C to 480^{0}C
Construction	:	Corrosion resistant, epoxy-painted metal with Composition heater base.
Aspirator Capacity		11.5 lit / min at a water flow rate of 6.5 lit / min. Water pressure shall be min.7.5 psi
Power	:	230V AC, 250 Watts.

4.57.00 NOT USED

4.58.00 **Weather Station**

Weather station to collect meteorological information, with sensors (Air Temperature, Relative Humidity, Wind Speed, Wind Direction and Rain Gauge with all accessories, communication system, software, Data storage & retrieval,

Masts for mounting, Mains power supply as well as rechargeable Battery all forming a complete system.

a) **Temperature sensor**: Thermistor based Air Temperature sensor, with shield for protection from Solar radiation to measure air temperature from -30° C to 70° C range, with sufficiently long cable to be connected to the data logger.

b) **Relative Humidity sensor**: To measure Relative Humidity from 0 to 100 % range, minimal error, to function in a temperature range of -30° C to 70° C, with low power requirement, adequately protected from solar radiation and dust, with sufficiently long cable to input in to data logger.

c) **Wind Sensor/Anemometer**: High resolution anemometer, 3 cup rotor, with digital photodiode pulse and analogue outputs with measuring range from 0.15 m/s to 60 m/s with low resolution error, to operate in a range of temperature from -30° C to 70° C with low power requirement, logger input and sufficiently long cable.

d) **Wind Wane:** Sturdy and highly responsive, based on near 360° micro-torque, with wind speed threshold of 0.6 m/s at 45° to flow.

e) **Rain Gauge:** Tipping bucket type rain gauge, with all accessories for fixing on mast, to measure rain fall of maximum 30 CM in 1 hour, to operate between -30° C to 70° C, with funnel and suitable logger and adequate cable.

f) **Data Logger:** Specifically made for the weather station, robust, with standard memory up to 128k, suitable to power the above mentioned sensors, with PC usable windows based software, to set up custom recording intervals, units. Facility to transport information to standard spread sheets and for display of data sets, data retrieval through outdoor weather proof RS232 cable, 40 mts long to be connected to in house computer. In addition provision shall be made for transfer and store data in any other computer system with standard protocol configuration.

g) **Power Supply:** To be supported by mains supply for Indian conditions, as well as stand by DC power adapter, rechargeable battery supply with long life of over 3 months.

h) **Mounting Mast:** Weather proof, strong, robust mast, with all accessories for fixing and mounting all sensors and logger, of minimum 2 mts height.

5.00.00 INSPECTION AND TESTING

5.01.00 Quality checks to be carried out for chemical lab equipment shall include but not limited to following:

a) Physical & chemical properties of material of construction.

b) Dimensional check of all fabricated vessels as required.

c) Type, routine & acceptance test of electrical items, functional test of panels.

5.02.00 **Guarantee**

All equipment shall be guaranteed by the Contractor for workmanship, materials and satisfactory performance. The guarantee for performance shall cover individual items and systems including electrical for their ratings / outputs as well as for the integrated operation of the equipment and its auxiliaries as a whole.

On completion of satisfactory installation, Contractor shall demonstrate the performance/ operation of the equipments.

ATTACHMENTS

30.03.2009
(KIRAN PANDA)
WPCPL

薛利
(XUE LI)
2009.03.30

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ANNEXURE-I

COAL AND ASH ANALYSIS

ANNEXURE-I
COAL AND ASH ANALYSIS

1. COAL ANALYSIS

A)	**Proximate Analysis**			
		Design Coal	**Worst Coal**	**Best Coal**
	Fixed Carbon	31.00%	27.00%	42.00%
	Volatile matter	22.00%	18.00%	27.90%
	Ash	36.00%	40.00%	21.00%
	Moisture	11.00%	15.00%	9.10%
	GCV (kCal/kg)	4200	3800	4900
B)	**Ultimate Analysis**			
	Carbon	43.10 %	38.00 %	53.90 %
	Hydrogen	2.85 %	2.50 %	3.00 %
	Nitrogen	0.9 %	0.50 %	1.20 %
	Sulphur	0.4 %	0.60 %	0.30 %
	Moisture	11.0 %	15.00 %	9.10 %
	Oxygen	5.75 %	3.40 %	11.50 %
	Ash	36.00 %	40.00 %	21.00 %
	GCV (kCal/kg)	4200	3800	4900
C)	**Handgrove Index**	50	45	55
D)	**Initial Deformation temp.**	1170 °C	1170 °C	1170 °C
	Hemispheric temp.	1300 °C	1300 °C	1300 °C
	Flow	1400 °C	1400 °C	1400 °C

Note:- For ESP and Mill Design, Analysis of Worst Coal Shall be Considered.

2. ASH ANALYSIS

ASH FUSION TEMP.
(Reducing Temperature)

Deformation Deg.C	:	1170
Hemisphere Deg.C	:	1350
Flow Deg.C	:	1500
Sample Dried at 100	:	105 Deg.C
Moisture	:	0.14 %
Unburnt Carbon	:	0.36%
SiO_2	:	55.9
$A1_2O_3$	:	36.67
Fe_2O_3	:	4.09
TiO_2	:	1.92
P_2O_5	:	0.10
KO	:	0.40
CaO	:	0.08
MgO	:	0.06
MnO_2	:	0.03
NaO	:	0.28
Loss on Ignition	:	0.32
Undetermined	:	0.15

3. SIEVE ANALYSIS

Above 600 microns	:	0.19%
Between 600 – 500 microns	:	0.53%
Between 500 – 250 microns	:	3.95%
Between 250 – 125 microns	:	12.61%
Between 125 – 50 microns	:	19.36%
Between 50 – 30 microns	:	6.08%
Less than 30 microns	:	57.28%

ANNEXURE-II

FUEL OIL CHARACTERISTICS

ANNEXURE-II

A. FUEL OIL CHARACTERISTICS

Sl.No.	Characteristics	Heavy Furance Oil IS-1953,Grade HV
1.	Total sulphur content	4.5% (Max.)
2.	Gross calorific value	of the order of 11,000
3.	Flash Point (Min.)	66 Deg.C
4.	Water content by Volume (Max.)	1.0%
5.	Sediment by weight (Max.)	0.25%
6.	Asphaltene content by weight (Max.)	2.5%
7.	Kinematic Viscosity in 370 (Max.) Centistokes at 50 Deg.C	180
	At 98.9 Deg.C --	20 - 30
8.	Ash Content by weight (Max.)	0.1%
9.	Acidity (in inorganic)	Nil
10.	Pour Point (Max.)	24 Deg.C (Max.)
11.	Sodium content	--
12.	Vanadium content	25 ppm
13.	Specific heat (KCal/KG. Deg.C)	0.5

ANNEXURE-II

B. LIGHT OIL CHARACTERISTICS

[AS PER IS 1460 WITH AMENDMENTS]

1.	Pour Point (Max.)	12 Deg.C & 18 Deg.C for Summer and Winter respectively
2.	Kinematic viscosity in centistokes at 38 Deg.C	2.5 to 15.7
3.	Water content, percent by volume (Max.)	0.25
4.	Sediment percent by mass (MAX.)	0.10
5.	Total sulfur percent by mass (Max.)	1.8
6.	Ash percent by mass (Max.)	0.02
7.	Carbon residue (Rans bottom) percent by wt. (Max.)	1.50
8.	Acidity in organic	Nil
9.	Flash point (Min.) (Pensky Martens) closed cup	66 Deg.C
10.	Acidity, total, mg of KOH/g (Max.)	Nil
11.	Copper strip corrosin for 3 hours at 100 Deg.C	Not worse than No.2

ANNEXURE-III
DESIGN RAW WATER ANALYSIS REPORT

Sr. No.	Test Samples	Design Raw Water Analysis
1	Colour (Pt Co Units)	20
2	Temperature °C	27
3	pH Value	8.4
4	Odour	Un-objectionable
5	Total Suspended Solids, mg/l	1500 (During Monsoon)
6	Turbidity NTU	1000 (During Monsoon)
7	Residual free chlorine / oxidants	Nil
8	Total Dissolved Solids, mg/l	400
9	E C (micro Siemens/cm)	600
10	Total Hardness as $CaCO_3$, mg/l	185
11	Calcium hardness as $CaCO_3$, mg/l	115
12	Magnesium Hardness as $CaCO_3$, mg/l	70
13	Sodium as Na, mg/l	30
14	Potassium as K, mg/l	5
15	Carbonate hardness as $CaCO_3$, mg/l	185
16.	Non carbonate hardness as $CaCO_3$, mg/l	Nil
17	Alkalinity to Phenolphthalein as $CaCO_3$, mg/l	Nil
18	Alkalinity to methylorange as $CaCO_3$, mg/l	185
19	Sulphate as SO_4, mg/l	35
20	Chloride as Cl, mg/l	22
21	Nitrate as NO_3, mg/l	3
22	Sulphide as H_2S, mg/l	0.01
23	Phosephates as PO_4, mg/l	0.03
24	Reactive Silica as SiO_2, mg/l	14
25	Colloidal silica, mg/l (Non-reactive)	8
26	BOD_5, mg/l	7
27	COD, mg/l	35
28	T O C	-
29	Phenol/any other aromatic hydrocarbons	<0.01
30 a	Oil & grease, mg/l	<1
b	Free floating, mg/l	<1
c	Emulsified, mg/l	<1
31	Carbon dioxide as CO_2, mg/l	0.9
32.	Free ammonia, mg/l	Nil
	HEAVY METALS :	
33	Total Iron as Fe, mg/l	<0.5
34	Manganese as Mn, mg/l	<0.01

Sr. No.	Test Samples	Design Raw Water Analysis
35	Chromium as Cr, mg/l	<0.01
36	Copper as Cu, mg/l	<0.01
37	Nickel as Ni, mg/l	<0.01
38	Zinc as Zn, mg/l	<0.01
39	Aluminium + as, mg/l	<0.01
40	Cadmium as Cd, mg/l	<0.01
41	Arsenic as As, mg/l	<0.01
42	Boron as B, mg/l	0.05
43	Mercury as Hg, mg/l	<0.001
44	Lead as Pb, mg/l	<0. 01
45	Dissolved Oxygen, mg/l	6
46	Cyanides as CN, mg/l	<0.01
47	Fluoride as F, mg/l	0.5
48	Barium as Ba, mg/l	Nil
49	Strontium as Sr, mg/l	<0.01
50	Total Kjeldahl Nitrogen, mg/l	1
51	Vanadium as V, mg/l	<0.01
52	Selenium as Se, mg/l	<0.01

ANNEXURE-IV

CLIMATLOGICAL TABLE

STATION : Champa 42783 LAT: 22 02 N LONG: 82 42 E HT. ABOVE M.S.L. 245 METERS DATA 1951 TO 1980

		Mean Temperature						Extremes				Cloud		Rainfall				
MN	SLP	DB	WB	MAX	MIN	HIGH	LOW	MAX DT	MIN DT	RH	VP	TOT	LOW	TOT	RAINY	WET	DRY	HEAVY	DAY	WS
1	988.7 985.1	15.8 25.3	12.7 16.9	27.2	13.0	30.3	9.0	32.6 28 1980	6.2 22 1963	67 39	12.1 12.6	1.9 2.1	0.5 0.6	14.9	1.1	79.2 1959	0.0	64.0	06 1945	4.4
2	986.7 982.8	19.0 29.2	14.3 17.9	30.7	15.6	35.0	10.8	37.5 29 * 1980	8.3 08 * 1977	57 29	12.6 11.4	1.6 2.1	0.5 0.7	13.8	1.3	67.2 1961	0.0	43.6	01 1961	3.2
3	984.5 980.0	24.2 33.8	16.7 19.5	35.5	19.6	40.0	15.1	42.4 29 1972	11.5 04 1965	44 23	13.0 13.1	1.9 2.5	0.5 0.7	21.3	1.9	156.0 1951	0.0	88.1	06 1951	5.6
4	981.2 976.1	29.8 38.3	20.0 21.5	40.2	24.4	43.9	20.0	46.9 28 1980	16.1 02 1965	38 19	15.3 12.1	2.2 3.4	0.4 1.0	9.2	1.1	37.3 1945	0.0	34.6	19 1971	6.7
5	976.7 971.8	33.0 40.7	22.5 23.1	42.7	27.9	45.9	23.2	48.0 23 1978	19.9 01 1963	38 20	18.6 14.0	2.5 3.8	0.3 1.3	15.0	1.4	60.0 1956	0.0	37.6	29 1956	6.6
6	973.5 969.6	30.1 34.9	24.4 25.0	38.2	27.0	44.3	22.8	47.2 03 * 1978	20.4 09 1971	64 48	26.0 23.8	5.7 6.6	2.6 4.0	173.1	8.5	475.0 1966	46.4 1976	154.6	25 1966	8.0
7	973.5 970.5	26.5 29.1	24.8 25.7	31.3	24.5	35.8	22.4	39.4 01 1954	20.4 16 1963	87 76	29.9 30.3	7.2 7.4	6.0 5.9	390.1	17.7	877.1 1947	216.8 1965	347.2	06 1947	7.6
8	974.5 971.4	26.3 28.6	24.8 25.6	30.7	24.5	34.1	22.6	37.4 01 1972	21.5 17 1964	88 79	30.1 30.5	7.2 7.3	6.1 5.6	454.8	17.1	796.5 1946	202.7 1976	260.4	11 1963	7.1
9	978.1 974.8	26.7 29.1	24.7 25.4	31.6	24.3	34.3	22.3	36.0 11 1968	19.6 29 1972	85 74	29.6 29.4	5.6 6.4	3.7 4.2	222.7	11.4	535.4 1973	55.5 1979	199.9	13 1966	5.1
10	983.7 980.2	24.4 29.0	21.9 23.2	31.7	21.4	34.1	17.3	36.2 12 1957	15.3 30 1974	79 61	24.4 23.9	3.0 3.6	1.3 1.5	49.1	3.3	259.1 1973	0.0	100.2	01 1973	3.6
11	987.7 984.1	19.7 26.8	16.6 19.2	29.7	16.4	32.0	12.8	35.1 22 1979	9.6 30 1960	71 46	16.5 16.1	2.1 2.4	0.4 0.6	4.5	0.4	47.5 1946	0.0	41.1	20 1946	4.3
12	989.3 985.7	16.0 24.5	13.1 17.0	27.3	13.0	29.9	9.7	32.1 01 1963	6.9 30 1968	70 44	12.9 13.5	1.8 2.2	0.3 0.4	5.6	0.3	55.6 1978	0.0	45.4	11 1967	4.1
YR	981.5	24.3	19.7	33.1	21.0	46.1	8.5	48.0	6.2	66	20.1	3.6	1.9	1354.1	65.5	2134.1	866.2	347.2		5.6
LY	977.7	30.8	21.7							47	19.1	4.2	2.2			1961	1979			
YRS	30 30	30 30	30 30	30	30	30	30	36	36	30 30	30 30	30 30	24 24	30	30	36	36	36		30

* Occurred More Than Once

STATION : Champa 42783 .. contd

MN	Weather PPT	HAIL	THUN	FOG	D.STM	SQUA	Wind speed 62	61	19	0	% Wind Direction N	NE	E	SE	S	SW	W	NW	0	Total Cloud 0	T-2	3-5	6-7	8	Low cloud 0	T-2	3-5	6-7	8	ND	Visibility <1	1-4	4-10	10-20	>20
1	1.6	0.0	0.8	0.1	0.0	0.0	0	0	23	8	52	5	5	2	0	0	0	11	25	16	5	4	4	2	28	1	1	0	1	0	0.1	0.1	0.0	6.2	24.6
							0	0	20	11	26	4	5	2	2	2	13	10	36	13	9	4	3	2	23	5	2	0	1	0	0.0	0.0	0.0	1.5	39.5
2	2.0	0.0	1.7	0.0	0.1	0.0	0	0	20	8	50	4	5	1	0	1	1	11	27	16	5	3	3	1	24	1	1	1	1	0	0.0	0.0	0.0	3.8	34.0
							0	0	22	6	25	3	3	1	2	5	25	15	21	11	7	5	3	2	20	5	2	0	1	0	0.0	0.0	0.0	0.6	37.4
3	3.2	0.1	3.9	0.0	0.8	0.0	0	0	21	10	38	6	7	3	1	2	3	9	31	17	4	4	4	2	26	1	2	1	1	0	0.0	0.0	0.6	10.6	19.8
							0	0	25	6	18	4	4	1	3	7	28	17	18	13	7	6	3	2	22	5	3	0	1	0	0.0	0.0	0.1	4.5	36.4
4	2.4	0.0	3.8	0.0	0.9	0.0	0	0	21	9	18	4	12	4	4	7	13	10	28	14	6	5	4	1	27	1	1	0	1	0	0.0	0.0	0.6	9.3	19.9
							0	1	24	5	17	2	3	1	2	11	31	17	16	6	8	8	5	3	16	8	4	1	1	0	0.0	0.0	0.1	5.7	34.2
5	2.0	0.0	4.8	0.0	1.3	0.0	0	1	24	6	12	4	17	8	6	9	16	10	18	12	7	6	5	1	28	2	1	0	0	0	0.0	0.0	0.4	6.3	34.3
							0	2	25	4	18	4	6	3	4	4	22	27	12	4	8	9	6	4	14	9	6	1	1	0	0.0	0.1	0.3	5.6	35.0
6	12.0	0.0	10.7	0.0	1.2	0.0	0	1	24	5	5	2	9	4	4	18	35	7	16	2	3	6	10	9	15	2	5	2	6	0	0.0	0.1	0.1	4.2	18.6
							0	3	24	3	11	4	8	2	4	20	23	17	11	1	1	5	8	15	6	5	9	3	8	0	0.0	0.1	0.1	5.6	13.6
7	22.7	0.0	9.6	0.0	0.0	0.0	0	1	26	4	2	2	6	3	3	25	41	4	14	1	0	3	8	19	4	3	5	4	16	0	0.0	0.1	0.5	7.1	12.3
							0	2	24	5	5	3	5	3	5	29	28	8	14	1	0	2	7	21	1	3	9	3	15	0	0.0	0.1	0.6	6.6	13.5
8	22.1	0.0	10.5	0.0	0.0	0.0	0	0	25	6	4	1	8	4	4	18	40	5	16	0	0	2	10	19	2	2	6	5	16	1	0.0	0.1	0.5	6.1	14.7
							0	1	25	5	5	2	5	2	5	21	32	10	18	0	0	3	7	21	1	3	10	3	14	0	0.0	0.1	0.7	7.0	14.9
9	15.0	0.0	8.3	0.0	0.0	0.0	0	0	22	8	16	4	10	4	3	8	21	8	26	2	3	6	10	9	9	3	6	4	8	0	0.0	0.2	0.3	8.7	16.7
							0	0	22	8	11	3	7	4	5	12	19	14	25	0	2	6	8	14	2	7	10	3	8	0	0.0	0.0	0.4	7.6	16.1
10	4.9	0.0	2.4	0.0	0.0	0.0	0	0	19	12	30	5	10	3	1	1	3	10	37	10	6	6	6	3	20	3	4	2	2	0	0.0	0.1	0.1	2.1	15.1
							0	0	19	12	22	5	10	2	2	3	8	10	38	5	8	8	5	5	14	9	5	1	2	0	0.0	0.0	0.1	2.1	14.8
11	0.8	0.0	0.2	0.0	0.0	0.0	0	0	21	9	55	3	3	1	0	0	0	11	27	15	6	3	5	1	27	1	1	1	1	1	0.0	0.1	0.1	1.5	16.1
							0	0	19	11	42	5	3	1	1	1	2	9	36	12	8	4	4	2	23	4	1	1	1	1	0.0	0.1	0.1	1.6	16.1
12	0.8	0.0	0.3	0.0	0.0	0.0	0	0	24	7	65	3	2	0	0	0	0	9	21	16	6	4	4	1	29	1	0	0	1	0	0.0	0.0	0.1	3.9	25.7
							0	0	17	14	36	2	3	1	1	1	3	10	43	13	8	5	3	2	27	3	1	0	0	0	0.0	0.0	0.1	1.6	29.6
YR	89.5	0.1	57.0	0.1	4.3	0.0	0	3	270	92	29	4	8	3	2	7	14	9	24	121	51	52	73	68	239	20	33	19	54	0	0.1	0.3	3.4	87.4	193.8
LY							0	9	266	90	20	3	5	2	3	10	20	14	23	79	66	65	62	93	169	66	63	14	53	0	0.0	0.4	3.3	42.7	318.0
YRS				28					24						28							29					29							29		
									24						28							29					29							29		

ANNEXURE-V

VASTU REQUIREMENTS

TABLE 5 : VASTU REQUIREMENTS

PART A : Detailed write up on Vastu requirement

1. **Layout**

The layout of the plant shall be made in such a way that

- Main STG building, Boiler, ESP and chimney shall be located in South-West corner of the plot
- Switchyard and associated structures shall be in South-East corner.
- Water associated structures like Raw water reservoir, cooling tower, DM plant etc., shall be located in North - East corner.
- Fuel associated structures like Cola Handling plant, Coal stockyard, Reclaim hoppers, crushers etc., shall be located in North-West corner.
- Chimney shall be the last structure on the South-West corner and no structures shall be allowed beyond this.

2. **Grading**

Site shall be graded from South-West corner to the North-East corner and the storm water drains and associated roads shall be following the same terrain. If such grading calls for a cut & fill, the following precautions shall be taken :

- The foundations are always resting on the virgin soil and not on the filled up soil (in filling)
- The Finished Floor Level (FFLO, Finished Ground Level (FGL) and the Finished Road / Pavement Level (FRL/FPL) shall be fixed over and above the Maximum Flood level (MFL).

3. **Boundary Wall & plant entrance**

The boundary wall should follow the finished terrain of the land and all the places it shall be as per the height requirement as detailed in the technical specifications. Since it is following the graded / finished ground level, it shall be high in the South West corner and low in the North East corner.

The main entrance in to the plant shall be from North-East corner, either from East or North Direction.

4. **Buildings :**

i) The buildings shall be rectangular or square in shape and however the size shall be as per the system requirement.

ii) The internal staircase shall be in the North-west Corner and external staircases in the South West corner.

iii) The toilets shall be in South-East or North-West corner of the building.

iv) The slope of the roof drainage shall be towards North or East.

v) The no. of doors and windows shall be even in any floor or building and shall not end with zero like 10,20,30, etc.

vi) The septic tanks if provided shall be in South East side of the building.

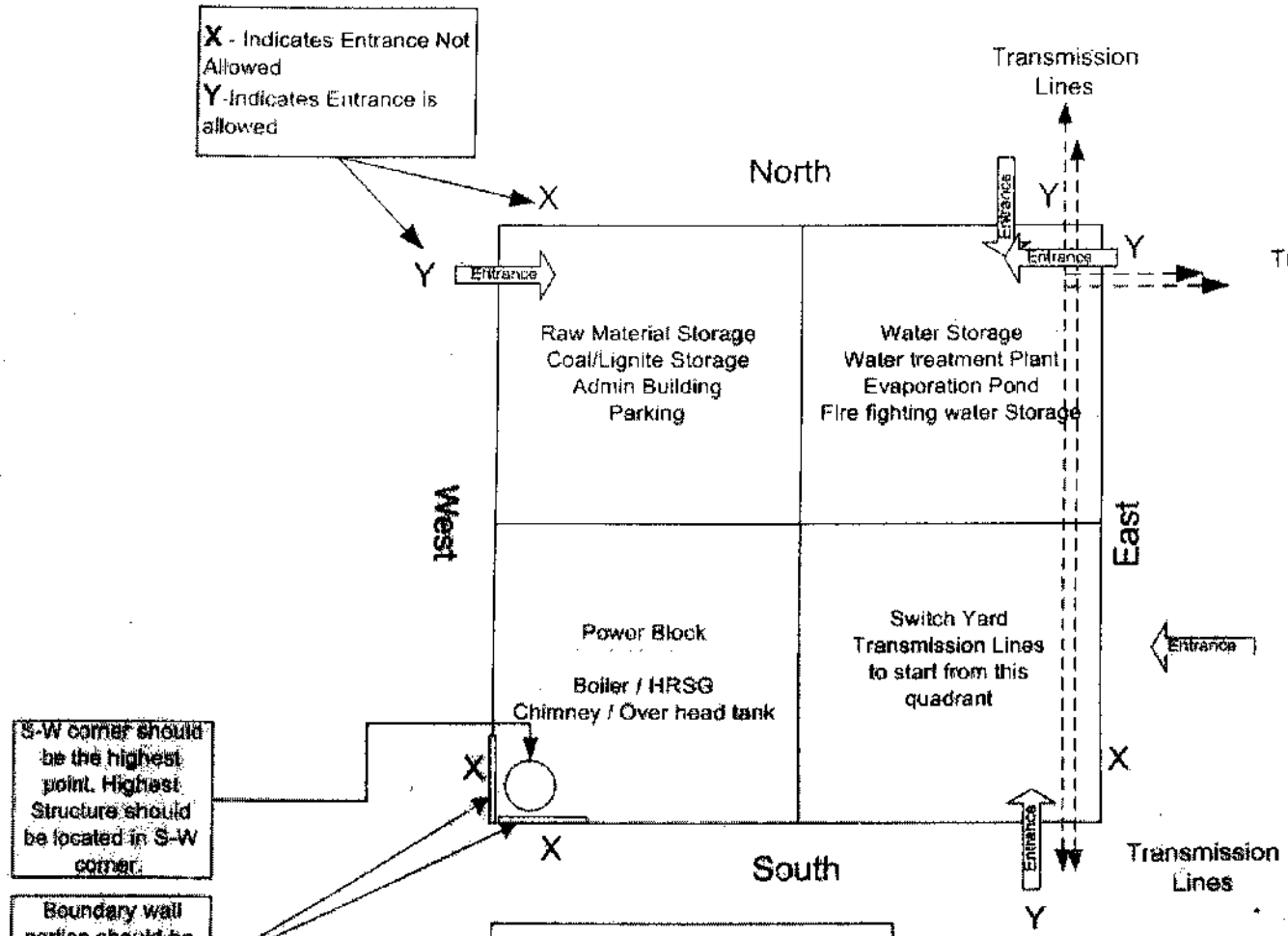
vii) Main entrance shall be of the maximum size and shall be bigger than all other doors in the building.

viii) The entrance to the buildings shall be as per attached sketch.

ix) The over head tank shall be in the South East corner of the roof.

WARDHA POWER COMPANY PRIVATE LIMITED

SCHEMATIC ON VASTU



Plot shape should be square or rectangle. Rectangle also should be a proportionate rectangle.

Total plot should be divided in four quadrant as shown above and then the relative location of each structure should all be decided.

No. of entrance, doors, windows should be an even number but not ending with "0" like 10, 20, 30

Main entrance to the plant should be of maximum width. No other door / entrance should be wider than the main entrance.

Main Entrance to the plant as well as any input / output to/from plant should be from at any of "Y" indicated above.

Evacuation lines / transmission lines should go out from the plant either from NE - N corner or SE-S corner or NE-E corner.

Toilets /sewage / septic tanks shall be South East or North West side

All these rules of vastu are also applicable to all the buildings and structures

ANNEXURE-VI

RECOMMENDED VELOCITIES FOR SIZING OF PIPING

RECOMMENDED VELOCITIES FOR SIZING OF PIPES

AVERAGE VELOCITY IN METRE/SECOND

Nominal pipe Size in mm	Below 50 mm	50 to 200 mm	above 200 mm
Saturated steam at sub-atmospheric pressure	--	10-15	15-20
Saturated steam at 0-1 kg/cm2g	15-20	18-30	20-30
Saturated steam at 1.1-7 kg/cm2g	15-23	20-33	25-43
Saturated steam over 7 kg/cm2g	15-25	20-35	30-50
Superheated steam at 0-7 kg/cm2g	20-30	25-40	30-50
Superheated steam at 7.1-35 kg/cm2g	20-33	28-43	35-55
Superheated steam at 35.1-70 kg/cm2g	23-33	30-50	40-60
Superheated steam above 70 kg/cm2g	23-35	35-60	50-75
Compressed air 0-1.75 kg/cm2g	15-20	20-30	25-35
Compressed air 1.75-7 kg/cm2g	23-30	25-40	35-45
Compressed air over 7 kg/cm2g	23-35	30-45	40-50
Pump Suction , condensate	--	0.4-0.6	0.6-0.7
Pump discharge , condensate	0.9-1.2	1.2-2.1	1.5-2.2
Pump suction, Boiler feed	-	0.6 – 0.9	0.6 – 0.9
Pump suction, General service zero head	0.6 – 0.9	0.7 – 1.4	0.9 – 1.5
Pump suction, vertical submersible zero head	0.6 – 1.2	0.9 – 1.2	0.9 – 1.5
Pump suction, vertical submersible plus 10 head	-	0.6 – 1.5	1.2 – 1.8
Pump suction, viscous liquids	0.2 – 0.3	0.2 – 0.4	0.4 – 0.5
Pump discharge Boiler Feed	1.2 – 1.8	1.5 – 2.1	1.8 – 2.4
Pump discharge, General service	0.9 – 1.8	1.5 – 2.4	1.5 – 2.4
Pump discharge viscous liquids	0.9 – 1.1	1.0 – 1.1	1.2 – 1.5
Headers, circulating water	-	1.2 – 1.8	1.5 – 2.1
Headers, General service under 2 kg/cm^2(g)	-	1.3 – 2.0	1.8 – 2.4
Headers, General service above 2 kg/cm^2(g)	-	1.5 – 2.4	2.1 – 2.4

Note : This standard sets the maximum limited of the flow velocity.
Lower velocity may be selected if found necessary.

ANNEXURE-VII

RECOMMENDED INSULATION THICKNESS

RECOMMENDED INSULATION THICKNESS

Mineral Wool Insulation of Density : 150 kg/m3

Insulation thickness in mm for various temp. ranges							
Sr. No.	**Pipe Size**	**100 C & Below**	**Between 100 C & 200 C**	**Between 201 C & 300 C**	**Between 301 C & 400 C**	**Between 401 C & 500 C**	**Above 500 C**
1.	50mm outside dia and below	25	50	50	75	100	100
2.	Between 51mm and 100mm O.D.	25	50	75	100	125	125
3.	Between 101mm and 150mm O.D.	50	75	75	100	125	150
4.	Between 151mm and 200mm O.D.	50	75	75	125	125	150
5.	Between 201mm and 250mm O.D.	50	75	100	125	150	150
6.	Between 251mm and 300mm O.D.	50	75	100	125	150	150
7.	Between 301mm and 350mm O.D.	50	75	125	150	150	150
8.	Between 351mm and 425mm O.D.	50	75	125	150	150	150

Note : 1) The metallic jacket over the insulation shall be Aluminium sheet and thickness shall be as follows :

Pipe size upto 300 mm OD : 0.559 mm

Pipe size over 300 mm OD
And valves, flanges, equipment etc. : 0.711 mm

2) The insulation thickness shall be such that surface temperature shall not exceed 60°C considering ambient air temperature of 40°C and 1 m/sec wind velocity.

ANNEXURE-VIII

WORKSHOP EQUIPMENTS LIST

ANNEXURE-VIII
LIST OF WORKSHOP EQUIPMENTS

Sl. No.	Equipment	
1.	**Lathes**	
1.1	One (1) no. General purpose Lathe complete with drives and all other accessories	Height of centres : 300 mm Swing overbed : 600 mm (dia) Distance between centres: 2000 mm
1.2	One (1) no. General purpose Lathe complete with drives and all other accessories	Height of centres : 450 mm Swing overbed : 900 mm Distance between centres : 2000 mm
1.3	One (1) no. General purpose Lathe complete with drives and all other accessories	Height of centres : 600 mm Swing overbed : 1150 mm Distance between centres : 5000 mm
2.	**Drilling Machines**	
2.1	One (1) nos. radial drilling Machine complete with drives and all other accessories	Drilling capacity : 50 mm (steel), Drilling radius (max.) : 1500 mm
2.2	Two (2) nos. bench drilling Machine complete with drives and all other accessories.	Drilling comm. steel.
2.3	Two (2) nos. portable drill guns complete with drives and all other accessories.	
3.	**Grinding Machines/ Milling Machines**	
3.1	One (1) nos. cylindrical grinding machine complete with drives and all other accessories	Grinding Wheel dia. 350 mm, Distance between centre : 1500 mm
3.2	Two (2) nos. double ended pedestal grinder complete with drives and all other accessories.	Wheel size 350 mm
3.3	One (1) no. tool and cutter grinder complete with drives and all other accessories.	Grinding wheel dia : 250 mm
3.4	Two (2) nos. flexible shaft grinder wheel complete with drives and all other accessories.	Grinding wheel dia : 150 mm
3.5	Surface Grinders	

4	**Bending and Shearing Machine**	
4.1	One (1) nos. hydraulic pipe bender complete with drives and all other accessories.	Bending capacity 10 – 80mm pipe size, 8mm thick.
4.2	One (1) no. plate shearing machine complete with drives and all other accessories.	Capacity : width x thickness 2500 mm x 12 mm
4.3	One (1) no. hand operated shear	Capacity : 12 SWG sheet cutting.
5.	**Press**	
5.1	One (1) no. mechanical press complete with drives and all other accessories.	Capacity 15 Ton
5.2	One (1) no. fly press complete with drives and all other accessories.	
6.	**Other Machinery**	
6.1	One (1) no. Hydraulic hacksaw	Capacity : to cut square / round Material upto 300 mm sq./300 mm dia.
6.2	One (1) no. power hack saw	Capacity : to cut square / round Material upto 200 mm sq./200 mm dia.
6.3	One (1) no. pipe threading complete with drives and all other accessories.	Capacity : Upto 6" diameter Pipe Size machine.
6.4	One (1) set of balancing equipment complete with drives and all other accessories.	
7.	**General Equipment For Machine Shop**	
7.1	Three (3) no. work benches with vices	(Size 1800 x 1200 x 900 mm)
7.2	One (1) set of snap on tools	
7.3	One (1) lot of measuring tools minimum consisting of the followings :	
i)	Vernier Calliper of size 6" (2 nos.)	
ii)	Vernier Calliper of size 12" (2 nos)	
iii)	Screw Pitch Gauge (4 nos.)	
iv)	Internal Circlip Plier of size 7" (2 nos.)	
v)	External Circlip Plier of size 7" (2 nos.)	
vi)	Steel Rule of size12" (4 nos.)	
vii)	Dial Gauge (6 nos.)	
viii)	Tachometer-Contact type (1 no.)	
ix)	Tachometer-Non-contact type (1 no)	
7.4	Six (6) sets of general tools : Consisting of screw drivers (4 set), cutting pliers, Ring Spanner Set, 6-32mm (12 nos.), D/E Spanner Set, 6-32 m (12 nos.), Socket Spanner, 8-32mm (2 Set), Spanner Set 1/8" to ¾" (1 Set), Ring Spanner 1/8" x ¾" to 9/16" x 11/16" (2 Set), Allan Keys 1.5mm to 10 mm (2 Set).	

7.5	Two (2) set of pneumatically operated spanners complete with drives and all other accessories (Range to cover to 16mm, to 32 mm size).	
7.6	Six (6) sets of hand lamps of 24V A.C. along with Transformers.	
8.	**Paint Shop**	
8.1	One (1) no. portable compressor complete with drives and all other accessories with 10 gallon capacity compressed air spraying equipment complete with spray gun, stirrer and accessories.	
8.2	One (1) no. portable sanding machine.	
8.3	One (1) no. set of sign writing equipment and stencils.	
8.4	One (1) no. buffing and polishing machine.	
9.	**Welding**	
9.1	Two (2) nos. A.C. welding transformer complete with all accessories	
9.2	Two (2) nos. welding generator complete with all accessories.	
9.3	Two (2) nos. TIG welding set complete with all accessories.	
9.4	Four (4) nos. oxy-acetylene gas welding sets with regulating nozzles and welding of size /capacity of 2 ft x 2 ft.	
9.5	One (1) no. electrode drying oven 50 – 250 deg.C (size 500 mm x 500 mm) with thermostatic temperature control of capacity 8 kg (500 Watts).	
9.6	Four (4) nos. welding tables of size 900mm x 600mm.	
9.7	Four (4) nos. soldering irons.	
9.8	Two (2) nos. Portable Welding Sets with portable electric crucible of 250 V, 31.5 kW and portable screen (6 ft high)	
9.10	Oxy-acetylene profile cutter of size 80 in. x 40 in.	
9.11	Eutectic – metal spray	
10.	**Shaper**	
	One (1) no. Shaper complete with drives and all other accessories with 660mm long Ram with travel distance 660 mm.	
11.	**Milling Machine**	
	One (1) no. Milling Machine complete with drives and all other accessories with Swing – 280 mm, Height of centers - 130mm and distance between tailstock centers – 760 mm.	
12.	**Slotting Machine**	
13.	**Pneumatic hammer**	
14.	**Battery / hand operated trolley**	

ANNEXURE-IX

LABORATORY EQUIPMENT LIST

ANNEXURE-IX
LABORATORY EQUIPMENT LIST

1) Equipment for Water Analysis

Sl No.	Description	Quantity Required
1.	Air Oven	One (1)
2.	Muffle Furnace	One (1)
3.	Conductivity Meters (Bench top + portable)	Three (3) - (each Type)
4.	Digital pH Meters (Bench top + portable)	Three (3) - (each Type)
5.	Dissolved Oxygen Testing Kit	One (1)
6.	Electronic Analytical Balance	One (1)
7.	Lab Flocculator	Two (2)
8.	Photoelectric Calorimeter	Three (3)
9.	Spectrophotometer	One (1)
10.	Turbidity Meter (Nephelometer)	One (1)
11.	Refrigerator 165 Liter	One (1)

2) Equipment for Coal Testing

Sl No.	Description	Quantity Required
1.	Air Oven	One (1)
2.	Muffle Furnace	Two (2)
3.	Bomb Calorimeter	One (1)
4.	Electronic Analytical Balance	One (1)
5.	Hard groove Grindability Index Apparatus	One (1)
6.	Humidity Cabinet	One (1)
7.	Jaw Crusher	Two (2)
8.	Laboratory Disc Mill	One (1)
9.	Sieve Shaker & Sieves	One (1) Set

Sl No.	Description	Quantity Required
10.	Steel Cabinet	Two (2)
11.	Silica Crucible	Thirty Six (36)
12.	Refrigerator 165 Liter	One (1)

3) **Equipment for Oil & Flue Gas Testing**

Sl No.	Description	Quantity Required
1.	Bomb Calorimeter	One (1)
2.	Cloud & Pour Point Apparatus	One (1)
3.	Dean & Starks Distilling Trap	One (1)
4.	Electronic Analytical Balance	One (1)
5.	Flash Point Apparatus	One (1)
6.	Karl Fischer Apparatus (Manual)	One (1)
7.	Orsat Gas Analyzer	Two (2)
8.	Viscometer:	
	a) Viscometer, Redwood No: 1	One (1)
	b) Viscometer, Redwood No: 2	One (1)
9.	Digestion Apparatus	One (1)

4) **Equipment for Pollution Control Cell Laboratory**

Sl No.	Description	Quantity Required
1.	Air Oven	One (1)
2.	B.O.D. Cabinet	One (1)
3.	Electronic Semi-Micro Analytical Balance	Two (2)
4.	Photo Electric Calorimeter	One (1)
5.	Digital pH-meter	Two (2)
6.	Digital Conductivity Meter	Two (2)

Sl No.	Description	Quantity Required
7.	Magnetic Stirrer with Hot Plate	One (1)
8.	Water Bath	One (1)
9.	Hot Plate	One (1)
10.	Refrigerator 165 Liter	One (1)
11.	Big size steel cabinets	Three (3)
12.	High volume air samples	Five (5)
13.	Stack monitoring kits	Four (4)
14.	Vacuum Pump	One (1)
15.	Nephelometer	One (1)
16.	Weather station for continuous recording of: a) Ambient temperature b) Relative humidity c) Wind velocity and direction	One (1)
17.	Hot air Dryer	One (1)

5) **General Equipment/Apparatus**

Sl No.	Description	Quantity Required
1.	Analytical Balance – Equal Arm, Chain Weight type	Two (2)
2.	Balance – Harvard trip	One (1)
3.	Balance – Barranger	One (1)
4.	Disc Comparator	One (1) Set
5.	Dry-Wet Thermometer	Four (4)
6.	Electric Bunsen	One (1)
7.	Electric Stirrer	One (1)
8.	Fortins Barometer	One (1)
9.	Heating Mantles	One (1) Set
10.	Hot Plate	Two (2)

Sl No.	Description	Quantity Required
11.	Laboratory Centrifuge & Accessories	One (1)
12.	Magnetic Stirrer with Hot Plate	Two (2)
13.	Microscope – Binocular	One (1)
14.	Platinum Ware	One (1)
15.	Steel Cabinet	Three (3)
16.	Stop Watch	Two (2)
17.	Vacuum Pump	One (1)
18.	Water Bath	One (1)
19.	Water Still	One (1)
20.	Glassware & Accessories	As specified
21.	Laboratory Safety Equipment	As specified
22.	General Laboratory Requisites	As specified
23.	Jar test Apparatus	One (1)
24.	Hydrometer (density)	Two (2)
25.	Wet & dry Bulb Hygrometer	Two (2)
26.	Laboratory Stirrer	Two (2)
27.	Dust fall jar	Two (2)
28.	Sulphation Candle	Two (2)
29.	Noise level meter	One (1)
30.	Infra red heating lamp	Two (2)
31.	UV electro photometer and Digital flame photometer	Two (2)
32.	Fume Cabinet	One (1)

ANNEXURE-XI

LIST OF DRAWINGS ENCLOSED

ANNEXURE-XI

LIST OF DRAWINGS ENCLOSED

SL. NO.	DRAWING NO.	DESCRIPTION
1.	K7V12-000-DWG-M-GA01	PROPOSED PLOT PLAN
2.	K5V20-020-DWG-M-FS00	LEGEND FOR FLOW SHEETS
3.	K5V20-020-DWG-M-FS01	FLOW DIAGRAM FOR STEAM SYSTEM
4.	K5V20-020-DWG-M-FS02	FLOW DIAGRAM FOR CONDENSATE AND FEED WATER SYSTEM
5.	K5V20-020-DWG-M-FS03	FLOW DIAGRAM FOR CONDENSATE POLISHING UNIT
6.	K5V20-020-DWG-M-FS04	FLOW DIAGRAM FOR AIR AND FLUE GAS SYSTEM
7.	K5V20-020-DWG-M-FS05	FLOW DIAGRAM FOR HFO AND LDO SYSTEM
8.	K5V20-020-DWG-M-FS06	FLOW DIAGRAM FOR ECW SYSTEM
9.	K5V20-020-DWG-M-FS07	FLOW DIAGRAM FOR COAL HANDLING PLANT
10.	K5V20-020-DWG-M-FS08	FLOW DIAGRAM FOR CONDENSER COOLING WATER SYSTEM
11.	K5V20-020-DWG-M-FS09	FLOW DIAGRAM FOR AUXILIARY COOLING WATER SYSTEM
12.	K5V20-020-DWG-M-FS10	FLOW DIAGRAM FOR PRE-TREATMENT PLANT
13.	K5V20-020-DWG-M-FS11	FLOW DIAGRAM FOR CHLORINATION SYSTEM FOR C.W AND P.T PLANT
14.	K5V20-020-DWG-M-FS12	FLOW DIAGRAM FOR DM PLANT
15.	K5V20-020-DWG-M-FS13 (2 SHEETS)	FLOW DIAGRAM FOR CHEMICAL DOSING SYSTEM
16.	K5V20-020-DWG-M-FS14	FLOW DIAGRAM FOR COMPRESSED AIR SYSTEM
17.	K5V20-020-DWG-M-FS15	FLOW DIAGRAM FOR HFO AND LDO UNLOADING & FORWARDING SYSTEM
18.	K5V20-020-DWG-M-FS16	FLOW DIAGRAM FOR EFFLUENT TRREATMENT PLANT WITH RO SYSTEM
19.	K5V20-020-DWG-M-FS17	FLOW DIAGRAM FOR SEWAGE TREATMENT PLANT
20.	K5V20-020-DWG-M-FS18	FLOW DIAGRAM FOR BOTTOM ASH & COARSE ASH HANLDING SYSTEM

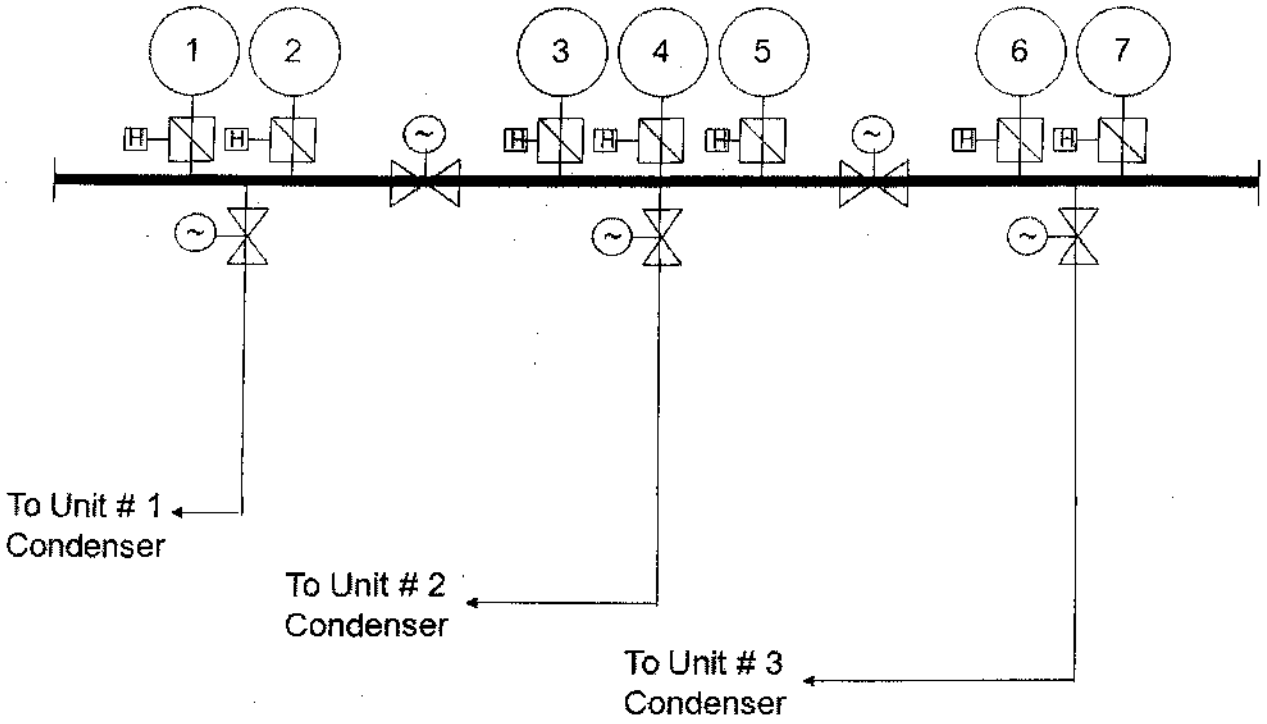
21.	K5V20-020-DWG-M-FS19	FLOW DIAGRAM FOR BOTTOM ASH TRANSPORT SYSTEM
22.	K5V20-020-DWG-M-FS20	FLOW DIAGRAM FOR FLY ASH SYSTEM – ESP TO BUFFER HOPPER VESSEL
23.	K5V20-020-DWG-M-FS21	FLOW DIAGRAM FOR FLY ASH SYSTEM – BUFFER HOPPER TO SILO
24.	K5V20-020-DWG-M-FS22	FLOW DIAGRAM FOR FLY ASH SILO AREA
25.	K5V20-020-DWG-M-FS23	FLOW DIAGRAM FOR HIGH CONCENTRATION SLURY DISPOSAL
26.	K5V20-020-DWG-M-SK01	RAIN WATER HARVESTING SYSTEM
27.	K7V12-000-DWG-E-0101	KEY SINGLE LINE DIAGRAM ELECTRICAL DISTRIBUTION ARRANGEMENT
28.	K7V12-000-DWG-E-0201	TYPICAL CONTROL SCHEMATIC FOR 415V PMCC/MCC
29.	K7V12-000-DWG-E-0400	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES
30.	K7V12-000-DWG-E-0600	EARTHING DETAILS
31.	K7V12-000-DWG-E-0800	ILLUMINATION DETAILS
32.	K7V12-000-DWG-E-1000	LIGHTNING PROTECTION DETAILS
33.	K7V12-000-DWG-I-001	PLANT CONTROL SYSTEM ARCHITECTURE
34.	K7V12-000-DWG-I-002	TYPICAL HOOK UP DIAGRAMS

ANNEXURE-XII

SCHEMATIC DRG OF CW , DM-ETP SYSTEM

WARDHA POWER COMPANY PRIVATE LIMITED-6 x 600 MW

CW PUMP HOUSE SCHEMATIC

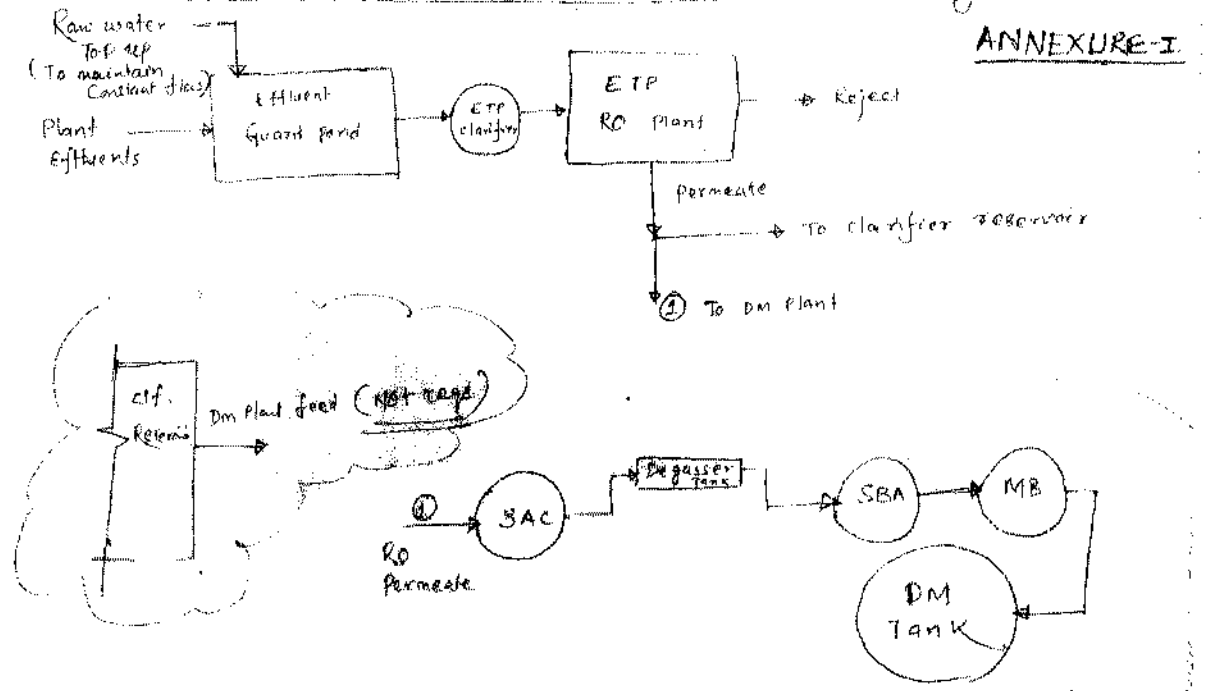


Note: This schematic is for Phase-I, For Phase-II similar arrangement to be repeated

24.9.2008

ETP & DM Plant Schematic for 6×600 MW WPCPL Nariyara

ANNEXURE-I



Note 1) Minimum Permeate to be Supplied to Proposed DM Plant is 480 m³/hr for 18 hrs/day

2) To maintain min^m output of 480 m³/hr Permeate from ETP, Raw water top up ~~supply~~ to be Supplied to Effluent Guard pond in Case Effluent is not sufficient.

薛利 1/4/09
(XUE LI)

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SCHEDULE II

TECHNICAL SPECIFICATION

VOLUME # 2

(SERVICES)

Project	6 x 600 MW THERMAL POWER PLANT PROJECT AT NARIYARA, CHATTISGARH, INDIA	
Owner	KSK Power from knowledge	**Wardha Power Company Private Limited, India**
Owner's Consultants		DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI
E P C Contractor	SEPCO	SEPCO Electric Power Construction Corporation, China

1/4/09

(XUG 2I)

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SECTION-XIII	PROJECT MANAGEMENT SERVICES
SECTION-XIV	SITE SERVICES
SECTION-XV	QUALITY ASSURANCE SERVICES
SECTION-XVI	DATA AND DOCUMENTS TO BE FURNISHED BY THE CONTRACTOR/CONTRACTOR
SECTION-XXII	MECHANICAL & ELECTRICAL ERECTION & COMMISSIONING PROCEDURE

薛利 1/4/09
(XUELI)

VOLUME-II

SECTION-XII

ENGINEERING SERVICES

25.03.09
(KIRAN PANDA)
WPCPL

(XUG LI)
2009.03.25

VOLUME-II

SECTION-XII

ENGINEERING SERVICES

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VOLUME-II

SECTION-XII

ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 The Contractor shall render complete engineering services for the project including complete detailed engineering, design submission and documentation as specified and as required for a good design and installation ensuring efficiency, operability, availability, maintainability and reliability of the plant and efficient archiving of plant documentation for future reference. As part of the overall project management activity, the Contractor shall be responsible for proper engineering, co-ordination and management during various phases of execution of the contract.

2.00.00 GUIDELINES FOR ENGINEERING SERVICES

2.01.00 Prior to commencement of the engineering work, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins, analysis and design calculations etc. shall be stated by the contractor in design basis reports. As part of design submissions, the design basis reports shall be submitted for approval by the Owner/Consultant. The approved design basis reports shall form the basis for the detailed engineering work.

2.02.00 Engineering work shall be performed on modern and proven concepts and internationally accepted good engineering practices but shall also be made fully compatible with the Indian environment. The plant design shall be optimized with uniform focus on the power block and the balance of plant so that their integration results in highest reliability and availability.

2.03.00 At any stage during the performance of the works , the Owner may require upgradation/improvements in the Contracted Plant and consequent modification in the equipment/system designs in view of additional information available at a later date(s) or feedback(s) received during execution/operation of similar units. If so desired by the Owner, the Contractor shall make the necessary design modifications and carry out the upgradation/improvements in the Plant. Commercial and time implications of such action shall be mutually agreed upon between the Owner and the Contractor.

2.04.00 During the course of review of detailed engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants engineered by the Contractor. In case Owner so desires the Contractor shall submit such analogous data and information to the Owner.

2.05.00 It is not the intent to give details of every single task covered in the total engineering work to be carried out by Contractor, however, all engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Contractor. Broadly, the following are the minimum requirements in respect of scope of major items of work :

2.05.01 Preparation of design basis for all systems/equipment including selection criteria determination of parameters, sizing calculations and optimizations.

2.05.02 Interface engineering and complete coordination work among various sub-vendors' equipment packages included in the Contractor's scope.

2.05.03 Preparation, updating and finalization of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings covering all mechanical, electrical, C&I and civil, structural and architectural items, equipment, systems and facilities.

2.05.04 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalization of corresponding sub-contractors.

2.05.05 Review of sub-contractor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.

2.05.06 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments etc. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.

2.05.07 Preparation and finalization of process piping and instrumentation diagrams and schematics, complete in all respects for all systems of the power plant.

2.05.08 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.

2.05.09 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of piping stress analysis including static and dynamic analysis as necessary; hangers & support engineering.

2.05.10 Final revision of all documents.

2.05.11 Preparation and compilation of operating Manuals and Maintenance Instructions. Refer clause 6.00.00 for the specific requirement in this regard.

2.05.12 Certification and submission of final as-built drawings and documents for all areas.

2.05.13 Preparation and compilation of all erection and assembly drawing schedules and instructions which may be required at site.

2.06.14 Preparation of a write up on erection strategy for erection of major equipment taking into consideration the layout of plant and auxiliaries.

2.06.15 All scale model tests like flow modelling of electrostatic precipitator, model testing of stack, flow model test of intake and CW pump sumps etc. required for validation of designs of equipment/systems.

3.00.00 DESIGN COORDINATION MEETING

The Contractor and his sub-vendors will be called upon to attend design coordination meetings with the Owner's Engineer, other Contractors, Consultants or agencies authorised by the Owner during the period of execution of Contract. The Contractor including his sub-vendors shall attend such meetings at their own cost at Owner's office or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

4.00.00 COOPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS

The Contractor shall cooperate with the Owner's other Contractors and Consulting Engineers and freely exchange with them such technical information as are necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Owner's Engineer shall be provided with copies of all correspondences addressed by the Contractor to other Sub-contractors and Consulting Engineers in respect of such exchange of technical information.

5.00.00 POST-CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE

5.01.00 The Contractor shall furnish a comprehensive and detailed schedule of drawings and design documents which shall be submitted by him indicating submission dates against each document. The list shall be subject to the approval of the Owner/Consultant.

The documents shall be divided into two categories:

a) For approval

b) For information/reference only

In preparing this schedule, the Contractor shall allow four (4) weeks from date of receipt for review and comments by the Owner/Consultant for each submission of a document.

This schedule of drawing and design document submission shall require approval by the Owner/Consultant before award of Contract.

5.02.00 All contract documents shall be marked, without fail, with the name of the Owner and Owner's consultant, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

5.03.00 Documents submitted during bid stage, shall be revalidated or revised as required and submitted as certified contract document for approval/information of the Owner/Consultant.

5.04.00 Unless specified otherwise, in the Section-XVI of this specification, the following categories of documents shall require approval of the Owner/Consultant.

a) System scheme drawings, pipeline and instrumentation diagrams

b) Design basis reports

c) Specification for major bought-out items

d) Equipment data sheets and general arrangement drawings

e) Materials of construction

f) Layout drawings.

g) Operation logic diagrams.

h) Typical control circuits.

i) Protection schemes.

5.05.00 Unless specified otherwise, the following categories of documents/ drawings would be treated for information/reference only. The Contractor shall, however, incorporate all additional information and clarifications in these documents/ drawings as and when desired by the Owner/Consultant.

a) Equipment foundation drawings.

b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.

c) Predicted performance curves of equipment.

d) Various bills of quantity, schedules etc.

e) Piping fabrication drawings, isometrics etc.

f) Panel wiring diagrams.

g) Instruction/Operation manuals.

h) Service manuals and trouble shooting guide for C & I system and instruments.

i) Cable schedule and interconnection chart.

j) Drive/feederwise control scheme showing all external interfaces.

5.06.00 Upon review, the Owner/Consultant shall put his remarks and one of the following action stamps on the drawing/document:

ACTION-2 : Approved

ACTION-3 : Approved except as noted, forward final drawing

ACTION-4 : Approved except as noted, resubmission required.

ACTION-5 : Disapproved.

ACTION-6 : For information/reference only.

Documents stamped with ACTION-4 or 5 must be resubmitted for review by the Owner/Consultant. For documents stamped with ACTION-3, further review by Owner/Consultant would not be necessary provided the Contractor agrees and incorporates the comments made on the document.

Except when a document is stamped ACTION-4 or 5, the Contractor can proceed with manufacturing and other sequential activities for those areas of a document which do not have any review comment by the Owner/Consultant.

The Owner/Consultant may accord approval in category ACTION-4 or 5 in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Contractor shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds.

The Contractor's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Owner/Consultant.

Any Contractor's drawing or document stamped with Action-3, 4 or 5 will be accompanied with reasons for such approval as noted. If the contractor disagrees with any comment made by the Purchaser on the drawing then the Purchaser's/ Consultant's comments on any Contractor's Drawing/ Document stamped Action-3, 4 or 5 will be addressed by the contractor with justification. The contractor will provide full reasons for such disagreement when resubmitting the applicable drawing and document to the Purchaser for approval.

5.07.00 All drawings and documents, including all revisions, shall be forwarded by the Contractor through FTP server/e-mail for faster communications. Design review meetings shall be held for expediting the process. All drawings shall be in AUTOCAD only. No document should be submitted in Adobe Acrobat form.

5.08.00 Drawing submission and review will be done through FTP Server/e-mail as under:

a) Submission of drawings on FTP server of
   i) WPCPL Hyderabad
   ii) KSK, Chennai (Engg)
   iii) DCPL, Vashi

b) Review and Approval will follow the FTP server / e-mail approach.

   When the drawing/ document reaches category A-2, DCPL will affix Digital Approval stamp and signature and send soft copy to SEPCO.

Upon action under category ACTION-2 or 6 the Contractor shall directly distribute the documents to the various offices of the Owner and other agencies in number of copies as specified in the contract document. Such distribution copies shall be

marked with the reference and date of the letter by which the Owner/Consultant has accorded his final approval.

c) Eight hard copies approved drawings for construction will be sent by SEPCO as under:

i) Two copies for KSK- Hyd
ii) One copy to KSK Chennai
iii) One Copy to DCPL Vashi
iv) Four copies to KSK Site office.

d) Finally, SEPCO will submit Two copies of As built drawings along with soft copy on CD with in 1 month before COD.

e) Regarding O& M manuals Six hard copies and One soft copy will be submitted.

f) Typical document flow chart is separately attached as Appendix-I.

During drawing review and approval stage in case of disputes on comments, the drawing will be commented and resubmitted max. three times including comments on first revision. After this, SEPCO shall resolve the issues across the table with the Owner at Owner's/Consultant's office in India.

Upon action under category ACTION-2 or 6 the Contractor shall directly distribute the documents to the various offices of the Owner and other agencies in number of copies as specified in the contract document. Such distribution copies shall be marked with the reference and date of the letter by which the Owner/Consultant has accorded his final approval. Penal action shall be taken against the Contractor for any unauthorized revision in the drawings so distributed from the drawings approved by the Owner/Consultant.

6.00.00 OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS

6.01.00 The Contractor shall submit to the Owner/Consultant, instruction manuals for all equipment covered under the contract at least thirty (30) days before the first shipment of the equipment.

6.02.00 The operating manuals and maintenance instructions shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, re-assemble, adjust or replace all equipment and components during the lifetime of the plant. The manuals shall be specifically prepared for the contracted plant. Only a collection of manufacturer's standard leaflets shall not be acceptable as the manuals.

6.03.00 The Contractor shall provide at least six (6) months before the time of commissioning and before taking over of the plant and equipment, all other necessary maintenance manuals and operating instructions.

6.04.00 The operating manuals and maintenance instructions manual shall be submitted in the form of one (1) reproducible original and fifteen (15) copies as well as four (4) copies in compact disks (CDs).

6.05.00 The information provided, which shall be contained in loose leaf stiff backed covers, shall include:

a) A complete inventory of all main items of plant, with identification details; procedure for ordering spares.

b) Service manuals for all plant and equipment giving full descriptions, drawings and specifications of the main items and auxiliary items such as power packs, hydraulic equipment, actuators, lubricating pumps, etc., performance/rating curves.

c) A separate electrical manual covering items such as switchgear, cabling, instrumentation, controls, protection, cabling layouts and wiring diagrams.

d) A schedule of recommendations for routine maintenance of all electrical and mechanical equipment, recommended inspection point, information on detection, cause and rectifications of troubles & faults.

e) A lubrication schedule with all necessary drawings diagrams to identify the lubrication points.

f) Manufacturer's literature.

6.06.00 The instruction manuals shall be subject to the approval of Owner.

6.07.00 If after the commissioning and the initial operation of the plant, the instruction manuals require modifications/additions, the same shall be incorporated by the Contractor and the updated final version of the manuals shall be submitted in the form and copies as indicated in Cl. 6.04.00.

6.08.00 The Contractor shall submit fifteen(15) sets of spare parts catalogues.

7.00.00 **PLANT HANDBOOK AND AS-BUILT DOCUMENTATION**

7.01.00 **Plant Handbook**

The Contractor shall submit to the Owner, a preliminary plant handbook preferably in A-4 size sheets which shall contain all approved design basis and design calculations, the design and performance data of various plant, equipment and systems covering the complete project including single line flow diagrams, within twenty four (24) months from the date of his acceptance of the letter of award. The final plant handbook complete in all respects shall be submitted by the Contractor three (3) months before start-up and commissioning activities. The plant handbook

shall be submitted in the form of one (1) reproducible original and twenty five (25) copies alongwith four (4) copies in Compact Disks (CDs).

7.02.00 **"As-built" Documentation**

The Contractor shall provide and keep up to date "As built drawings of all structures constructed and all equipment and accessories and miscellaneous metal works erected or installed. These drawings shall show all changes and revisions from the original drawings and specifications, including the exact "As-built" locations, sizes and kinds of equipment and accessories, miscellaneous metal works, embedded piping and electrical systems and other concealed items of work. These drawings shall be kept in Contractor's field office but shall be made available at all times for review of the Engineer. At the end of everywork, all entries, changes or revisions made in the drawings by the Contractor shall be checked and approved by the Engineer. Reproducible prints with requisite copies of all "As-Built" drawings shall be progressively handed over to the Purchaser after taking over of the plant by the Purchaser.

8.00.00 **DOCUMENT SUBMISSION**

8.01.00 The Contractor shall submit all documents/drawings as requested in the section-XVI of this specification. The documents shall also include the following unless otherwise stated in Section-XVI :

a) Location plan showing power plant, major installations, pipe routes, roads etc.

b) Detailed Plot Plan.

c) P & ID and schematics of all main plant equipment/systems and processes including the following:

i) Complete steam, condensate, feedwater, air, make-up, blowdown, drain and vent circuits.

ii) Boiler air and flue gas circuits.

d) Mass and energy balance diagrams under various modes of operation including the following:

i) For various loads corresponding to rated upstream steam pressure and temperature and each of the following condenser operating conditions shall be furnished.

0% make up and *mm HgA vacuum

0% make up and *mm HgA vacuum

3% make up and *mm HgA vacuum

3% make up and *mm HgA vacuum

* To be decided by the Contractor

ii) Following load condition mass and energy balances shall be given as minimum :

100% load, 75% load, VWO condition, 60% load, 40% load, H.P heater out of operation, turbine bypass condition, house load operation.

e) Performance and characteristic curves for boiler, turbine, generator, ESP, crushers, all major fans and pumps in main plant and in auxiliary system.

Complete set of correction curves for the above equipment with all parameters for determining correction factors to be applied on performance figures if parameters vary from specified design conditions.

f) Write up on the design and construction features control philosophy of the main plant, turbine and boiler.

g) Key One line diagram of electrical system indicating protection and metering philosophy.

h) P&ID and schematics, brief write up on design, operation and control philosophy general layout and equipment arrangement for following auxiliary plants/systems :

Coal handling plant

Ash handling plant

Plant water system

CW, ACW and DMCW system

Fuel oil system

Compressed air system

Air conditioning and ventilation

Fire fighting system

Wastewater Management System, Effluent Recovery and Zero Discharge system

i) General layout and equipment arrangement for all the auxiliary buildings.

j) General layout and equipment arrangement at different floors in the power house (ground floor, mezzanine operating floor, miscellaneous floor and roofs), floor plans for all elevation of the electrical and control building and technical building. Cross section of the powerhouse building and boiler (upto the chimney).

k) Equipment GA, Layout, P & I diagrams interlock and other write-ups, catalogues/literature etc. as required for clear understanding of the bid submitted.

l) L-1 network indicating target dates for intermediate milestones and final commissioning of equipment supplied; This network shall be supplemented by a detailed write-up on proposal procedure of project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

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SECTION-XIII

PROJECT MANAGEMENT SERVICES

28.03.2009
(KIRAN PANDA)
WPCPL

薛利
(XUE LI)
2009.03.28

VOLUME-II

SECTION-XIII

PROJECT MANAGEMENT SERVICES

C O N T E N T S

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2.00.00	ORGANISATION	V.II/S-XIII : 1
3.00.00	GENERAL REQUIREMENTS OF PROGRAMMES AND SCHEDULES	V.II/S-XIII : 3
4.00.00	IMPLEMENTATION SCHEDULE	V.II/S-XIII : 5
5.00.00	DETAILED RESPONSIBILITIES	V.II/S-XIII : 6
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Attachment – I	Occupation Health and safety Guidelines	

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SECTION - XIII

PROJECT MANAGEMENT SERVICES

1.00.00 **RESPONSIBILITY**

1.01.00 The Contractor shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. From Engineering services responsibilities of the Project Management team shall cover the areas listed below:

a) Planning and Monitoring

b) Engineering Management

c) Contracts Management

d) Quality Management

e) Construction Management

f) Spares Management

g) Commissioning Management

h) Resource Control

i) Manufacturing and Production Control

j) Project Coordination

Detailed responsibilities in the above areas are discussed below:

2.00.00 **ORGANISATION**

The Contractor shall describe how his management organisation will meet the requirements of this specification. The Contractor shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives, managerial and supervisory staff at different levels shall also be indicated separately for headquarters, central coordination cell and site organisation indicating names, qualifications and experience.

During construction phase, the Contractor shall notify any proposed changes to senior staffing numbers or arrangements to the Owner for approval.

2.02.00 **Headquarters**

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.00.00, who, in turn, will report to the Project Manager for all matters related to the Contract.

2.03.00 **Field Engineering Cell**

The Field Engineering Cell shall preferably be based at or near site and shall have sufficient technical personnel to coordinate technical and to quickly resolve day-to-day queries or references made by Owner and his Consultants without having the need to refer to his headquarters each time.

2.04.00 **Site Organisation**

The site should have a competent Construction Manager for all site operations with sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the Civil, Mechanical, Electrical, and Control & Instrumentation fields for construction, erection & commissioning of the Project. Site organization should also include Safety, ,technical services cell (planning, environment , quality), Administration (for coordinating all statutory approvals) .

2.05.00 **Management of Health & Safety**

The Contractor shall provide the following:

- A management structure for coordinating health and safety from the design stage through construction and final commissioning.
- A management system for ensuring arrangements for safety training, safety meetings and reporting of accidents.
- A method of assessing design information for health and safety requirements during construction.
- A safety plan for the construction phase.

A guideline to Occupation Health and safety is attached as Attachment-I at the end of this section.

3.00.00 **GENERAL REQUIREMENTS OF PROGRAMMES AND SCHEDULES**

The programs supplied by the Contractor as part of the Contract shall fully inter-relate design, manufacture, erection and commissioning. Events shall be identified

in all programs and agreed with the Consultant. Events shall indicate points in the programs at which a significant stage has been reached and which is of sufficient status for reporting to management. All programs containing scheduled dates including those for Design, Manufacturing and for Site Erection shall be adhered to by the Contractor and shall not be changed except as may be agreed by the Owner/Engineer.

The Contractor shall designate a Planning Representative who shall be readily available at all reasonable times to the Engineer and who shall be of sufficient status to have free access to the Contractor's management staff and to the Contractor's and Sub-Contractors workshops, site works etc. and shall be able to represent the Contractor on all matters of planning and progress.

3.01.00 **Form of Programs**

3.01.01 **Bar Charts**

Bar charts shall be submitted in form of standard computer print-out, metric suitable for presenting in A4/A3 sizes. They shall have a date scale at the top and plant/areas of work sections identified at the left hand side. All floats shall be shown and where logical connections exist between activities, they shall be indicated.

3.01.02 **Networks**

Networks shall be presented in the form of arrow or precedence diagrams with clearly defined plant/areas of work indexed at the left hand side. Where more than one sheet is used, the activities shall be cross-referenced to other sheets for ease of identification.

3.01.03 **Computer Printouts**

Each network, bar chart and PERT shall be generated by an internationally recognized software (Primavera /MS Project) which shall contain a minimum of an activity list sorted by activity number and including an activity description, duration, calendar, float, predecessors and logical connections, target start and finish dates, together with details of the calendar(s) used.

3.01.04 **Schedules of Dates**

Where appropriate, schedules of dates may be submitted in support of Network activities. They shall be to a standard format, preferably A4 size, for ease of filing and indexing and should clearly show the work/area of plant concerned at the bottom of the sheet with an identifying number and date.

3.01.05 **Time Units**

In all programs where time units are identified, calendar dates shall be used. For dating purposes the week shall start on Monday.

3.01.06 **Abbreviations**

A list of all standard abbreviations used on each network or bar chart shall be displayed on each individual sheet of the programme.

4.00.00 **IMPLEMENTATION SCHEDULE**

4.01.00 The schedule for the completion of the Power Project shall be as stated in the Section-III of this Specification.

4.02.00 Contractor shall furnish a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

To achieve the targets shown in L-1 network, the Contractor shall furnish to the Owner, various schedules as defined below:

4.02.01 **Engineering Schedules**

These schedules shall cover various design submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Contractor for each and every plant/systems/equipment item covered in the scope of this specification.

4.02.02 **Manufacturing and Delivery Schedule**

The Contractor shall submit to the Engineer his manufacturing and delivery schedules for all equipment within sixty (60) days from the date of issue of the Letter of Acceptance. Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). All despatch details and item lists shall be made available to both Owner & site immediately after shipping.

4.02.03 **Erection Schedules**

The Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/agreements with the Owner subsequent to the award of contract.

4.03.00 The Contractor shall provide the Owner all such schedules in electronic media within a time schedule to be agreed between Owner and Contractor at the time of award. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a form compatible with Owner's project management software.

5.01.02 **Monitoring & Progress Reporting, Management Information system**

The progress reports would be issued every month, one from the head office of the Contractor and another from the site office. Reports shall include such schedules, charts and drawings as the Owner/ Consultant considers necessary for adequately monitoring the Contract. The reports shall be made available to the Owner/Consultant at least five working days prior to scheduled progress review meeting. The monthly report to be released before the 10th of the next month .Monthly meetings can be scheduled 15th to 20th of the month .

The progress report issued from the head office should necessarily include the following sections:

a) Report on key milestones.

b) Management summary indicating critical areas with details of actions initiated and effect of any on the project.

c) Action needing attention of the Owner/Consultant.

d) Detailed package wise status of engineering submissions, quality plan submissions and approval, procurement, manufacture and despatch.

The monthly report generated from the site office should necessarily include:

e) Report on key milestones.

f) Management summary indicating critical areas with details of actions initiated and effect if any on the project.

g) Action needing attention of the Owner/Consultant.

h) This report shall also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning including status of all statutory requirement /approvals.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports on progress in critical areas so that actions can be expedited. The exact format and contents of the progress reports shall be finalised before award of Contract.

5.02.00 **Engineering Management**

Based on the ground master network for the project (L-1) the Contractor shall prepare an exhaustive list of engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for engineering activities.

5.00.00 DETAILED RESPONSIBILITIES

The Contractor shall provide effective management of the Contract which shall be compatible with the Owner's requirements as set out in this Specification. He shall allow access to his works and those of his sub-contractors at all reasonable times to permit the Owner/Consultant's participation if the Owner/Consultant considers it necessary in monitoring the Contract. He shall also work with other contractors who interface with the contract in order to ensure the smooth development of the project completion. Such participation up to its completion shall not, in any way affect the Contractor's obligations to complete the works in accordance with the Contract.

5.01.00 Planning & Monitoring

5.01.01 Planning

The Contractor shall prepare a Master Network Schedule in the form of PERT network consisting of at least 500 activities. The network shall be prepared on a Work Breakdown Structure.

The master network shall identify milestones of key events for each system/package in the areas of engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans.

The master network shall be submitted and shall be mutually discussed and finalised before the award of Contract and not later than release of initial advance and to be tied up with release of advance. This master network shall clearly indicate the responsibility of the Contractor and project management team. This master network would form a part of the Contract. The master network shall also identify a complete list of inputs to be furnished by the Owner, which may be required for proper interfacing and tie-up. The scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

The Contractor shall not change the Master Network without the prior approval of the Engineer in accordance with the Conditions of Contract. In the event that the Engineer approves a revision to the Master Network in accordance with the Conditions of Contract, the Contractor shall submit a revised Master Network within two weeks thereafter. This programme shall fully comply with the requirements of the specification and where necessary, reflect changes to the sequence or progress of the Works directed by the Engineer, or as proposed by the Contractor and accepted by the Engineer. Such an agreed revised programme shall become the Overall Contract Programme for the outstanding Works.

Based on (L-2) network, the Contractor shall further develop the Level-3 (L-3) network for engineering activities which will indicate schedule for data availability, drawing release date and document submission dates. These can be in the tabular form giving the schedule dates tying up with L2 Schedule.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of award of Contract and finalised within one (1) month thereafter.

The engineering management team shall also co-ordinate all interface engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

5.03.00 **Contracts Management**

Based on the master network, the Contractor shall submit L-2 programs of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programs shall be submitted in two (2) months time from the date of award of Contract and finalised within one (1) month thereafter. The Contractor shall also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor shall also submit L-3 programs for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Engineer or his authorised representative(s) before further manufacture can take place. These L-3 programs for the manufacture and despatch shall clearly identify responsibilities of the Contractor, sub-contractor and Owner. These networks shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programs shall be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of bought out items, and shipping schedule for Owner's approval.

5.04.00 **Construction Management**

5.04.01 Based on the L-1 Master Network Programme, within two (2) months of the award of the Contract, the Contractor shall submit a programme of construction/erection/ commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These programs would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based

on the site conditions would be prepared based on these L-3 programs. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment, which should be taken care of in the despatch programs.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/system supplier.

5.04.02 **Construction Methods, Logistics and Equipment**

a) **Contractor's Proposals**

The Contractor shall describe the sequence of erection of major plant items and his proposed construction methods supported by diagrams and drawings, as necessary. The sequence of operations shall incorporate the designers' health and safety requirements. The Contractor shall relate movement of major Contractor's equipment to the construction programme time scale. The Contractor should identify the list of Over Dimension Components (ODC) items .The Contractor shall propose his delivery methods and routes to the site including ODC items and identify special or abnormal loads or cargoes with dimensions and the actions to be taken including any road diversion or strengthening of bridges/culverts

b) **Contractor's Contract Equipment**

The Contractor shall detail all his Equipment to be used on site including various cranes like tower cranes , gantry cranes in the fabrication yard , chain mounted crane etc., fixed workshop equipment and vehicles. The information shall include size and capacity and indicate the duty for which they are required. The Contractor shall describe the usage intended for each crane.

c) **Contractors Proposals**

The Contractor's proposals with regard to construction methods, logistics and equipment confirming the above bid proposals and agreed amendments thereto, shall be submitted to the Engineer for approval within two (2) months of the award of Contract along with his construction management programme. The contractor also submit the proposal for the lay down area, colony (residential) area for labour for each of the sub contractor to facilitate organized systematic planning.

5.05.00 **Spares Management**

5.05.01 The Contractor shall provide a suitable spares management system.

5.05.02 It is the responsibility of the Contractor to ensure availability of spares during the period of testing and commissioning and all spares to meet Contractor's obligations under the Defects Liability Period.

5.05.03 The Contractor shall provide a spares storage facility which shall be equipped with suitable lifting and handling devices where needed. The storage facility shall be designed for long term storage of spares.

5.05.04 Contractor shall define the spares management system and the storage facilities provided.

5.06.00 **Resource Control**

To enable the Owner to assess that the Contractor's proposals are adequate to meet the contract Programme requirements, he shall describe his resource management system for the Contract

The Contractor shall define the resources that shall be deployed during design, manufacture, erection, setting to work and commissioning phases and show that those will be adequate to meet the Contract commitment. He shall provide in histogram form for each discipline, the resource disposition for design development, manufacture, erection and commissioning and state the degree of supervision.

The site labour requirements given in the above Schedule shall be segregated into trade categories to meet the site erection programme and shall be confirmed at the time of award of Contract and updated and agreed one (1) month before work commences on site.

Following the placing of a Contract, the Contractor shall submit monthly resource deployment schedules segregated into design, manufacture, erection and commissioning. The Contractor shall, on a weekly basis, submit for signature, detailed labour returns for all site personnel throughout the construction and Plant Commissioning activities.

5.07.00 **Production Control and Manufacture**

5.07.01 **Manufacturer's Standards**

The Contractor shall state the Standards to which a manufactured equipment/component is offered where the Specification has not specified any requirement.

5.07.02 **Places of Manufacture**

The manufacturers and places of manufacture, testing and inspection of the various parts of the Contractors Works shall be stated in the Bid.

5.07.03 **Sub-Contractors**

The Contractor shall submit, a list of all items that he deems necessary to be sub-contracted.

The Contractor's orders to the Sub-Contractors shall quote the Owner's contract reference and station name, and instruct the sub-contractors to quote that number and name and also the order number in all correspondence.

A copy of all orders (which may be unpriced) placed on sub-contractors, and of all orders placed by sub-contractors shall be supplied to the Owner/Consultant.

The Contractor shall be responsible for maintaining an up-to-date list of all sub-orders and interworks order and shall make this available to the Engineer as required.

The Owner's Contract Reference and Station name shall be added to all interworks and sub-orders.

The Owner reserves the right to check that the Contractor is making timely payments to his sub-contractors.

The Contractor shall ensure that their sub-contractors follow the requirements of the Specification and have adequate control over all aspects covered by the specification.

5.07.04 **Progress Reports**

During the design and manufacturing stages the Contractor shall submit to the Owner's Engineer reports and information on the progress and manufacture by himself and by the Sub-Contractors of all plant and materials required for the execution of the works. The reports shall be based on the plant manufacturing programs.

The detailed procedure and requirements for progress reporting will be agreed with the Engineer during the early phase of the works, as part of regular contract/project status reporting.

5.07.05 **Access for Progress Monitoring**

The Owner's Engineer or his nominated representative shall be entitled at all reasonable times to visit all premises where design and manufacturing of the plant is being carried out in order to monitor and verify progress.

5.08.00 **Commissioning Management**

5.08.01 For commissioning of the various equipment/system covered under the scope of Contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

a) Steering Committee.

b) Commissioning Panel.

c) Working Parties.

d) Testing Teams.

5.08.02 Commissioning documents shall be prepared by the Contractor in the following manner and submitted for Owner's approval:

a) **Paper of Principle**

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least twelve (12) months before the actual commissioning:

i) Establish design data against which Plant Performance will be compared.

ii) Set-out the testing objectives and proposals.

iii) Define the documentation required.

b) **Testing/Commissioning Schedule**

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

c) **Standard Check Lists**

Standard checklists shall be prepared for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

d) **Instrument Proving Schedules**

These schedules shall be prepared for proving various instruments associated with all equipment/packages.

Schedules and lists under items (b), (c) and (d) above shall be submitted at least six (6) months before the actual commissioning of the equipment/systems.

5.08.03 **Test Reports**

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-a-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

6.00.00 **OWNER'S RIGHTS**

The Owner reserves the right to evaluate and audit the Contractor's management systems and controls in the following areas: Contract Management, Management Information, Programme Management, Resource Management, Quality Assurance, Design, Production and Manufacture, Industrial Relations, Erection, Testing, Commissioning, Sub-Contract Control and Site Management. The Contractor shall provide all necessary assistance to enable the Engineer carry out such audits and evaluations. Such audits and evaluations shall not in any way relieve the Contractor of any of his liabilities and responsibilities under the Contract. A corrective action programme shall be agreed and implemented in respect of any deficiencies revealed by such monitoring, without any cost implication to the Owner and impact on the time schedule for the project.

7.00.00 **PROJECT PROGRESS REVIEW MEETINGS**

Periodic project progress reviews will be held at least once every month at venues mutually agreed. These meetings will be attended by of the Contractor and their leading sub-contractors. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued and circulated to all concerned for reference and action. The Contractor shall be responsible for ensuring that actions placed on him in such meetings are carried out in time.

In addition to the above, a suitable frequency and forum of periodic meetings between the Contractor and the Owner's Engineer will be decided upon as part of erection coordination procedure.

Besides the above at site level there will be departmental meetings with Main contractor/ subcontractor to review the weekly quantity achievements against target in predefined format with provision of identifying the next week target and a remarks column to spell out action for meeting delays.

ATTACHMENT TO VOLUME-II - SECTION-XIII

PROJECT MANAGEMENT SERVICES

1.00.00 OVERVIEW

The occupational health and safety management and environment management plays a significant role in the effective assurance of staff health and safety as well as the effective control on pollution to environment resulted from the construction. It becomes one of the important contents in project management.

The documented safety management system and environment management system must be established for the Project based on the occupational health and safety management system and environment management system and must be implemented effectively.

The occupational health and safety management system and environment management system are compliant with the scale and nature of the Project.

2.00.00 OBJECTIVE

- Nonoccurrence of major structure safety accident on works due to design;
- Nonoccurrence of major injured and fatal accident of staffer;
- Nonoccurrence of major accident on damage of equipment;
- Nonoccurrence of major accident on damage of construction machinery;
- Nonoccurrence of major fire disaster;
- Nonoccurrence of major traffic accident with main responsibility borne;
- Nonoccurrence of accident on environmental pollution and major accident on collapse and slump;
- Nonoccurrence of accident on occupational mass poisoning and food poisoning;

3.00.00 ON-SITE HAZARD IDENTIIFICATION AND RISK ASSESSMENT

The contractor shall organize and carry out hazard identification and risk assessment so as to realize the safety objective by means of the risk control approach as "identification, assessment, plan, control, performance monitoring and continuous improvement".

4.00.00 PLANNING OF OCCUPATION HEALTH AND SAFETY

4.01.00 The contractor and his subcontractor (including survey, design, equipment manufacture, transportation, construction, debugging and commissioning, etc.) shall carry out the hazard identification and risk assessment in accordance with the characteristics of its own task, and shall scheme the occupational health and safety management and contrive the program of

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occupational health and safety management, based on the hazard identification and risk assessment. The program shall be submitted to the Owner approval. After being approved, it shall be used as the basis of safety management for the Project.

4.02.00 The contractor and his subcontractors shall establish Procedure File of occupational health and safety management, so as to ensure the effectiveness of occupational health and safety management system for this project.

Main Procedure File of occupational health and safety management to be established shall include but not limited to:

a) Control Procedure for Hazards Identification and Risk Assessment

b) Safety Education and Training System

c) Control Procedure for Monitoring and Measurement of Occupational Health and Safety Performance

d) Rules on Handling of Breaking Rules and Regulations

e) Control Procedure for Emergency Preparation and Response

f) Special Operation Management Procedure

g) Hazardous Chemicals Management Procedure

h) Management System for Radiation Protection

i) Rules on Fire Safety Management

j) Rules on Traffic Safety Management

4.03.00 The contractor and his subcontractors shall allocate the requisite safety facilities according to relevant regulations.

5.00.00 MAIN CONTROL MEASURES FOR OCCUPATIONAL HEALTH AND SAFETY IN PHASE OF DESIGN

5.01.00 Proposal on design of fire protection, explosion protection, dust prevention, antipoisoning, chemical injury prevention, sunstroke prevention, winter protection, shock resistance and lightning strike prevention shall be get approved by the Owner.

5.02.00 Stability of structure and equipment, strength of components, bearing capacity of embedded parts, and design of pipe bracket and hanger, cable bracket and thermal protection of pipe, etc. shall be get approved by the Owner.

5.03.00 Implementation of survey and design of control measures on risk factors of field operation will be supervised and inspected by the contractor as well as by the Owner's representative at site.

6.00.00 **MAIN CONTROL MEASURES FOR OCCUPATIONAL HEALTH AND SAFETY IN PHASE OF EQUIPMENTS/ MATERIALS PURCHASING**

6.01.00 Emphasis shall be laid on review of technical requirements for safety management of explosive, inflammable and leaky equipment, such as the equipment of pulverizing system, fuel system and water treatment system, etc.

6.02.00 Proposal on massive products transportation safety shall be reviewed.

6.03.00 It shall be supervised and inspected whether or not the package, protection and storage management of equipment and material meet the requirement of safety.

6.04.00 All the above proposals/procedure shall be got reviewed and approved by the Owner before implementation.

7.00.00 **MAIN CONTROL MEASURES FOR OCCUPATIONAL HEALTH AND SAFETY IN PHASE OF CONSTRUCTION**

7.01.00 Arrangement of safety management institution, personnel allocation of the contractor and subcontractor as well as arrangement of safety tools and instruments and labor protection articles, safety training programme etc. shall be reviewed from time to time by contractor's safety incharge along with the Owner's representative to suit the project requirement.

7.02.00 Product certificate, permit certificate, installation and dismantling license, test report, test record, etc. of hoisting machinery shall be reviewed. Workload of any equipment shall not be allowed to exceed the allowable safe load. Approval of local authorities shall be obtained by the contractor, if called for.

7.03.00 Qualification and proposal of the contractor / subcontractor for blasting shall be reviewed and approved by the Owner. The petrolic products and explosive for engineering shall be stored in accordance with rules and regulations specified in Petroleum Act, Explosives Act and Petroleum and Calcium Carbide Manual. The Contractor shall be responsible for obtaining the necessary approval from Chief controller of Explosives and other statutory authorities.

7.04.00 The contractor / subcontractors shall provide adequate qualified and certified fire equipments for warehouse, office, temporary structure, living quarters etc. as well as for inflammable and explosive operation sites, etc. The scheme shall be got approved by the owner and by Statutory Authorities.

7.05.00 The Contractor and his Subcontractors shall identify all important and hazardous process of the Project and shall prepare detailed Operation Instruction. The Instruction shall be checked by the personnel with corresponding level, and shall cover the preparation of safety measures, determination of measures executive and safety supervisor, etc. and safety technical clarification system shall be executed as well. The copies of such documents shall be furnished to the Owner for approval.

7.06.00 Main safety measures shall include but not limited to:

a) Safety measures for construction during summer and monsoon.

b) Safety measures for lifting of heavy equipment components such as steam drum, deaerator water tanks, generator stator and main transformer, etc.

c) Safety measures for construction inside vessels and pipelines

d) Measures on fire protection, explosion prevention and lightning prevention

e) Safety measures on charged operation and electric test

f) Safety measures on high-altitude erection operation

g) Safety measures on heat processing and non-destructive inspection

h) Safety measures on blasting of earth and stone

7.07.00 A construction management programme proposed for the project shall be submitted. The security/safety group activities at site shall be formed by the Contractor for management of all Administrative Regulation on Arrival at and Departure from Site shall be established for all personnel of the Contractor and his Sub-Contractors, identifying the procedures and safety requirements for personnel and material arriving at and departing from the site.

7.08.00 The Contractor shall ensure proper hygienic atmosphere at residences, offices, dining halls etc. for all staff engaged by him and his sub-contractor.

8.00.00 **EDUCATION AND TRAINING ON OCCUPATIONAL HEALTHE AND SAFETY**

8.01.00 The Contractor shall ensure establishing, maintaining and implementing acceptable Administrative Procedure for Education and Training on Occupational Health and Safety, enabling all personnel under him and his Subcontractors to obtain relevant training on the subject.

8.02.00 The Contractor shall provide education on safety consciousness and training associated with safety knowledge for on-site personnel entering the site in a hierarchical manner, enabling them to get aware of the safety requirements and risk factors at the Site.

8.03.00 The Contractor shall deploy the training and safety drill about emergency response plan on the employees, and make them to learn the measures and countermeasures of emergency response plan for various possible events in the Project and knowledge about first aid, and practice their ability of escape and self rescue under various conditions.

9.00.00 **MANAGEMENT FOR CIVIL CONSTRUCTION ACTIVITIES**

Planning for safety regarding civil construction activities of the Project shall be carried out regarding the following aspects: the gate design, safety publicity, atmosphere rendering safe and civilized construction, fixation

management, responsible area management, laying of high pipelines, pressure, environmental protection as well as planning for temporary buildings, etc.

9.01.00 Management system of civil construction

Prior to commencement of the project, the Contractor shall establish the following management systems including but not limited to: Basic Content and Standards for Civil Construction, Civil Construction Inspection System and Implementation Methods for fixation Management, etc.

9.02.00 Basic requirements for civilized construction:

a) The relevant name plates/sign boards shall be set in the conspicuous position of the gates on the construction sites. The sign board for prohibition, alarm or prompt shall be set at the dangerous places and buildings shall be displayed.

b) The managerial personnel as well as workers shall wear the identification cards which validate their identities on the construction site.

c) Each temporary facility shall be arranged in accordance with the general layout plan for construction.

d) The construction machinery shall be set as per the location and route specified in the general layout plan for construction. The safety inspection and test shall be carried out for the construction machinery which will enter the site. The operators of construction machinery must possess competence certificates for operating the machines.

e) The roads on the construction site shall be kept smooth, and the drainage system shall be in good condition for use. The site shall be kept tidy and clean. The construction rubbish shall be cleared as soon as possible, and not later than the end of the none shift.

f) Necessary living facilities for the staff, which meet the requirements of sanitation, ventilation and disinfection, etc., shall be provided on the construction site.

9.03.00 The Contractor and his Sub-contractors shall execute the management system for Construction in all areas.

9.04.00 The living area, the construction area and office area shall be arranged separately. Efforts shall be made to enable standardization and keep unified identification in office building, temporary living building and temporary construction building.

9.05.00 Parts of the construction for the underground facilities shall be implemented in time.

9.06.00 The site office, tool room and living area shall be kept tidy, neat and standardized as far as possible. Temporary construction sheds at random shall be avoided.

9.07.00 The centralized rubbish stacking yard shall be arranged on site, where the rubbish shall be stacked by category. The Contractors in each section

shall be responsible for cleaning and sanitation of the site and the construction access road. The site shall be kept tidy and the road shall be kept smooth and accessible without obstructions due to rubbish/equipment/parked vehicles etc.

9.08.00 During the site construction, "completion of construction, exhaustion of materials and cleanness of site" shall be accomplished.

9.09.00 Construction cables shall be embedded under the ground directly, and the signs shall be marked.

9.10.00 The roads of plant area, drainage channels, stacking yard for equipment and materials and the waste soil must be planned and managed in accordance with the general layout planning for construction during the construction. The field shall not be occupied at random. Application permissive system shall be executed for the temporarily occupied construction access roads or passages, water-break and power cut for the requirements of the construction.

9.11.00 The Contractor/his Subcontractors shall implement the strengthening fixation management of equipment and materials, especially in some important places such as assembly yard, boiler room and steam engine room, etc.

9.12.00 During the erection of heavy equipment, adequate measures shall be taken to prevent the falling of objects/components from high altitude.

9.13.00 All kinds of scaffold in the construction area must be erected and dismantled by the professional construction personnel. The structure shall be rational and firm. After accepted via inspection, it can be signed and marked with the principals, load capacity and service life.

9.14.00 The Contractor/Subcontractor shall ensure that the mechanical equipment for construction is in intact and tidy condition, and the safety operation procedures are complete. Operators engaged in duty shall possess competence certificates, and shall be familiar with the mechanical performance and working condition. Inspection and maintenance shall be carried out regularly.

10.00.00 **ENVIROMENTAL PROTECTION**

10.01.00 Identification and assessment for environmental factors

a) The Contractor and his subcontractors shall endeavor to identify, analyze and assess the environmental factors which may be affected by the Project, and shall determine the important environmental aspects and establish controlling planning to avoid any detrimental consequences.

b) The following types shall be considered for the Identification for environmental factors.

- Pollutants discharging into the water body;
- Pollutants emitting into the atmosphere;
- Pollutants discharging into the soil mass;
- Utilization of raw materials, energy sources and resource;

- Impact of noise on the ambient environment;
- Energy release (such as heat radiation, electromagnetic radiation and vibration, etc.)
- Discharge of solid and liquid waste;
- Impact on the surrounding residential community and residents.

10.02.00 Measures for environmental protection in the phase of design

a) The Design Department shall make assessment on environmental impact due to the Project, and shall consider how to enable the solid waste, waste liquid and waste gas discharged from the thermal power plant to completely meet all the requirements of the Contract, and enable them as the input for environmental protection professional design.

b) Suitable API oil separator shall be designed for the treatment of waste oil and water.

c) The acid and alkali neutralization tank shall be designed to treat the waste generated from chemical scrubbing for the boiler and auxiliary equipment during the commissioning phase. The dimension and equipment of this tank shall be designed sufficiently for recycle, and shall be used and treated by means of environmental protection.

10.03.00 Measures for environmental protection in the phase of construction/commissioning

a) Each Construction Contractor shall duly clean and transport the living rubbish and garbage generated during the construction of the Project to the specified site; stacking by category as well as centralized treatment shall be employed so as to prevent pollution to the environment.

b) Necessary water flushing toilet shall be set on site. All the polluted water on site shall be discharged after the treatment.

c) Construction for waste slag and soil due to the construction shall be carried out strictly in accordance with the construction scheme so as to prevent partial water and soil loss and impact on flood flowing in river courses.

d) Each Construction Contractor shall treat the package and wastes remained after the use of hazardous chemical so as not to pollute the environmental.

e) Each Construction Contractor shall establish the procedures for control for dust and noise emission, and shall take effective measures to control the noise emitted from blowpipe of steam engine, etc. and shall monitor the emission regularly.

f) Phenomena such as leakage for coal, dust, wind, gas, steam, oil, water, smoke, etc. shall be eliminated from each main and auxiliary equipment and various pipelines, boxes and tanks.

11.00.00 **CONTROL FOR MONITORING AND SURVEY ON PERFORMACE OF OCCUPATIONAL HEALTH AND SAFETY AS WELL AS ENVIRONMENT MANAGEMENT**

In order to verify whether prospect for the planning has been realized or not, the Contractor shall monitor and survey the occupational health and safety as well as environment management.

12.00.00 **PLAN FOR EMERGENCY PREPATATION AND RESPONCE**

12.01.00 The Contractor shall along with the subcontractors, identify the potential accidents, incidents or emergency.

12.02.00 The Contractor and his relevant Subcontractor shall establish emergency rescue system, prepare relevant emergency schemes, and submit them to the Owner for approval and implementation.

12.03.00 The emergency schemes for fire accidents, accidents of scaffold collapse, large construction implement accidents, fatal traffic accidents, etc. shall be established for the Project.

12.04.00 The emergency fire fighting and command organizations composed of each construction Subcontractor as well as the obligation fire brigade on its own shall be established. The members of obligation fire brigade shall be trained relatively and shall be of corresponding capability.

12.05.00 Infirmary/First Aid Stations shall be set on site, and first-aid medicines and stretchers shall be made available. An arrangement for rescue and treatment for the wounded shall also be established with the local hospitals. In case of group injury accidents, emergency rescue shall be organized, and help of local hospitals shall be asked for when necessary.

OCCUPATIONL HEALTH, SAFETY AND ENVIRONMENTAL (HSE) MANAGEMENT SYSTEM FOR THE CONTRACTOR

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ATTACHMENT-1

1.0 SCOPE AND PERSONAL PROTECTIVE EQUIPMENTS (PPE's)

1.1 SCOPE

The Health, Safety and Environment (HSE) Management System shall ensure the following:

1.1.1 All product supplies, Engineering, Construction /Erection and Commissioning within the Owner's Plant compound or within the property of the Owner is made/ carried out in a manner, which does not present a Health, Safety and Environment risk.

1.1.2 Compliance of all the local regulations (Acts, Rules and IS specifications) Pertaining to Health- Safety and Environment including employment and conditions of services.

1.1.3 Compliance of HSE standards and guidelines

1.2 PERSONAL PROTECTIVE EQUIPMENTS (PPE's)

All personnel of Contractor/ his Sub-contractors within power plant's works premises must use standard quality PPE's in line with uniform guidelines.

- Safety helmet with chin strip
- Safety shoes
- Hand gloves
- Nose mask
- Ear plug
- Safety goggles for dust protection
- Full body safety harness

- Leg guards
- Aprons
- Welding goggles
- Cutting goggles
- Fire suit
- Shock proof shoes and gloves against electrical safety

2.0 CONTRACTOR's HSE MANAGEMENT SYSTEM FOR PROJECT SITE.

This system shall include the following as minimum:

1. Selection of Contractors/Sub-contractors
2. Engagement of Contractors /Sub- contractors
3. HSE Risk Assessment
4. Registration of Contractors/Sub-contractors
5. Contractor/Sub-contractor Induction
6. Contractor's/Sub- contractor's Equipment and Materials -

Hoist, Cranes and other Lifting Appliances, Electric Tools, Pneumatic Tools, Scaffolding/ Ladders/ Roof-work and Excavation, Oxygen/ Acetylene Equipment, Explosive, Powered Tools, Radiation Equipment, Petrol and Diesel Driven Equipment/Traffic and vehicles, Plant and Machinery, Fire, Welfare, Electricity, Tag out, Emergency preparedness etc.

3.0 HSE IN PURCHASING – SUPPLY ITEMS

This shall cover:

Purchasing data, Verification of Purchased products /services, product identification and traceability, Control of non-conforming product/ process handling, storage, packing, Identification of risks, hazards and countermeasures.

4.0 HEALTH and SAFETY (H and S) MEASURES and STANDARDS

The H & S measures shall ensure the following as minimum:

4.1 H & S of Contractor's Workers, H & S of other workers and Visitors not employed by the contractor but affected by the Contractor's Work.

4.2 Compliance of all the regulations (Acts, Rules and IS specifications) pertaining to Health - Safety and Environment including employment and conditions of services.

4.3 Effective implementation of Contractor's own H & S policies, practices and procedures as an integrated system with set of process – "Plan- Do-Check-Act"

1. Display of Project EHS (Environment, Health and Safety) Policy
2. System education and training
3. Identification of risks, hazards and countermeasures.
4. EHS Plan and EHS Targets
5. Implementation and operation of Project EHS Plan
6. Evaluation of Sub-contractors EHS and Safety Management Capabilities

7. Emergency Plan
8. Routine Inspections/audits and corrective and preventive actions.
9. Investigation of accidents /incidents and corrective actions.
10. Documentation , recording and reporting
11. Documented procedures for medical treatment, Lockout, Alert, etc
12. Monitoring/Auditing of Contractors Activities
13. Reporting and Investigation Injuries and incident

4.4 H &S STANDARDS

Sl. No.	AREA	SUB SECTION	SHORT DESCRIPTION
1	FIRE SAFETY	HAND APPLIANCE	Installation of Suitable Portable Fire Extinguishers (DCP and CO2) at identified locations.
		MECHANICAL DRIVEN FIRE ENGINE	Portable Tailor water Pump with 30litre/second at 5.6 kg/cm2
		WATER SUPPLY	One static over head tank 45000 liters capacity
		FIRE HYDRANT SYSTEM	Suitable for entire plant with 7 kg/cm^2 pressure and 150 mm dia pipelines.
2	CONVEYOR SAFETY	NIP /TOE GUARDS	Gravity tensioning units must be enclosed in a 2.5 metre high guard with no gate access.
			The head, tail and tensioning elements of conveyors systems must be guarded.
			On conveyors longer than 200 metre, isolation and lock out system shall be installed at each end of the conveyors.
			Each conveyor system must have an audible start up warning system support by a visual system where necessary.
3	STAIR	General Best Practice	Use of stairs as opposed to vertical ladders.
			New Stairs installed in wood is not acceptable due to high combustibility. Steel meets LCM standards.
			200 mm Wide stairs are to be used.
		Treads	Use Aimico or equivalent manufacturer.
			Welded construction with checker plate nosing and serrated bracing bars 900 mm long x 250 mm wide.
			8 bracing bars @ 32 mm x 5 mm
		Hand Railing	All members to be 40 mm x 40 mm x 6 mm angles HSS or equivalent
			Top railing and mid railing covering 1.2 meter height.
			Use 250 mm stringer channel.
			Run size – 250 mm, Rise Size – 180 mm min.
		Toe Guards	All staircase platforms should be provide with Toe Guards
		Color codes	Railing - Yellow, Grating - Black, Toe Guard - Fire red.

5	Working at Height	Movable ladders	Six monthly ladder inspection.
			Rubber footed all portable ladders.
			Ladders shall be extend at least 1 metre above a landing.
			Use Cats Walk Way ladders for fragile roof.
			Apply the 1 out, 4 up rule to ensure ladders are set at the most suitable angle.
		Fixed Ladders	Ladder runs shall not exceed 9 metre without a landing area /platform at suitable intervals.
			Safety hoops shall be provided for vertical fixed ladders. The hoops shall commence at height of 2.5 meter above the base of ladder
		Scaffolding	Suitable precautions shall be taken to prevent all fall from scaffolds. Guard rail at height of at least 900 mm and toe boards at least 150 mm high shall be provided at the side of all platform, where person is liable to fall a distance of 2 m. Intermediary guard rail, screens or similar shall be used to ensure the maximum unprotected gap between guard rail and toe board does not exceed 500 mm. All scaffolding shall be constructed so that they are stable including when they are altered or modified. Platform shall be a minimum of 600 mm wide and the boards closed together to prevent gaps in the platform.
		Matter specific to Tower scaffolding	The maximum height to base ratio for a free-standing external, mobile scaffold shall be 3:1. The base can be increased by the use of out triggers.
		Working on Roofs	No work shall be carried out on roof , except on those fitted with permanent provisions to prevent falls until roof permit has been issued.
			With latest amendment in Law, Every roof should have safety railing at the corner to protect the person while working on roof.
		Safety Harnesses	Full body safety harnesses.
		Medical Certification	Persons working at Height should be thoroughly examined by CMO.
			A competent person must be deployed.
6	HEALTH		Occupational Health check up, rest shelters, drinking water and toilet to be provided as per regulation.
7	LIFTING TOOLS and TACKLES (Including Cranes, Hoists, etc)		Properly maintained and shall be thoroughly examined by competent person and a register shall be kept for such records.
8	PORTABLE TOOLS		In confined space use 24-volt hand lamp with net protection and use of suitable ELBS in case of 240 Volts.

9	**BUILDING CONSTRUCTION**	All building duly checked for Stability test within six months of Commissioning of Site.
10	**SAFETY OFFICER**	Competent Safety Officer.
11	**Emergency Plan**	Emergency plan/disastrous management plan and mock drill.

5.0 ENVIRONMENTAL MEASURES

These shall cover:

5.1 Compliance of all Local Regulations and Environment Standards.

5.2 Waste minimization, recovery and disposal and compliance to MSDS.

5.3 **HOUSE KEEPING**

i. Safe storage, handling, use and disposal of all materials.

ii. Storage of materials while job execution at defined locations, on shift/ daily basis.

iii. Scrap and Waste material disposal at pre defined storage locations in field and subsequently to one central storage yard.

iv. The scrap and waste must be separately stored in following 3 main categories:

(a) Ferrous material storage (Iron and steel)
(b) Non-ferrous material storage (Aluminum, Copper, Tin etc.)
(c) Non bio-degradable materials (Plastic, rubber etc)

5.4 Storage, handling and use of Petroleum paint other hazardous materials.

5.5 Exhaust emission control from mobile (vehicles) and fixed equipments.

5.6 Monitoring and control of CO_2 Emission.

5.7 Conservation of water, electricity and other non-renewable materials.

6.0 CONTRACTOR'S MANAGEMENT RESPONSIBILITY and COMMITMENT:

6.1 Responsibility

The Management Responsibility shall ensure compliance with all requirements of defined procedures to meet the EHS Standards by

1. Company Representative /Manager
2. Contractors
3. Sub Contractors
4. Consultants

6.2 Commitment

6.2.1 Health - Safety and Environmental Policy

Contractor's Project Management should publish the occupational health and Safety and Environmental Policy of the Organisation, declaring their commitment. The copy of the same should be made available to all working persons at construction site. The project management should also formulate their safety programme.

- Identify the Contractor's Site Manager or Team Leader.
- Confirm insurance cover.
- Confirm that the personnel on Site are those specified in the Project Preparation evaluation. If there are differences, check competence, qualification and licensing.
- Check plant, equipment and substances being brought onto Site against earlier listings. Confirm maintenance and statutory inspection details. Have electrical equipment being brought onto site checked by competent company electrical personnel

7.0 CONTRACTOR REGISTRATION

- Confirm that the Contractor and any Sub-contractors are not permitted to use the Owner's equipment or personnel without specific prior arrangements having been made by the Project Co-ordinator. Normally such use shall not be permitted.

- Confirm the extent to which the Contractor may use the Owner's services and utilities.

- Provide Site induction training in full for all Contractor's personnel, ensuring that understanding is checked by examination.

- Issue dated badges or passes, valid for the contract term to each of the contractor's personnel who have passed the induction training evaluation.

- Sign and date the Contractors Registration checklist and get it signed by the contractor's Site representative.

ATTACHMENT-2

OCCUPATIONL HEALTH, SAFETY AND ENVIRONMENTAL (HSE) CLAUSES AND SPECIFICATION FOR CONTRACTOR'S WORK CONTRACT

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II)	WORKING AT HEIGHT: MOVABLE LADDERS, FIXED LADDERS, SCAFFOLDING, TOWER SCAFFOLD, WORKING ON ROOFS, SAFETY HARNESS, SAFE MEANS OF ACCESS TO RAIL, ROAD CEMENT TANKS, FALLING OBJECTS, MOBILE ELEVATED WORK PLATFORMS (MEWP), APPENDIX-1* & 2*	2
III)	SCAFFOLD SAFETY: FALLING OBJECTS, ELECTRICAL HAZARDS, GROUND CONDITIONS, SCAFFOLD MATERIALS, WORKING AT HEIGHT, PROTECTION FROM FALLING OBJECTS, SCAFFOLD STRUCTURE, COMPETENCE, PLANNING, STABILITY AND PPE's	11
IV)	ROAD SAFETY and DRIVING: MANDATORY CLAUSES, CHECK LIST FOR CONTRACT VEHICLE*	12

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(*) REPORTING FORMATS

WORK INSTRUCTIONS AND PROCEDURES FOR HIGH RISK AREA

I) SILO CLEANING/ SILO CONSTRUCTION AND WORKING IN CONFINED SPACE

Following procedures are to be carried out under the supervision of an experienced supervisor as safety precautionary measures.

✓ Selection of competent contractor (having job experience) for silo cleaning activities.

✓ Inform safety officer before cleaning the silo.

✓ Dummy to be provided at cement filling entrance point.

✓ Remove materials inside silo by opening discharge chutes connected with extraction screw conveyor.

✓ Unlock the door bolts slowly and slightly tilted outside for checking the deposition of materials inside the door.

✓ Insert a MS Rod/ GI Pipe between the gap of sleepers to ensure the deposition of cement/bridge formation.

✓ If found obstacle inside the door, then insert additional compressed air in between the sleepers/chutes to break the bridge formed materials inside door.

✓ If obstacle remains as before, repeat the same, till MS Rod / GI Pipe smoothly passes inside the silo.

✓ When there is no obstruction then remove the sleeper one by one and access the condition.

✓ Then check the position of materials, if any with the help of torch light/ halogen light from out side of the door.

✓ If any struck up materials found inside the wall of silo then trained persons wearing safety belt, insert a long pointed pipe inside silo to break the hanging materials.

✓ After breaking the bridge/ struck up materials inside silo, provide a ladder inside silo from the door opening and free end of ladder at door side to be tied up by rope with platform to prevent falling.

✓ Proper illumination to be provided inside silo and dust filter system on silo top to be operated.

✓ Only trained persons wearing nose mask, goggles, helmet, safety belt are allowed to go inside the silo through the ladder. Rope end of safety belt to be tied with outside platform.

✓ Standby persons shall stand outside the door, to keep close watch on the persons working inside silo.

✓ Workers should remove the materials through the discharge chutes of silo.

✓ After cleaning all the materials inside silo, close the aeration valve and remove all aeration pipes from the silo.

✓ All the pipes shall be fitted after repairing the same.

✓ Remove all other materials (light, scrap materials, tools etc.) inside the silo.

✓ After inspection by shift in-charge/ engineer, the ladder inside silo to be taken out from door opening and close the door properly with sealing.

✓ Remove the dummy provided silo top cement filling entrance point and inform to quality control dept. for operation / silo filling.

✓ Medical fitness from any registered medical officer for contractor employees to be deployed for silo cleaning activities

✓ Contractor employees will start work only after obtaining PTW for silo cleaning from plant manager.

✓ Implementation of Group best practices for silo cleaning activities.

✓ Take PTW

II) **WORKING AT HEIGHT:**

- Scaffolds
- Ladder
- Roof work
- Roof work permit
- Harnesses
- Access to bulk rail and road tankers
- Mobile elevator work platform

1.0 Introduction

The purpose of this document is to provide brief safe and simple guidelines. Necessarily these guidelines are not comprehensive but they are meant for emphasising the key points.

1.1 Great care shall be practised to control all work carried out where persons may suffer by fall from a height, which is generally a major cause of fatal accidents.

1.2 As a basic principle, secure fencing shall be provided wherever possible at any place where a person might fall by 2m or more.

2.0 Types of Risk

2.1 The main risks covered by this guidance, of which all can be eliminated or reduced if the correct safety equipment and procedures are adhered to, are:

- Falls from heights
- Falls through roofs
- Falls of materials from heights

2.2 **Working on a roof shall require a roof work permit**

3.0 **Moveable Ladders**

3.1 Every location shall implement a six monthly ladder inspection system with labelling of inspected equipment, which ensures that only safe ladders are in use.

3.2 All employees required to use ladders shall first receive instruction in the use of ladders. The instruction will include the following safe practices:

- All ladders shall be safely secured against slipping by, for example, being tied at the top or if this is not possible by being secured at the sides of the foot or being "footed".

- Ladders shall extend at least I m above a landing.

- Ensure that the area around the ladder is safe (never place ladders where there is any danger from moving vehicles, overhead cranes or electricity lines. Use wooden ladders when work involves electricity).

- Ensure that the ladders are supported on a firm surface. (Never on a fragile surface such as gutters - use a ladder stay if necessary).

- Ladders shall always have a secure base and never be supported on their rungs.

- The ladders shall be set at the most suitable angle, e.g. 1 horizontal: 4 vertical.

- Climb ladders using both hands and feet and never jump the last few rungs. Find a suitable means of carrying tools and equipment. Always face the ladder when climbing or descending.

- Always inspect equipment carefully before use and destroy if unsafe - list the items to check, e.g. no broken rungs, no major "splits" etc.

- Ladders shall not be used as a working platform if a reasonably practicable alternative exists [e.g. tower scaffolds or a "cherry picker"].

4.0 Fixed Ladders

Ladder runs shall not exceed 9 m without a landing area/platform at suitable intervals.

4.1 Safety hoops shall be provided for vertical fixed ladders. The hoops shall commence at a height of 2.5 m above the base of the ladder.

4.2 Accidents may occur to persons descending from fixed ladders particularly from mobile vehicle. Care should be taken when stepping from the ladder to the ground.

5.0 Scaffolding

5.1 Scaffold shall only be erected, altered, or dismantled according to the ContractorContractorContractorContractorContractorContractorContractorContractorCon tractorContractorContractorContractorContractorContractorContractor's instructions by competent workmen under the immediate supervision of a competent person. A person may be considered competent because of his training and experience. Suitable training has to be provided by specialised organisations.

5.2 Suitable precautions shall be taken to prevent all falls from scaffolds. Guard rails at a height of at least 900 mm (or according to local regulatories) and toe boards at least 150 mm (or according to local regulatories) high shall be provided at the side of all platforms where a person is liable to fall a distance of 2 m. Intermediary guard rails, screens or similar shall be used to ensure the maximum unprotected gap between guard rail and toe board does not exceed 500 mm (or according to local regulatories)

5.3 All scaffolds shall be constructed so that they are stable including when they are altered or modified. Platforms shall be a minimum of 600 mm wide and the boards closed together, to prevent gaps in the platform.

5.4 Scaffolds must be kept tidy and free of any debris to prevent persons slipping and tripping and to allow ease of access.

5.5 Scaffolds shall be inspected:

- Before first use
- After substantial alteration, dismantling or other alteration.
- After any event likely to affect its strength or stability [e.g. after high winds]
- Weekly, and a record of the inspections shall be kept. The relevant form is shown at Appendix 1.

5.6 A simple scaffold safety checklist is attached at Appendix 2.

6.0 Matters specific to Tower Scaffolds

6.1 The manufacturer's/ ContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractor's instructions on erecting and using the tower scaffold shall be followed,

6.2 The maximum height to base ratio for a freestanding external, mobile scaffold shall be 3:1. The base can be increased by the use of outriggers.

6.3 A safe means of climbing the tower shall be provided. The outside of the tower should not be used as a means of access.

6.4 The tower shall be positioned only on firm level ground and the wheels shall be locked.

6.5 All users shall be aware of the safe capacity of a scaffold and platforms shall not be overloaded or pressure applied which could tilt the tower. Tools and equipment shall be spread evenly on the load bearing surfaces.

7.0 Working on Roofs

7.1 No work shall be carried out on a roof, except on those fitted with permanent provisions to prevent falls [e.g. guard rails around silo tops] until a roof permit has been issued.

7.2 Prominent permanent warning notice shall be fixed at the approach to any fragile roof. e.g. asbestos cement, translucent plastic.

7.3 Before persons start work on a roof their Manager shall define, as they want to work safely, detailing the precautions they shall take. (Method statement)

7.4 Employees and contractors shall be reminded of the following key points:

Tools, equipment and materials should not be placed on a roof in such a way as to cause a strain, which may result in a fracture to the roof.

On fragile or pitched roofs always use crawling ladders or boards and never use less than two boards when moving along a roof.

Inspect for skylights, covers and mark the covers. Watch for any glass that may have been painted over.

If there is a risk of falling from a roof, temporary guard -rails, toe boards and edge protection shall be installed or anchorage points and safety harnesses used.

Protect people below by the use of suitable barriers, warning notices and/ or a lookout.

Never work at heights during poor weather conditions.

8.0 Safety Harnesses

8.1 Safety harnesses shall be used to arrest the fall. They should, therefore, only be used where there is no other reasonably practicable alternative [e.g. short duration work at height] to prevent the fall occurring in the first place.

8.2 When using safety harnesses, suitable anchorage points shall be provided, capable of withstanding the anticipated shock load. Before starting working on site, it is necessary to anticipate the means to rescue the victim in case of fall.

8.3 'Free fall' distances shall not be more than 2 m. Excessive shock loads on the anchorage, the equipment or the wearer shall be avoided. To be taken into account in particular when the anchorage point is located below the wearer's feet. Inertia controlled reels to allow greater movement without excessive slackness in the rope should be considered. Safety harnesses and associated equipment exposed to a shock load should be returned to the ContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractor for damage assessment and suitable remedial action taken.

8.4 All safety harnesses and associated equipment shall be properly maintained and inspected. The user shall inspect the equipment immediately before use and regularly inspected by a competent person - some manufacturers recommend this inspection by a competent person is carried out every 3 months-. A competent person with the date shall keep a record in a register of the inspection and signature of the competent person stating it is in good order.

Any permanent wire rope running lines shall be thoroughly examined every six months in line with lifting tackle.

8.5 **Safety belts do not provide a suitable level of protection in the event of a fall and shall not be used in lieu of safety Harness.**

9.0 Safe Means of Access to Rail, Road Cement Tanks

9.1 Access to cement tanks for loading, cleaning, washing, maintenance and any other purpose including the removal and replacement of lids shall be such as to effectively prevent a person from falling from the tank to the ground below. Where access onto the top of a tank is required it shall be from a suitable platform or staging which shall allow for up to 50 cm variation in tank height. At the edge of a flat surface a top rail at waist height (1m) and a mid rail is normally adequate but on a curved surface of a cement tank, additional rails may be required on both sides of the tank.

9.2 Access to the platform shall, where possible, be by a suitable stairway or as a last resort by a fixed ladder with suitable hoops and extending beyond the access platform.

10.0 Falling Objects

10.1 Materials and objects shall be stored and stacked in such a way that they are not likely to fall and cause injury. Racking shall be of adequate strength and stability having regard to the loads placed on it and its vulnerability to damage from vehicles etc.

10.2 Suitable steps shall be taken through the provision of barriers or by covering any access routes to prevent persons from being struck by falling objects.

10.3 Throwing or tipping from a height of materials or objects is prohibited unless suitable precautions in the form of barriers are provided to prevent anybody being struck.

11.0 Mobile Elevated Work Platforms [MEWP]

11.1 MEWP covers a wide variety of power operated access platforms, including cherry pickers, boom lifts and scissors lifts. They are very versatile and provide a suitable alternative to ladders, scaffolds, staging, etc.

11.2 Suitably trained, competent and authorised persons shall only operate MEWPs.

11.3 Those working from a work platform shall wear safety harnesses. Harnesses should be attached to a suitable anchorage on the work platform and not attached to an external point.

11.4 The Safe Working Load (SWL) must be shown on the basket. The total load indicated includes personnel and tools and equipment. The SWL shall never be exceeded.

11.5 The manufacturer's recommendations on maximum height and reach shall not be exceeded. MEWPs should be positioned on firm, level ground and outriggers fully extended [if fitted] before use.

11.6 Platforms should not be moved in the raised position unless specifically designed to do so. If moving the platform, ensure the route is clear of obstructions.

11.7 Elevated platforms should not be used in high winds in excess of the manufacturer's recommendations.

11.8 Ensure suitable clearance all round and above the platform from other structures and machinery, overhead power lines, transport and pedestrian routes.

11.9 Moving parts and nip points should be suitably guarded. This is especially relevant to the base of scissors lifts when lowering, which should be protected by a 2m high enclosure. Operators of MEWPs should stay within the confines of the basket to prevent them being trapped between the basket and an external fixed object.

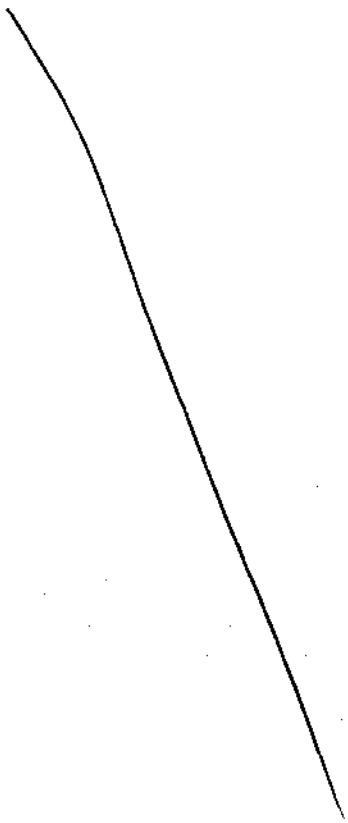
11.10 Maintenance and inspections should be carried out at the following intervals:-

- Daily/before use:- Operator should check tyre inflation, batteries, fuel, hydraulic oil, controls, structure, etc.

- At intervals determined by Maintenance Service as required.

- 6 monthly: A thorough examination by a competent person.[also after accident, repair and modification] e.g. insurance company engineer, in conjunction with lifting tackle inspection.

According to applicable regulations.



Appendix 1

INSPECTION RECORD - WORKING PLATFORMS

i- Name of contractor and contract No. ....
ii- Address of Site .....
ii- Work Commenced-Date .....

Location and Description of Workplace (1)	Date and Time of Inspection (2)	Matters requiring Attention (3)	Details of Action Taken (4)	Details of Future Necessary Action (5)	Name an Position Person wh made th inspection (6)

Footnote: To be completed by end of the shift during which inspection is carried out and report shall be submitted within 24 hours.

Appendix 2

Name / Signature of Contractor's Safety Officer .....

SCAFFOLD SAFETY CHECKLIST

Does the scaffold you are using meet the following requirements? ☐

1. Adequate foundation - placed on level firm ground with base plates and sole plates where necessary. ☐

2. Platform 3 - 5 boards wide, depend on the use. ☐

3. Each board is supported by at least 3 supports not more than 1.5m apart. ☐

4. Scaffold boards are tied down or overhanging each end support by at least 50mm, but not more than 150mm.

5. Vertical supports [standards] are not more than 2 to 2.5m apart. ☐

6. No more than 2m between lift.

7. Scaffold tied to the building at least every 4m vertically and 6m horizontally. ☐

8. Scaffold suitably braced - diagonal [ledger] bracing on alternate parts of standards and facade bracing to full height of scaffold.

9. Guard rails and toe boards along the outside edge and at the ends of any working platform from which people or materials could fall.

10. Guard rails at a height of 910mm, toe boards 150mm high. ☐

11. Extra guard rails or bricks guards to ensure maximum unprotected gap no more than 470mm. ☐

12. Scaffold materials are in good condition - boards are not warped, poles not rusty or bent. ☐

III) SCAFFOLD SAFETY

The following points should be taken into account before and during the erection of any scaffold.

1. **Falling objects**: Ensure the area above where scaffolds are due to work has been assessed and suitable measures have been taken to prevent injury from falling objects. This is particularly relevant when erecting scaffolds in process plant, e.g. cyclones.

2. **Electrical hazards**: All overhead electric cables should be identified and isolated prior to the erection of scaffolding. These and any other overhead services should be suitably protected against damage.

3. **Ground conditions**: The ground upon which a scaffold is to be erected should be firm and level. Underground drains, soft ground and excavations etc. should all be identified to prevent point loads being placed on or near them.

4. **Scaffold materials**: All scaffold materials [boards, tubes, fittings, ladders, etc.] should be in good condition. No use of GI sheet by contractor for making scaffolding platform is desired. If there is need to use the GI sheet for scaffolding platform, prior permission from company's Safety Officer must be obtained by Contractor

5. **Working at height**: Ensure that scaffolds are constructed in such a way that they work only from a suitable platform. Harnesses shall be used wherever the situations call for such device.

6. **Protection from falling objects**: When erecting scaffolds, it is vital to protect passers by from falling objects by preventing unauthorised access to the work area by erecting suitable barriers and signs.

7. **Scaffold structures**: Scaffolds should be erected so that they are fit for their intended purpose. The width of platform and its bracing should be suitable for the intended loading. Double guardrails and toe boards should be fitted.

8. **Competence**: Only trained and competent persons should erect, alter or dismantle scaffolds. Scaffold equipment should be hoisted/lowered in a controlled manner, not thrown. Competent Contractor's Safety officer shall supervise the activities of working at height.

9. **Planning**: All scaffolds should be planned. A competent engineer should design the more complex structures.

10. **Stability**: The structure against which a scaffold is to be erected should be able to support the scaffold and provide enough places for it to be tied into.

11. **PPEs :** Use of full body safety harness by the Contractor's workmen while working at height (Full body safety harness shall be provided by the Contractor.)

IV) ROAD SAFETY and DRIVING

[SAFETY TERMS AND CONDITIONS FOR TAXI/ VEHICLE HIRING]

✓ Copy of vehicle registration papers giving details such as model no., year of Manufacturing.

✓ Copy of insurance covering passengers and drivers as well as third party Including Validity of the same.

✓ Driver details:
✓ Name and age

✓ Copy of driving license no. Including date of issue and validity.

✓ Medical fitness certificate covering vision and general medical check up on yearly basis.

✓ Contact details of the contractors such as telephone numbers and address etc.

➢ **MANDATORY CLAUSES FOR CONTRACT VEHICLE and DRIVER**:

✓ Any non-compliance of mentioned safety clauses shall be viewed seriously with immediate termination of vehicle / driver or contract itself.

✓ Dully verified / signed safety checklist for Vehicle and its driver must be submitted with each and every travel bill.

✓ MARUTI VAN and Old Model Ambassador Car are not to be used.

✓ Light and medium vehicles- Cars and Jeeps etc should not be more than 5 years old and should not have met with any major accident in last 5 years. Heavy vehicles, Passenger Bus should not be more than 10 years old and should not have met with any major accident in last 5 years.

✓ Driver must have at least 5 years driving experience.

✓ Fitness of driver and vehicle condition against healthiness must be ensured.

✓ Safety belt to be provided and used by the driver while driving.

✓ Driver should be in proper dress and shoe.

✓ Prior to reporting for any travel the driver must have taken min. 4-6 hrs rest in daytime /6-8 hrs in nighttime if he was on duty for 8-12 hrs before joining duty.

✓ Driver should follow all traffic regulations.

✓ Driver should not be under alcoholic influence during his duty.
✓ The details of drivers should be submitted to Purchase/HR Department.
✓ Deputation of any new driver should be informed to Purchase/HR Department.

CHECK LIST for Contract Vehicle
(To be filled up by Driver)

Name of Contractor: _ _ _ _ _ _ _ _ Name of Driver: _ _ _ _ _ _ _ _ _ _

Vehicle Regd. No. Date and Time of reporting: _ _ _ _

Relieving time and place:_ _ _ _ _ _ _ _ _

[VEHICLE check list is to be filled up by driver before start up of the journey and verification signature by user employee. DRIVER'S Checklist is to be filled up by user employee while releasing the vehicle]

VEHICLE'S Check List	HEALTHY (✓)	FAULTY(✗)	REMARKS
➢ Break and wipers			
➢ Wheel and tyre	---------	---------	
➢ Fuel level in tank	---------	---------	
➢ Lights and Horn	---------	---------	
➢ Safety belts, First aid Box,	---------	---------	
➢ Stephanie including tools and tackles, torch	---------	---------	
➢ Side and rear view mirrors	---------	---------	

SIGNATURE OF DRIVER - _ _ _ _ _ _ _ _

CHECK LIST for driver's driving performance
(To be filled up by the officer using the vehicle at the time of vehicle release)

	SATISFACTORY	UNSATISFACTORY
➢ Not Under influence of Alcohol	---------	---------
➢ Use of proper shoe and dress	---------	---------
➢ The driver must have min. 4-6 hrs rest in daytime / 6-8 hrs in nighttime, if he Was on 8-12 hrs duty prior to reporting for any fresh travel.	.....	.....
➢ Speed control and compliance of traffic rules while driving		---------
➢ NOTE - STATE NEAR MISS INCIDENT, IF ANY		

➢ REMARKS:
Name and Signature of user employee:
Verification by HR/ Administration while certifying the bill:

V) GENERAL WORK

a) CANTEEN CONTRACT

✓ Examination for annual medical fitness of each member of the canteen staff who handles food stuffs shall be carried out by the factory medical officer or the certifying surgeon in following manner:

i. Blood shall be examined for venereal disease, in addition to routine blood examination.

ii. Stool and urine examination shall be done for worms inspection.

iii. Skin disease such as scabies, dermatitis shall be thoroughly investigated.

iv. X-ray and other examination shall be done to detect tuberculosis.

✓ Any person, who in the opinion of the factory medical officer or the certifying surgeon is unsuitable for employment, on account of possible risk to the health of others shall not be employed as member of canteen staff.

b) CONTRACT FOR PESTICIDES

✓ Use of nose masks by the Contractor's employees while spraying pesticides.

✓ Availability of Material Safety Data Sheet with Contractor for chemicals used by Contractor for pesticides work.

✓ Display of work instructions for taking corrective action incase of any hazards due to chemical use.

✓ Follow provisions of 'The Insecticides Rules'1971.

c) HORTICULTURE (TRIMMING OF TREES)

✓ Contractor will identify the area where the branches are to be cut.

✓ **Contractor will arrange to take shut down through horticulture dept. from Electrical Department of HT lines before starting the job.**

✓ Manpower deployed for the job should wear shockproof shoes, gloves and hamlets/ belts.

✓ After completion of the job, horticulture supervisor should ensure that no man/ material are near the HT lines and then give clearance to the Electrical Department to recharge the HT lines.

VI) RAILWAY and LOCO TRACK MAINTENANCE/ ERECTION

✓ Safety talk before starting the job.

✓ Work permit to be taken before starting the job by Supervisor/ consultant.

✓ Fix caution flag on both side of track.

✓ Supervisor should ensure that workmen should not be on or near the track while movement of train.

✓ After completion of job superior / mate will inform the operation department to release the caution order.

✓ Follow Railway signal traffic control rules and regulations.

VII) MECHANICAL NATURE OF WORK

a) GAS CUTTING and WELDING

Cutting:

✓ Ensure availability of flash back arrestor while gas cutting operation.

✓ Keep the cylinders in trolley locked with chain during shifting.

✓ Ensure the proper position of cylinders during operation.

✓ Check the condition of knob and gauges.

✓ Ensure proper clamping of hoses with cylinders and torch. After completion of work gas cylinder valves must be closed.

✓ Check the condition of hoses, nozzles and torches.

✓ Oxygen cylinders are to be stored at least 20 feet away from source of ignition.

✓ While cutting, ensure that sparks should not fall on hoses.

✓ Leaking gas cylinders should be taken out of use immediately.

✓ Use safety goggles, hand gloves and other necessary Protective Equipments.

✓ Always keep cylinders in upright position and secure them against falling and collision.

✓ Use lighter for lightening of torches.

✓ Cylinders should be stored in dry and ventilated place and away from source of ignition /heat/electrical fittings.

✓ Never keep Cylinders in horizontal position.

✓ Never use the fire /match stick / welding holder for lightening of torch.

✓ Normally cutting operation should not be permitted in and near hazardous locations.

✓ Do not use cylinders as rollers or for support purpose.

✓ Magnets, slings, chains or ropes should not be used for handling cylinders.

✓ Never use oil or grease as lubricants on valve attachments of oxygen cylinders.

✓ Do not permit sparks, molten metal, elect. Current, excessive heats or flames to come in contact with cylinder or attachments.

Welding:

✓ Take work permit while carrying out jobs in flammable areas.

✓ Ensure proper Earthing

✓ Use proper personal protective equipments like goggles, glass shield, gloves, shoes, masks etc.

✓ Ensure proper ventilation during operation.

✓ Check the condition of welding machine, leads and other electrical fittings.

✓ Use lugs to clamp the welding leads to welding machines.

✓ Keep away flammable objects during welding.

✓ Never use multiple connections from a single machine.

✓ Never carry out welding at wet conditions.

✓ Carry out welding in well-ventilated and illuminated places.

✓ Always supervise work carried out by external agencies.

✓ Carry out the work as per the job specification.

✓ Ensure that welding sparks/ cutting hot iron pieces do not fall through floor opening/ floor grating on chemicals/ equipment / cable etc.

✓ Store the waste flux, cutting material, waste cloth and other wastes in designated areas / bins.

✓ Clean the workplace after finishing work.

✓ Cylinders used in horizontal position shall be so secured that they cannot roll.

b) MECHANICAL ERECTION

✓ All precautions mentioned pertaining to structural jobs should be followed.

✓ Load shall be properly ascertained and position of the centre of gravity and load transfer at sling point shall be taken into consideration before handling any equipment.

✓ A special check is required regarding fitness of all lifting and haulage tackles, ropes, slings, etc.

✓ Selection of Tommy bars, roller skids, etc should be made depending on the type of equipment to be handled.

✓ The common tendency of checking gear meshing lubrication, coupling matching, hole matching etc. by feeling with a finger must be strictly curbed.

✓ Gas cutting of any member should be avoided.

✓ In case of all installation to be tested and tried, the ContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractor's instructions should be properly studied and followed during installation and testing.

✓ A general check on integral or other service system, lubrication system and check on free and easy movement of all moving parts and their safe clearance, to be taken care of before such test.

✓ All safety features shall be checked and PTW procedures shall be followed properly.

✓ Attention should be paid to all mechanical safety guards, hand railing (at a height of at least 900 mm from the floor with at least two rails), toe boards (at a height of at least 100 mm from the floor), hatch way covers, ladders, etc.

✓ Grinding wheels should be handled with care. These should be visually inspected/checked by ringing test for possible damage before mounting. Before mounting the wheel, maximum operating speed (marked on tag) should be checked against machine speed. Mounting flanges should be equal and of a diameter at least 1/3 the dia of the wheel. Guard should cover wheels for at least one-half of the grinding wheel and operator should use safety goggles. Wheels should not be tempered for mounting and no materials should be ground for which the wheels are not designed.

✓ If work is to be carried out over fragile roof, all men required to work on the rooftop should be trained for work on the rooftop. Crawling boards should be made use of during any work on fragile rooftop. Also caution boards should be fixed up at the ladders leading to the roof top " Danger: do not go on the roof top without permission"

✓ Eye bolts fixed at correct slinging points for heavy machinery parts, motors, generators, bins, etc, should be utilized for handling.

✓ Torque wrenches are provided for taking the correct strain during tightening of nuts on bolts.

✓ ContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractor's instruction should be strictly followed for special installation, e.g fixing of friction grip bolts etc.

✓ Safety valve for steam, compressed air and gas requirement and expansion joints should be checked.

✓ No slings should be over loaded. Safe working load for fiber rope and wire rope slings tag should be given.

✓ Pulley blocks of proper quality should be used. In no case, pulley block suitable for fiber rope should be used for steel wire rope.

c) MECHANICAL STRUCTURAL

STRUCTURAL ERECTION

✓ The structural members should be kept in orderly manners on the ground so that they do not roll down or slide while being handled.

✓ The structural members should be amenable to be taken out as per sequence of erection without disturbing the stack. At the same time, light structural members should not be stacked below heavy structural members where they are likely to be damaged.

✓ Clear passages should be left for easy handling and transportation of structural members.

✓ Plates and structural members should be stacked separately. Also loose materials should not be stacked with heavy materials.

✓ While removing any materials from the stack, care should be taken not to disturb the remaining materials of the stack.

✓ Safety appliances should be regularly used as indicated.

✓ Suitable standard scaffolding with hand railing and toe board should be prepared for working. No scaffolding should be overloaded.

✓ Safe approach to be provided to the scaffolding.

✓ While work is proceeding on scaffolding, roofs or other elevated places, precautions must be taken to prevent workers going underneath to avoid injury due to falling objects.

✓ The area below where work is going on should be cordoned off.

✓ No loose materials shall be kept over the scaffolding.

✓ No materials should be dropped on the ground from a height, instead they should be properly tied and lowered. Loose materials, e.g., muck, debris, etc. should be lowered by filling in gunny bags.

✓ Proper signaling arrangement shall be made where lifting tackles/cranes are utilized.

✓ Tools, e.g., spanner, etc. riveting hammer, etc should be tied with a rope fixed so that they will not drop on the ground in case of any slip.

✓ While using a jack, care should be taken to provide wooden block both at the top and at the base of the jack. Also the jack should be tied by means of rope to prevent slippage of jack.

✓ If a hydraulic jack is used, the load lifting should rest on wooden block or temporary support to prevent mishap due to the failure of the jack.

✓ Only those persons who are skilled in working at height should be engaged for jobs to be done at a height. Persons suffering from diseases, such as epilepsy, blood pressure, height phobia etc. should not be allowed to work at height.

✓ Where the job demands physical exertion or working near a gas line or hot atmosphere, workmen should be regularly changed to avoid fatigue.

✓ Care must be taken to fasten the erected members properly and secured by guys, etc.

✓ Written clearance should be taken from appropriate authority while working near gas line, live electric line, crane gantry, etc. The clearance shall be returned in writing after completing the job and removing all men working near the area.

✓ For working near electric line, the program should be discussed with the operation department, safety department, electrical department and other concerned department, if any. An agreed procedure is to be decided for doing the job and the clearance is to be taken in witting from electrical department. In case of electric shocks immediate First Aid, e.g., artificial respiration should be resorted to.

✓ If a job is to be carried out in crane gantry, an agreed procedure shall be worked out in consultation with Electrical, Operation and Safety departments. Stop blocks should be provided on the gantry on either side at a distance about 6 m from working area. In addition, red flag or at night red light should be provided to caution the Crane driver about men working on the crane gantry. All men working on the crane gantry should be given induction regarding hazards due to clearance of the building, etc. Caution boards wherever required should be provided in appropriate places.

✓ For jobs to be carried out near gas line, steam line, fuel line etc., the program should be discussed with the operating department, Safety department, and any other departments concerned and an agreed procedure shall be worked out. Clearance should be taken in writing in the specified form from the appropriate authorities. Services of fire brigade and compressor to provide sufficient fresh air shall be ensured for wearing gas mask and regular testing arrangement shall be made for detection of gas leakage. After the job is over, the clearance shall be returned in writing.

✓ While lifting structural, the weight is to be approximately ascertained and proper lifting tackle of appropriate capacity is to be selected.

✓ Guy ropes shall be used while handling heavy materials.

✓ Padding over sharp edges should be provided protect ropes and slings.

✓ Slinging should be one in such a way as to prevent the load from slipping.

✓ All persons should use proper safety appliances.

✓ Proper sequences of erection shall be followed.

✓ Any specific note from the designer/ ContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractorContractor should be followed.

✓ Gas cylinder should not be dropped or dragged on the ground. Acetylene (D.A) cylinder should be kept in vertical position. Lifting magnet or chain should not be used for handling cylinders. Cylinders should be kept away from all sources of contamination, e.g. oil, batteries, fire and heat, etc. Cylinder valve should not be lubricated. Care should be taken not to give additional leverage for opening cylinder valves, which is likely to damage it.

✓ In structural members where provision for expansion, free movement, etc. are provided, they should be checked properly.

VIII) ELECTRICAL AND INSTRUMENTATION (E&I) NATURE OF WORK

✓ Availability of license of competency with contractor from electrical inspector.

✓ Follow provisions of Indian Electricity Rules 1956.

✓ Instructions of the electrical department should be strictly followed.

✓ Wires of proper size and of proper insulation shall be used.

✓ It is preferable not to use loose and temporary wiring even for power supply for lighting, machine or to any electrical equipment.

✓ All electrical equipment, switches, machines, welding machines, drilling machines, etc. should be properly grounded.

✓ Voltage and current rating should be prominently displayed at the installations.

✓ No rewirable fuses are to be used. Instead HRC fuses shall be used for all power connections.

✓ Caution boards should be properly displayed and marking of individual switches to be made.

✓ All electric lines should be drawn at least above man's height. No live wire should be laid on the ground or wet surface. All electrical joints should be properly insulated.

✓ Electrical installation should be protected from water and direct flame.

✓ Only competent persons should make electrical connections and installations and attend electrical defects. It is essential to ensure that they are not only capable or executing/ supervising the job but they also have the necessary competency certificate as per statutory requirement.

✓ While using arch welding machines, safety rules laid down should be followed.

✓ Selection of right safety appliances, tools, materials and instruments for particular job must be pre planed.

✓ Materials and equipment of correct quality should be used, e.g., asbestos insulated cables for hot locations, flame proof fittings, switch gear, motors, etc. for oil, gas and other inflammable installation areas where there are hazards of explosion, totally enclosed fan cooled motors in damp and corrosive surroundings, water proof fittings for under water installation, etc.

✓ Complete understanding and co-ordination should be prearranged with staff authorized to give clearance and staff supervising the job. Particular care should be taken in case of multiple sources of supply to see that all sources are made dead and all grounding precautions and tests are done before work commences. Clearances should be exchanged in writing in standard form.

✓ Before energizing any installation, testing of the insulation resistances of individual units, proper phasing out and voltage tests, performance of protective and control system, checking of earth resistance of the whole systems, checking connection, marking and tagging should be carried out. Safety appliances, e.g., rubber hand gloves, rubber mat, grounding rod, neon tester, insulated screwdriver and pliers, etc. should be used. Installations should be energized only after taking necessary clearance from the appropriate authority.

✓ Limit switches, interlocks, earth leakage circuit breaker, etc, if provided, should be checked before Commissioning any equipment.

IX) DISMANTLING WORK

✓ Use of safety appliances

a. Safety helmets and safety boot, safety goggles, hand gloves and dust mask must be used as per the job requirement.

b. Men working at height must wear safety belts/Full body Safety Harness of IS marked/certified by D. G. M. S. and this should be in good condition. Lifeline, which must not be less than 20 mm in diameter, shall be anchored firmly to a rigid structure and the anchoring point should not be above the working platform or the scaffolding.

✓ Lifting tools and tackles:

Chain blocks, pulley blocks, wire ropes, manila ropes, slings etc must be examined every day before starting the job and the observation must be recorded in a register. Defective tools, tackles safety appliances, equipment etc should not be used.

✓ Scaffolding and platform should be suitably made of strong materials. Hanging scaffolding should be suspended by means of adequately strong fiber rope or wire rope and shall not be overloaded. The standard design for scaffolding and platform should be used with the toe boards and railings.

✓ The ground area above which a job is to be done shall be cordoned and red flags should be displayed around the area. Men should be posted to caution persons approaching the area.

✓ Heavy materials are to be handled with the help cranes and other lifting devices.

✓ Scrap, muck and other dismantled materials must be regularly removed from the different levels of the structure being dismantled and also from the area surrounding the place of work on the ground level to maintain good housekeeping and prevent loose materials falling from the top of the building being dismantled.

✓ There must be proper co-ordination where more than one agencies are working at a particular area.

✓ Written clearance regarding electrical, fire, and other hazards (PTW) must be obtained, before starting the job from competent concerned authority.

✓ Heavy materials, before gas cutting them, should be held rigidly and lowered gradually to avoid sudden falling and swing of heavy structure.

✓ Regular safe approach must be used to go and come from the working area at height. In case such approaches are not provided, the Contractors should provide safe means of approach for his men. In no case should the existing structures be used for going up or down from the place of work at height.

✓ Personnel identity cards must always carried by the Contractor's employees and should be produced on demand by any authorized officer of the company to identify the persons in case of accidents.

✓ First Aid box, Accident Reporting Form and Performa with the stamp of the contractor should always be kept at the work site.

✓ All risk arising out of the work situations should be evaluated and suitable safety precautions must be taken.

✓ Only trained and competent persons should be engaged for this job.

✓ This job must be done under effective safety supervision.

X) CIVIL CONSTRUCTION WORK

a) SOIL TESTING, PILING and OTHER RELATED WORKS

✓ PTW must be obtained from the department.

✓ It should be ensured that there is no breakage of wire ropes during operation. A regular check of wire rope should be carried out. The wire ropes should be of sufficient diameter and strength to take the impact load of chisel and sludge pump.

✓ Wire rope with broken strands should bot be used. A register showing the history of the wire ropes should be maintained giving information laid under Factories Rules/ Acts.

✓ Suitable attachments should be made in the pump and chisel so that these may safely be recovered without sending any person inside the bore hole whenever necessary.

✓ In view of the diameter of the bore holes being small, it should be ensured that no person goes inside such bore holes unless the procedure adopted are completely safe in all respects.

✓ If a person is to be sent inside any confined space i.e. sewer line, tunnel, well etc, steps should be taken as per Factories Act.

b) SITE CLEARANCE

✓ Safe place for keeping the materials to be selected

✓ Either materials shall be properly stacked or shall be shifted to appropriate place.

✓ If any electrical connections or service connection are interfering with the site clearance job, they are to be diverted in consultation with the appropriate authority.

✓ Approach to a place of work should be cleared and preferably an approach should be provided at least from two sides, so that in case of any interference in one side approach, the job is not disturbed.

c) STORAGE OF CONSTRUCTION MATERIALS

✓ All materials should be stacked properly. The stack height should not exceed 1.2 m above ground level.

✓ Safe approach to be provided and maintained from individual stack to place of work. Stacking of materials should not disturb the handling of mechanical, structural or electrical materials stacked nearby.

✓ No stack of materials should rest against a structure or building wall.

✓ Construction materials should not be kept on the edge of the pits and excavated area.

✓ A clear passage should be provided for workmen

✓ Proper drainage should be provided so that the discharge of water, used for washing of materials, etc. does not flow into the pits or make the ground surface slushy.

✓ Boxes, pallets, containers, ropes, pulleys used for handling and transporting stacked materials should be checked properly.

✓ Proper care should be taken for nails while stacking dismantled planks.

d) EXCAVATION

✓ PTW must be obtained from civil maintenance department/ concerned authority.

✓ All excavated areas should be barricaded and there should be one entrance and one exit for 6 m length of excavation.

✓ Excavated materials should be thrown at least 1.2 m away from the edge of the excavated area.

✓ Excavated materials should not be allow to accumulate in a busy work area but should be removed promptly.

✓ If work is to continue at night, lighting should be provided around the barricade.

✓ Locations of underground water pipes, gas pipes, fuel pipes, storage tanks, electrical cables, telephone lines etc. should be ascertained by Competent Authority before commencing excavation of area.

✓ Adequate protection must be provided for underground pipes, cables, telephone lines, tanks etc.

✓ No shovel, crane or dragline should be used to excavate near electric lines. Power should be shut off while excavation is going on near them.

✓ If excavation is being done by means of picks or paving breakers, care should be taken not to puncture any cable or service line. Preferably, a shut–down of these lines should be taken while excavating near them or they should be well protected.

✓ Adequate suspension or support should be provided for hanging lines, pipes etc.

✓ If any excavation is to be carried out in the proximity of any structure, where it is likely to sink/ collapse, temporary supports are to be provided to transfer the load of the structure to a firm ground before excavation.

✓ Any blasting, if required to be done, then it should be as per applicable rule and regulations.

✓ Any surcharge like slopping ground, track line, building or machine structural if found within 45 degree from the bottom edge of the pit to be excavated, care should be taken to retain the surcharge.

✓ Heavy structure or the machine to be erected should not be kept within 45-degree line from the bottom edge of the pit.

✓ If any crack of ground near the excavated pit is noticed during the work in the pit progress, the work must be stopped immediately and brought to the attention of the appropriate authority. Nobody should be allowed to work there till preventive measures are taken.

✓ Open excavation adjacent to and lower than wall foundation or other footings, structural columns, etc., should be executed by experienced worker with the knowledge of soil. Special care should be taken to prevent undercutting in reclaimed or filled up soil.

✓ When excavation is to be done within a building, precautions have to be taken for the existing installation, structures, foundations, etc.

✓ Any trench 1.2 m or more deep should be provided with ladders, stairways or ramps, so spaced that no worker in the trench should be more than 15 m from one of them. Ladder should extend at least 900 mm above the ground.

✓ Pick and shovel men should, during excavation, keep at a safe distance.

✓ While excavation on the slope whose height is over 3 m men should use safety belts.

✓ For side of trenches more than 1.2 m deep shoring with timber should be done, where they are sloped to the angle of repose or unless the trench is in solid rock. Bracing conforming to recommended specifications should be used.

e) STUTTERING AND SHORING

✓ In case the soil is soft, loose, the bonding is loose, water seepage is observed, subsoil hydrostatic pressure is high or in case of superimposed load of structure or shock load, shoring of adequate strength has to be provided during excavation. Shoring should also be done below 1.2 m depth trench.

✓ Subsoil water accumulation should be pumped out from the excavated area. It slippage of soil is observed, then it should be protected by proper shoring or putting sandbags.

✓ The inflow of water should be diverted away from the area.

✓ Under cutting of the soil is strictly prohibited.

✓ Proper cribbing of support should be done as specified/ instructed by appropriate authority, if excavation is done below or close to railway track.

✓ If under-cutting is necessary, then shoring with proper propping should be done as specified or instructed by Competent Authority.

✓ Wooden planks or steel sheets of adequate strength should be used for shuttering.

✓ Planks or sheets should be rigidly fixed with one another by means of clamps, hooks or nails. The joint should be sufficiently strong to take care of load.

✓ Props used to support the shuttering should be of adequate strength.

✓ While dismantling shuttering, persons working below should be alerted.

✓ The vertical props should rest on firm base.

✓ After completion of job, the shuttering should not be left for a long time.

f) DEMOLITION AND REMOVAL OF DERBIES

✓ Before demolishing a building or structure, either protect or disconnect the utility services (gas, steam, electricity, water supply, oil supply etc.)

✓ Remove all fragile and hanging materials from inside the building.

✓ The area around should be cordoned off and barricaded. Caution boards and red tape/flag should be displayed at place. The distance of cordoning will depend on the height at which demolition is taking place.

✓ Chutes or container cage should be used to lower down debris.

✓ Proper and tested tackle to be used while lowering heavy materials.

✓ An experienced supervisor should give signals and supervise.

✓ The cage, hoist, tackles should not be over loaded.

✓ Debris should be removed at the earliest.

✓ Safe and easy approach to be provided for quick transport.

✓ Water should be sprayed to control dust wherever required.

✓ Trucks should not be overloaded or materials should not spill on the way.

✓ Materials should not project beyond the side or back panels of the truck.

✓ Before demolishing building with overhung chhajjas, etc., they should be properly supported or demolished first before demolishing the super structure of the building.

g) WHITEWASHING / PAINTING ACTIVITIES

✓ **Use of colour codes of paint for painting of structure / building as per IS code: 5- "Colors for ready mixed paints".**

✓ **Toe guards should be painted in signal red colour.**

✓ **PTW is required for working at height**

✓ **Manpower deployed for the job must not have height phobia.**

✓ **All other painting/ whitewashing shall be carried out as per IS standards**

XI) FIRST AID INTIMATION SLIP
(To be filled by plant employees)

Name of injured Person	:	_____
Department/Contractor	:	_____
P.No./Card No.	:	_____
Brought by	:	_____ ☐ Name of the Person Self
Date and Time of Accident	:	Date : _____ Time : _____
Site of Accident	:	_____
Body Part injured and Nature of Injury (To be filled by CMO)	:	Non-reportable Reportable
Name of reporting Officer	:	_____
Accident Report to H&S	:	Yes / No Date: _____ Time: _____
Departmental Accident Report followed	:	Yes / No
Attended by Dr./Medical Staff (to be filled by Hospital Staff)	:	_____ Date : _____ Time : _____
Use of Plant of First Aid Box	:	Yes / No
Whether PPE's used during Accident	:	Yes / No

SIGNATURE

(Shift Incharge/Sectional Incharge)
Date :
Time :

XII) INCIDENT INVESTIGATION REPORT

Please forward this form to the Department Manager immediately upon completion. This Form must be completed within the shift of the incident

1. AREA OF PLANT WHERE INCIDENT OCCURRED?	2. EXACT LOCATION IN THIS AREA	DATE and TIME OF OCCURRENCE
4. NAME OF PERSON REPORTING INCIDENT	5. DATE REPORTED	6. TO WHOM REPORTED
OBJECT/EQUIPMENT/SUBSTANCE RELATED EQUIPMENT : -	PERSON WITH MOST CONTROL OF ITEM 7	

INJURY OR ILLNESS ☐

9. INJURED'S NAME	10. CLASSIFICATION	11. REPORT ☐ Yes ☐ No

12. FIRST AID GIVEN Type : first aid Applied by OUR DOCTOR :Date:-	13. DOCTOR'S VISIT REQUIRED ☐ Yes ☐ No N/A	14. MODIFIED WORK REQ'D ☐ Yes ☐ No	15. LOST TIME ACCIDENT ☐ Yes ☐ No

16. PART OF BODY INJURED	17. TYPE OF INJURY/ILLNESS SUSTAINED

LTA

18. COST (If applicable)	19. NATURE OF INCIDENT **LTA**

DESCRIBE CLEARLY HOW THE ACCIDENT/INCIDENT OCCURRED, USE PHOTOS AND SKETCHES, INCLUDE A DESCRIPTION OF THE EMERGENCY RESPONSE IF APPLICABLE;

DATE :

ANALYSIS

HAT ACTS, FAILURES TO ACT AND/OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT/ILLNESS? PICTURES, PEOPLE, POSITION, PROCEDURE (See Guidelines - Immediate Causes and use Investigation Skills.)

22.
WHAT IS THE ROOT CAUSE FOR THE EXISTENCE OF THESE ACTS AND/OR CONDITIONS?
(See Guidelines - Root Cause – Use investigation skills.)

ROOT CAUSE:

EVALUATION OF RISK AND FOLLOW-UP

TENTIAL 24. 25. ☐ MINOR ☐ MAJOR ☐ SERIOUS ☐ CATASTROPHIC	PROBABLE REOCCURRENCE RATE ☐ NEGLIGIBLE ☐ LOW ☐ MODERATE ☐ HIGH

28. WHAT ACTION HAS OR WILL BE TAKEN TO PREVENT REOCCURRENCE?

ACTIONS	RESP.	TARGET DATE

29. COST OF CONTROL ☐ MINOR (0-500) ☐ LOW (501-2000) ☐ MEDIUM (2001-5000) ☐ HIGH (5000+)	30. DEGREE OF CONTROL ACHIEVED ☐ LOW ☐ MODERATE ☐ SUBSTANTIAL ☐ COMPLETE

INVESTIGATED BY	32. DATE

MANAGEMENT SIGN-OFF

COMMENTS RE EFFECTIVENESS OF PREVENTIVE MEASURES (Are the recommendations above appropriate? Has the follow up been carried out? Is loss control program adequate? Are the standards adequate? Are they adequately complied to? Has the incident been reviewed with people involved or affected?
34. SIGNATURE **(DEPT. MANAGER)** 35. DATE:-

INCIDENT INVESTIGATION SIGN-OFF

)MMENTS RE EFFECTIVENESS OF PREVENTIVE MEASURES (Have the sons learned from this incident been shared with the plant population?)
SIGNATURE (INCIDENT INVESTIGATION COMMITTEE REP) 38.

GUIDELINES

IMMEDIATE CAUSES

SUBSTANDARD	**SUBSTANDARD**
Operating Equipment Without Authority	Inadequate Guards or Barriers
Failure to Warn	Inadequate or Improper Protective
Failure to Secure	Equipment
Operating at Improper Speed	Defective Tools, Equipment or Materials
Making Safety Devices Inoperable	Congestion or Restricted Action
Removing Safety Devices	Inadequate Warning System
Using Defective Equipment	Fire and Explosion Hazards
Failing to Use PPE Property	Poor Housekeeping: Disorder
Improper Loading	
Improper Placement	

ROOT CAUSE

PERSONAL	**JOB**
Inadequate Capability	Inadequate Leadership or Supervisor
Physical/Physiological	Inadequate Engineering
Mental/Psychological	Inadequate Purchasing
Lack of Knowledge	Inadequate Maintenance
Lack of Skill	Inadequate Tools, Equipment, Materials
Stress	Inadequate Work Standards
Physical/Physiological	
Mental/Psychological	
Improper Motivation	

INVESTIGATION

Improper Lifting Improper Position for Task Servicing Equipment in Operation Horseplay Under Influence of Alcohol and/or Other Drugs	Noise Exposure Radiation Exposure Temperature Extremes Inadequate or Excess Illumination Inadequate Ventilation	**TIPS** Photos Sketches Mark positions and locations Do not destroy evidence	Abuse or Misuse Wear and Tear Interview witnesses Check procedures and records

VOLUME-II

SECTION-XIV

SITE SERVICES

28.03.09
(KIRAN PANDA)
WPCPL

薛利
(XUE LI)

VOLUME-II

SECTION-XIV

SITE SERVICES

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VOLUME-II

SECTION-XIV

SITE SERVICES

1.00.00 **SITE SERVICES**

1.01.00 These services shall be rendered by the Contractor as part of the overall project management service. The services shall broadly include but not be limited to the following:

1.01.01 Arranging material despatch from the shop and transportation by rail, road, air or sea as applicable; transit insurance.

1.01.02 Monitoring movement of materials as necessary with carriers, port clearance etc. from the time of despatch F.O.R. works/F.O.B. port of shipment by Contractor till receipt of the same at site.

1.01.03 Unloading of materials at Railway Station/Railway Siding inside project area/air port/sea port, transportation to site store, assessment of lost/damaged items in transit and arranging insurance claims and replacement of lost/damaged items.

Transportation of Over-Dimension Components (ODC) consignments taking care of all approvals, road widening, strengthening, etc. will also be a part of site service.

Contractor to submit method statement for all erection activities along with relevant calculation, certification etc. as required.

1.01.04 Taking custody of all the materials till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.

1.01.05 Comprehensive insurance for the plant, equipment and materials.

1.01.06 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.

1.01.07 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment and services for chemical cleaning, steam blowing as well as performance guarantee tests.

Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary.

1.01.08 Supply and application of the final paints on all the equipment to be erected under this specification.

1.01.09 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to be rendered under this specification.

1.01.10 Deployment of all erection tools & tackles, construction machinery, transportation vehicles and all other implements in adequate number, capacity and size.

1.01.11 Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary.

1.01.12 Construction of all civil, structural & architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other related activities as detailed elsewhere.

1.01.13 Taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives etc. for respective portions of work under the jurisdiction of such statutes or laws.

1.01.14 Quality assurance of all work executed at site.

1.01.15 Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.

1.01.16 Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner.

1.01.17 Providing `Industrial Relations' unit and `Medical' unit to take care of his erection staff. The Owner shall have no obligation in the regard.

2.00.00 SITE ORGANISATION

2.01.00 The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the Contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site.

2.02.00 A separate Quality Control Department shall be included in the site organisation with adequate number of competent quality control personnel, instruments etc. to ensure desired quality standards of all site-works.

2.03.00 On award of Contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

2.04.00 The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackles shall not be removed from site without written permission of the Owner.

3.00.00 **SITE FACILITIES**

3.01.00 **Contractor's Central Administration Area**

The Contractor shall submit, drawings showing proposed locations of both his and his sub-contractors central site office area together with any other temporary buildings associated with site administration. Car parks, cycle sheds, and access ways shall also be shown.

3.02.00 **Contractor's Site Office Accommodation**

Before the erection of any temporary site accommodation commences, the Contractor must obtain approval from the Engineer of the size, type, condition, location, access and services proposed. The Engineer's approval shall be obtained before any accommodation is dismantled or removed from the site. The site office accommodations shall be reasonably maintained and suitably identified with the Contractor's name and that of his site engineer.

3.03.00 **Telecommunication Facilities**

The Contractor shall provide his own on-site/off-site telephone facilities.

The Contractor shall state the proposed extent of supply for telephone facilities, indicating the number of lines to be connected on site for the duration of the Contract.

The Contractor shall obtain permission, from the appropriate authorities before any radio wave emanating system is used at the Site. This includes radio telephones and pagers, transceivers, cordless and cellular telephones and such any other systems. The Contractor shall ensure that the radio communication systems do not cause interference to control and instrumentation and communication systems in the power plant.

The Contractor shall provide facilities for wireless office LAN with township connectivity.

3.04.00 **Site Records Office**

The Contractor shall maintain a suitably staffed records office to maintain updated records of all relevant documentation and test certificates and to see that these are available to meet obligations to all statutory bodies and to any commissioning committees, working parties or test teams which are established to meet the needs of the Contract. These records shall be maintained and retained until handover on completion of all works on Site and shall be subject to Audit by the Owner's Engineer.

The relevant documents envisaged will include:

a) Site Register for lifting appliances, cranes, slings, hooks, lifting beams and tackle for construction of the works either mobile or fixed.

b) Site Register for lifting appliances, cranes, slings, hooks beams and tackle supplied as part of the permanent works.

c) Scaffold Register.

d) Commissioning documents.

e) Test Certificates from works and site.

i) Civil

ii) Mechanical

iii) Electrical

iv) Control and Instrumentation

f) Operation and Maintenance Instructions.

g) Quality Assurance Documents.

h) Site Register for all portable electrically powered apparatus and tools, both temporary and permanent.

i) Site Registers of all modifications carried out during execution by deviating from the approved drawing giving modification number against each. Such modifications shall have to be authorised/approved by the Owner's Engineer.

j) Measurement, inspection & alignment protocols

k) Mechanical completion protocol

l) Performance test protocols

m) Handing over/taking over protocols

n) Final Acceptance Protocol

3.05.00 **Canteen Facilities**

A food facility shall be provided on the Site by the Contractor for the reasonable use of his and his sub-contractor's employees, the Engineer and his staff.

A central site canteen or dispersed messing facilities may be provided to a suitable standard. There shall be an appropriate canteen for professional managerial staff. The Contractor shall submit of the canteen facilities.

3.06.00 **Site Security**

The Contractor shall furnish schedule for security facilities for the site and temporary storage areas, including but not limited to:

i) Road access gates manned during construction by uniformed security personnel.

ii) Security fencing : The location shall be agreed with the Engineer. The type shall be proposed by the Contractor and approved by Owner's Engineer.

iii) A manned security building/stores/compound for receipt/temporary storage of equipment prior to erection.

The Contractor shall submit his proposed site security policy and procedures.

The Contractor shall have responsibility for the security of the site. Security for all or part of the site will be taken over by the Owner at a time to be agreed with the Engineer on completion of the works.

3.07.00 **Contractor's Storage Areas**

Contractor shall submit details of requirements of space for storage and construction facilities.

The Contractor shall be responsible for provision of suitable temporary storage facilities including external hard standings.

3.08.00 **Sign Boards**

The erection of sign boards or posters will not be allowed without the Engineer's approval of the size, type, location, wording, etc.

3.09.00 **Use of Motor Vehicles, Parking and Cycle Sheds**

Parking facilities and cycle sheds shall be provided by the Contractor in a compound within the Site boundary but outside the security fence of the construction area and as near to the Site access as possible. Only Authorised vehicles shall enter the construction area and these must display the vehicle pass issued by the Contractor.

Designated parking spaces shall be allocated local to the main site office for the Contractor's Senior staff, Owner, Engineer, Consultants and other senior staff.

3.10.00 **Site Restrictions**

The Contractor and his employees shall not trespass beyond the curtilage of the site on to any adjoining land and the Contractor shall take necessary action to prevent trespass occurring.

3.11.00 **Site Access**

The Contractor shall be responsible for any road improvement required for construction traffic access, and for the provision of traffic control where the site access joins the public road. Public traffic shall not be impeded during the construction period, and access must be maintained for emergency vehicles.

The Contractor shall allow for the presence of other Contractors associated with the power plant development, and shall afford them the use of appropriate site facilities, including first aid and welfare.

4.00.00 **GENERAL GUIDELINES FOR FIELD ACTIVITIES**

4.01.00 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

4.02.00 The Contractor shall co-operate with the Owner and any other Contractors/ Agencies working at site and arrange to perform his work in a manner so as to minimise interference with other Contractors'/Agencies works. The Owner's Engineer shall be notified promptly of any defect in other Contractor's/Agencies works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner's Engineer shall be final and binding on the Contractor without any commercial implication.

4.03.00 The Owner's Engineer may hold meetings of all the Contractors/Agencies working at Site at a time and a place to be designated by the Engineer. The Contractor shall attend such meetings if called upon to do so, take note of the decisions of the Engineer and shall strictly adhere to those decisions in performing his Work.

4.04.00 The Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good such delays by or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Owner's Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

4.05.00 The works under execution shall be open to inspection and supervision by the Owner's Engineer at all times. The Contractor shall give reasonable notice to the Engineer before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Engineer.

4.06.00 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to Contractor's account.

4.07.00 All the works such as cleaning, checking, leveling, aligning, assembling, temporary erection, opening, dismantling, surface and edge preparation, fabrication, machining,

chipping, scraping, fitting-up, bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.

4.08.00 Equipment and material, which are wrongly installed, shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner's Engineer.

4.09.00 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of the Owner's Engineer.

5.00.00 SITE HEALTH AND SAFETY MANAGEMENT

5.01.00 The Contractor shall be responsible for:

- The management organisation for implementation of health and safety on site.
- The identification of site hazards and assessment of risks.
- The system of notifying all employees of the site safety plan, method statements and site safety rules.
- A schedule of safety meetings. The arrangements for site induction course, training and security. The arrangements for emergency plans, safety inspections and auditing.

5.02.00 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.

5.03.00 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled or prohibit the use of the same for safety reasons. Contractor shall abide by Owner's decision in such cases. No claim for compensation due to such prohibition will be entertained by the Owner.

5.04.00 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.

5.05.00 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.

5.06.00 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be periodically done by the Contractor. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.

5.07.00 All combustible waste and rubbish shall be collected and removed from the work site at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.

5.08.00 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.

5.09.00 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.

5.10.00 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.

5.11.00 **First Aid**

A central fully equipped first aid post shall be provided at Site by the Contractor and included in his Bid. The facilities shall comprise first aid personnel, including a registered/qualified nurse, the provision and manning of an ambulance, and the retention of the services of medical practitioners for advice and attendance where necessary. These arrangements shall not relieve the Contractor of any legal/statutory obligations.

6.00.00 **STORAGE AND PRESERVATION**

6.01.00 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the Contract. Manufacturer's instructions for preservation shall be strictly followed.

6.02.00 All empty containers, packing materials, gunny bags, transport frames as also surplus and unused materials shall be the property of the Owner and returned to the Owner by the Contractor.

6.03.00 The Contractor shall ensure that all electrical and electronic panels will be stocked in adequately sized shades at the construction site.

7.00.00 **SITE WELDING & HEAT TREATMENT**

7.01.00 The Contractor shall submit detailed procedures and specifications in respect of the following:

7.01.01 Welding and Brazing (codes, procedures and electrode specifications).

7.01.02 Welder's Qualification Test.

7.01.03 Destructive and Non-Destructive Tests (DT/NDT).

7.01.04 Pre/Post heating and stress relieving.

7.01.05 Quality Assurance of Welding and Brazing.

7.02.00 The above procedures and specifications shall be subject to the approval of the Engineer.

8.00.00 **SITE CLEANLINESS AND WASTE DISPOSAL**

8.01.00 Throughout the period of construction of the Works the Contractor shall maintain the whole area of his operations in a clean, tidy and safe condition and shall arrange his materials in an orderly manner, all to the satisfaction of the Engineer.

8.02.00 All rubbish, etc. shall be systematically cleared from the working areas and, if not removed directly from the Site, shall be deposited at general collecting points provided by the Contractor and agreed with the Engineer, pending removal from the Site. Where practicable, screening shall be provided to prevent the ingress of dust and dirt to any part of the Works. The Contractor shall clearly state, what provision is being made for disposal of waste materials both on and off-site.

8.03.00 The Contractor shall not cause pollution of the Site land drainage system or any water course by waste products from any source whatsoever. Whenever any pollution is attributable to any act or omission on the part of the Contractor, the Contractor shall clear the pollution as soon as possible and make early arrangements to remedy the cause.

8.04.00 The Contractor shall make himself familiar with all statutory requirements relating to the discharge of effluent from the Plant and shall take all steps to ensure that these are not contravened by the disposal of effluent from the site. No dangerous or noxious waste products, chemicals or materials shall be disposed of, on or off the Site without proper treatment to make the quality comply with environmental regulation.

8.05.00 The Contractor shall take all necessary measures to ensure the safe collection and disposal of waste oils pertaining to those Works or plant for which he has responsibility and to ensure the prohibition of:

i) Any discharge of waste oils into surface waters, ground waters or drainage systems of any kind.

ii) Any deposit and/or discharge of waste oils on to the ground or floors of buildings and any uncontrolled discharge of residues resulting from the processing of waste oils or the cleaning of oil contaminated surfaces with solvents.

In order to ensure compliance with this requirement the Contractor shall provide suitable vessels for the collection of all waste oils. Where large quantities of waste oils need to be stored prior to being disposed of in bulk, suitable storage tanks shall be provided by the Contractor for this purpose.

iii) Any processing of waste oils causing air pollution, which exceeds the level prescribed by existing statutory provisions.

In the event that the Contractor fails to comply with the above, the Owner reserves the right to carry out such work on his behalf and to recharge accordingly.

8.06.00 **Damage to Public or Existing Site Roads**

The Contractor shall make good damage to roads, drains, footways, paved areas, boundary walls and fences etc. and clean all fouled roads and pavings etc., whether public or existing at site, caused by or in any way attributable to the handling/transport of plant or materials by the Contractor or any Sub-contractor and indemnify the Employer against loss, damage or claims by the Local Authority or others for damage to or fouling of roads, pavings etc., by reason of unusual traffic or other causes.

8.07.00 **Cleanliness of Public or Existing Site Roads**

The Contractor shall at all times ensure that the public roads, giving access to site, are kept clean of any materials deposited by traffic from the Contractor or his sub-contractors. The contractor shall also ensure dust suppression of site roads.

8.08.00 **Sanitation and Drainage**

The provision and maintenance of all temporary and permanent foul drainage and sewage disposal at site shall, during the construction period, be the responsibility of the Contractor, who shall ensure that all national and local statutory requirements for the effluent discharge are complied with.

The permanent and the temporary surface and foul water drainage systems shall all be separate. The Contractor shall make his own arrangements for foul drainage from the site during the construction period. A sewage treatment plant of the requisite capacity to meet the permanent requirements for the Site, shall be installed under this contract. This must be capable of producing an effluent to meet the required national and local discharge standards at all times.

8.09.00 **Clean Conditions**

Where relevant, the Contractor shall include in his supply of temporary works, maintenance and operation of clean conditions changing facilities including changing areas, ablutions and amenities.

9.00.00 **LABOUR MANAGEMENT AND SITE INDUSTRIAL RELATIONS**

9.01.00 The Contractor shall be wholly and entirely responsible for establishing and maintaining a strategy for sound labour management practices, good industrial relations and acceptable levels of labour productivity to achieve completion of the works within programme and budget. A statement of this strategy must be submitted with the Bid.

9.02.00 The Contractor shall establish to the satisfaction of the Engineer a Site Contractors' Group, to determine site labour practices and ensure their effective implementation and observance by all concerned. The Engineer reserves the right to observe proceedings at Group meetings.

9.03.00 The Contractor, to the satisfaction of the Engineer shall employ a Site Industrial Relations Manager (together with any necessary staff) to support line management in operating an effective labour strategy and to collect and collate employment data covering all site workers.

9.04.00 The Contractor shall be required to promptly inform and advise the Engineer of all matters relating to the management of site labour affairs both current and anticipated. The Contractor and all his sub-contractors shall also make available to the Engineer details of labour deployed, by occupation or trade, on each of the major site activities arranged so that manning levels involved in modules and elements set out are clearly identifiable.

This information shall be reported against programmed manning levels required by Section-XIII of this specification. Other reports and data may be required regularly or occasionally on all matters concerning the employment of work people on site.

9.05.00 The appointment of all sub-contractors remains the responsibility of the Contractor including the assessment of their proposed site labour policies.

10.00.00 **SITE EMPLOYMENT POLICIES AND PRACTICES**

The Contractor shall submit full details in the schedule provided in Volume: III of this specification, of his own and his intended sub-contractor's proposed labour practices and policies for the employment of labour for site erection work, and the regulation of industrial relations on a multi-contractor project.

Submission of such information shall in no way affect the Contractor's obligations under the contract, nor does it affect his responsibility for the adequate suitability of such proposals to meet the requirements of the contract, which responsibility remains entirely with the Contractor.

The Contractor shall provide the following information:

1. The Contractor shall detail the experience he has on managing Indian construction projects site-wise indicating the staffing, organisation, procedures, co-ordination, labour management matters etc.

2. Name of Company. (For Sub-contractors, type and extent of work let in the Sub-contract to be indicated.)

3. List the Employer Owner Federation(s) or Association(s) of which the Contractor is a member.

4. The labour agreement(s) the Contractor will adhere to when employing labour on site.

5. The Contractor's experience in operating Labour Agreements on major construction projects.

6. Details of any other types of payment, benefits or allowances which the Contractor anticipates making on site in addition to those determined by the relevant Labour Agreement.

7. The daily and weekly hours of work including all weekday and weekend overtime and shift work systems.

8. The Contractor's policy concerning the numbers of workforce representatives, their representational areas normally recognised for the works, together with a senior or works convener and whether such appointments are a full time or some other basis. Indicate the facilities normally granted to workforce representatives on site.

9. The likely sources of labour supply and the numbers to be employed from the Contractor's existing labour force and those to be recruited for the project. The anticipated percentage of local employees and non-local employees should be provided.

10. Details of the intended method(s) of recruitment of the site workforce.

11. A list of sub-contracts the Contractor intends to let for the purposes of labour supply.

12. A detailed graph of the build up and depletion of each of:

    a) Directly employed labour force

    b) Sub-contractors' workforces.

13. The Contractor shall indicate his policy assuring quality and competence of the labour and supervision and provide an outline of what skill testing will be carried out for the site works, how employees' skill standards will be maintained throughout the contract and the nature of any employee training he intends to provide for the project works.

14. The Contractor shall state the intended supervisory ratio i.e. number of employees reporting to each foreman or supervisor of staff employees on site for each trade or group of employees on site.

15. The Contractor shall demonstrate how his supervision and other first line management are provided with acceptable conditions of employment in relation to the workpeople they supervise.

16. The Contractor shall indicate any other factors he considers relevant to the manning of the works or of significance to the project's industrial relations.

17. Erection drawings & Erection manuals shall be submitted 15 days before commencement of erection of any equipment/structure. This point shall be added suitable by you.

Wardha 6x 600 MW -SEPCO - Construction Methodology – Level 1

1. As discussed project schedule given for First unit is applicable for any unit out of the 6 units to start with .

2. Construction Methodology Level -1
   The plan is to follow this sequence of erection and commissioning
   Unit 3,4,2,5,1,6
   This will facilitate material feeding for erection , movements of cranes and enable commissioning 6 units in 4 months intervals between each unit utilizing 8 months time gap between adjacent units in this sequence of commissioning.
   Requirements of first unit commissioning (Third Unit).
   - Total boiler completion
   - Total ESP and its bag filters completion
   - Main power house building for unit 3,2,1
   - Coal bunker bay for unit 3,2,1
   - Cooling tower for first unit (unit 3)
   - Channel and fore bay for phase-1
   - CW pumps erection in phase-1
   - Ash handling system (bottom ash) from Intermediate Silo to Ash dyke (silo) for entire plant to be completed for evacuation by truck to the ash dyke (bottom ash)
   - Ash handling system (bottom ash) from individual unit to intermediate silo to be completed
   - Ash handling system (fly ash) from silos to ash dyke to be completed for the entire plant.
   - Ash handling system (fly ash) - from ESP (of individual units) to phase-1 silo to be completed
   - From phase-1 silo the HCSD system to be made ready for disposal at ash dyke (fly ash)
   - Coal handling system for unit 1,2,3 to be completed
   - Coal handling plant conveyor (for unit 4,5,6) above phase I ID fan should also be completed
   - Coal handling plant (conveyor crossings) at all railway crossing to be completed
   - Coal yard for phase-1 to be completed
   - Two stacker reclaimer to be completed
   - Tracker hopper-1 to be completed, 2nd track hopper wherever affected to be completed
   - Central control room for unit 1,2,3 to be completed
   - Fuel Oil pump house for the entire plant to be completed
   - Raw water system, pre-treatment system, DM plant system for the entire plant to be completed
   - Switchyard for the entire plant to be completed
   - Fire fighting system for the entire switchyard and coal handling plant, Ash handling plant, Unit-3 and other areas as required to be completed
   - Air compressor (instrument air and service air) for the plant to be completed
   - Ash system compressor for the plant to be completed
   - 2 EOT cranes in the TG hall to be completed
   - Chimney along with unit 3 steel flue to be completed.

   Requirement for Second Unit commissioning (Fourth Unit)
   - Unit-2 chimney to be completed
   - Coal handling plant entire plant to be completed
   - Coal handling plant balance works for unit 4,5,6 to be completed

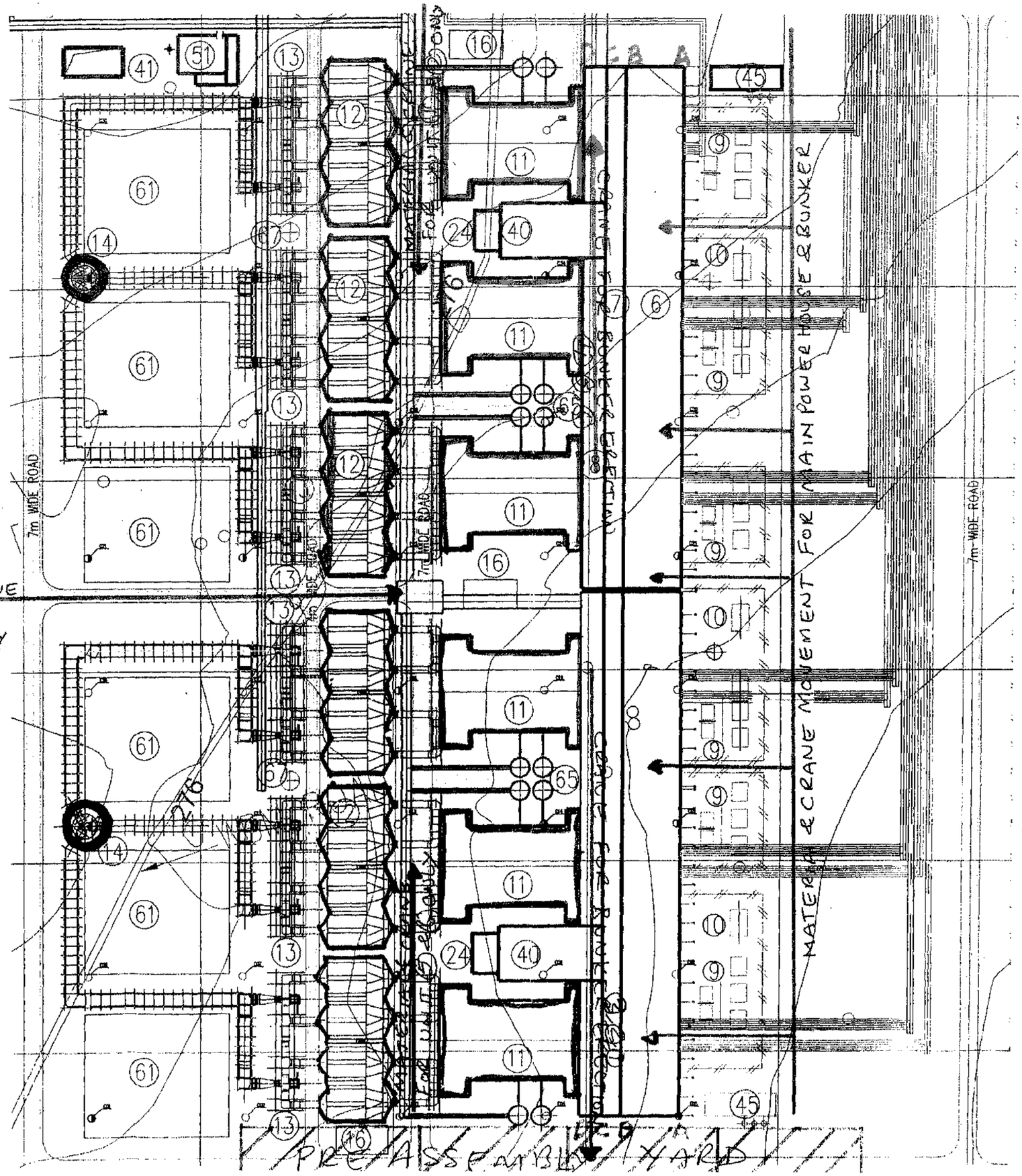
- Coal yard for phase-2 to be completed
- 2nd track hopper to be fully completed
- 3rd stacker reclaimer to be completed
- 2nd Central control room to be made ready
- Unit related cooling tower to be ready
- Channel and fore bay for phase-2
- CW pumps erection in phase-2
- Firefighting balance to be completed
- Any unit related system to be completed
- 3rd EOT crane in the TG hall to be completed

Positioning of the cranes

- For Boiler erection
  - 4 nos. tower cranes of capacity around 80 tones and two 250 tones crawler cranes will be deputed
  - In the ESP area two nos. 8 tone tower cranes and one nos. 75 tone tower crane will be provided
- Turbine hall structure
  - Two nos. 75 tone cranes per phase will be available for erecting the structures
- Central Control Room
  - Two nos. 75 tone crane will be made available
- Bunker Bay
  - Two nos. 250 tone cranes per phase will be available for erecting the structures
- CHP
  - Cranes as required will be made available at various points
- Other balance of Plant
  - Cranes as required will be made available at various points
- Fabrication of Bunker, structures etc
  - Four 40 tone gantry cranes (50 Mts) will be made available for fabrication of bunker hopper, steel structures fabrication in the yard adjacent to power house

3. In addition to above the list of T&P to be mobilized by SEPCO and its sub-contractors will be provided separately.

4. Detailed construction methodology will be submitted in 2 months time


7m WIDE ROAD
7m WIDE ROAD
7m WIDE ROAD
7m WIDE ROAD
CRANE FOR BOILER ERECTION
MATERIAL & CRANE MOVEMENT FOR MAIN POWER HOUSE & BUNKER
MATERIAL & CRANE MOVEMENT FOR UNIT 3 & 4 ONLY
PRE-FABRICATION YARD
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Mar 21, 2009

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SECTION-XV

QUALITY ASSURANCE SERVICES

26.03.09
(KIRAN PANDA)
WPCPL

(XUE LI)
2009.03.25

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QUALITY ASSURANCE SERVICES

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SECTION-XV

QUALITY ASSURANCE SERVICES

1.00.00 QUALITY ASSURANCE PROGRAMME

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Contractor's works or at his Sub-contractor's premises or at the Owner's Site or at any other place or work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be detailed by the Contractor and shall require acceptance and approval by the Owner/Authorised representative before the award of Contract.

1.02.00 This Section shall be read in conjunction with the Annexure-VI of this specification. In case of any contradiction the more stringent requirement shall be applicable.

1.03.00 A quality assurance programme of the Contractor and it's Vendors shall generally cover the following:

a) His organization structure for the management and implementation of the proposed quality assurance programme.

b) Qualification & experience of key personnel.

c) Use of suitably qualified and experienced personnel in required number for each type of work.

d) The procedure for quality assurance in design & engineering.

e) The methods, procedures and programme for presenting, collating and assessing information from the various sources, and its incorporation in designed submissions.

f) Documentation control system.

g) The procedure for purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

h) The method of protection, storage, stock control and issue of materials at site.

i) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

j) Inspection, sampling, testing, and acceptance procedures for plant and materials delivered to site.

k) Control of non-conforming items and system for corrective actions.

l) Inspection and test procedure both for manufacture and all site related works.

m) Control of calibration and testing of measuring and testing equipment.

n) System for quality audit and self-monitoring of QA Systems.

o) System for indication and appraisal of inspection status.

p) System for authorizing release of manufactured products to the Owner.

q) System for handling, storage and delivery to site.

r) Final inspection and certification of completed sections of work.

s) Site security procedures.

t) The recording and processing of variations to the Works and their incorporation on record drawings.

u) System for maintenance of records.

v) Furnishing of quality plans for design & engineering, manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of work.

w) Field Test Plan (FTP) and Inspection Test Plan (ITP) including the item l), j), l) and q) mentioned above shall be provided.

1.04.00 The Quality Assurance arrangements shall include the preparation of and adherence to documented quality plans. After approval by the Owner's Engineer the Quality Assurance arrangements shall form an integral part of the Contract. No changes shall be made without the prior written approval of the Engineer. The Bidder shall list the parts of the Works and Plant for which quality plans shall be submitted in Volume-III.

Also the QAP shall be in line with the agreed MOM's on Quality Plan as follows:

1. WPCPL furnished & explained the sample Quality Plans (QP) of WTP, CHP & AHP with minimum quality requirements for guidance of SEPCO. SEPCO shall follow the same & prepare similar QPs of other equipment of BOP. WPCPL shall submit the same for WPCPL's approval within 45 days from LOA. SEPCO shall float enquiries to Sub-vendors only with approved QPs.

2. WPCPL also furnished & explained the sample Field Quality Plans (FQP). SEPCO agreed to submit the filled up FQPs for WPCPL's approval within 45 days from LOA. SEPCO shall float enquiries to Sub-contractors only with approved QPs.

3. WPCPL already furnished & explained the KSK's Quality Plans (QP) for Boilers, Turbines & Generators, C&I and Electrical. SEPCO agreed to follow the same with minor changes, which shall be discussed & agreed after LOA.

Above Quality Plans mentioned are personally handed over to SEPCO during 21-02-09 , meeting at Jinan by WPCPL. For Point # 3 Quality plans are also sent on 5th January mail by WPCPL in 4 parts. Besides that C&I quality plans are again resend.

1.05.00 The Bidder shall list, in his Bid Proposal Sheets, his proposed sub-contractors and shall provide the following information in respect of each sub-contractor :

a) The items which the Bidder proposes to sub-contract.

b) The basis on which the Bidder has assessed, or proposes to assess, the quality assurance arrangements of the sub-contractors.

c) How sub-contractors' quality plans/procedures will be approved, monitored and audited on site during the Contract period.

d) The results of any recent evaluations and audits of the sub-contractor, which have been performed by the Bidder or other organizations external to the sub-contractor.

The Bidder shall also state the level of detail of the Quality Plan proposed for each sub-contracted item.

The information supplied in response to the above in the Bid shall be deemed a part of the Bidder's proposed Quality Assurance arrangements.

1.06.00 The Contractor shall provide documentation in such a manner that the Owner's Engineer is thereby enabled to satisfy himself as to the effectiveness with which the Contractor is implementing those provisions of the agreed and accepted Quality Assurance arrangements which relate to the monitoring by the Contractor to sub-tier Quality Assurance arrangements.

1.07.00 Audits of sub-tier Quality Assurance arrangements shall be recorded in such a manner that the relevant documentation constitutes, inter alia, objective evidence of the extent of the audits and of the effectiveness with which they have been conducted. All such documentation relating to any one audit shall be made available to the Owner's Engineer, on request, as a single self-contained document or as one discrete self-contained package of documents.

2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components, equipment and systems covered under this specification shall be designed, procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. Inspections, and tests at works including shop performance tests and test at site for all equipment and systems shall be as per respective codes and standards and also as required in the specification.

2.01.01 Bidder shall furnish a detailed and exhaustive list of all inspections and tests that he or his sub-contractors shall carry out at works and at site for all equipment and systems covered under this specification. The list shall have to be approved by the Owner/Consultant before Award of Contract.

2.02.00 The Quality Plan for design and engineering shall cover the procedure for independent verification, validation and assessment of designs in terms of fitness for purpose, constructability, safety, compliance with standards, maintenance requirements, cost effectiveness etc.

2.03.00 The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder separately and shall be submitted to Owner for approval. Schedule of finalisation of such Quality Plans shall be finalised before award of Contract.

2.03.01 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspections to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing.

2.03.02 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control organisation, during various stages of site activities from receipt of materials/equipment at site.

2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans alongwith Quality Plans. These Quality Plans and reference

documents/standards etc. shall be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the Contract. In these approved Quality Plans, Owner/Authorised representative shall identify Customer Hold Points (CHP). A Customer Hold Point signifies a stage in any item of work which requires documented proof of approval based on tests/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner/Authorised representative in writing.

All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner/Authorised representative for approval and dispositioning without formal approval of all such deviations, manufacturing should not proceed.

Any material/equipment procured from Third Party should be inspected /tested as per the specific and provision of relevant standards.

2.05.00 The Contractor shall submit to the Owner's Engineer complete field welding schedule for all field-welding activities for approval. The field welding schedule shall be submitted along with all supporting procedures like welding procedures, heat treatment procedures, NDT procedures etc.

2.06.00 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Engineer/Authorised representative, and duly authorised for despatch.

2.06.01 Quality assurance/Inspection group of Owner or its representative would issue a Material Despatch Clearance Certificate (MDCC) after the inspection clearance, which will enable the Contractor to despatch the equipment and claim the payment.

2.06.02 Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site upto erection.

2.07.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.08.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

2.09.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section-IX/BS-4870 or other International equivalent standard acceptable to the Owner.

All braziers, welders etc. employed on any part of the contract at Contractor's/Sub-Contractor's works or at site shall be qualified as per ASME Section-IX or BS-4871 or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner/ Authorised representative and test results should be properly documented for future reference.

For welding of pressure parts and high pressure piping the requirements of Indian Boiler Regulations (IBR) shall also be complied with.

2.10.00 All non-destructive examinations (NDT) shall be carried out in accordance with approved international standard. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non-destructive examination). Results of NDT shall be properly recorded and submitted for approval.

2.11.00 All the sub-vendors proposed by the Contractor for procurement of equipment, material and services and their quality assurance plans shall be subject to Owner's approval.

2.11.01 The list of all major sub-contractors would be submitted along with the Bid and this shall be mutually discussed and agreed to at the time of award of Contract. Regarding the various other minor sub-vendors, the list should contain their credentials (sub-vendor) & Vendor evaluation reports would be submitted within six (6) months of the award of the Contract and shall be mutually discussed and agreed to.

2.11.02 Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor. Also, the specification covered in contract should form Purchase Order.

2.12.00 All the purchase specifications, data sheets, drawings etc. for the major bought out items, list of which shall be drawn up by the Contractor and finalised with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed.

2.13.00 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub vendor's quality management and control activities. The Contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/approval of the results of tests and inspection shall not prejudice the right of the Owner to reject an equipment not giving the desired performance after

erection and shall not in any way limit the liabilities and responsibilities of the Contractor in earning satisfactory performance of equipment as per specification.

2.14.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.15.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner's Engineer.

3.00.00 QUALITY ASSURANCE DOCUMENTS

3.01.00 The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

a) Material mill test reports on components as specified by the specification.

b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

c) Non-destructive examination results/reports including radiography interpretation reports.

d) Factory tests results for testing required as per applicable codes and standards referred in the specification.

e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.

f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

g) Stress relief time temperature charts.

h) Inspection and test reports duly signed by QA personnel of the Owner and Contractor for the agreed customer hold points. During the course of inspection, the following will also be recorded:

   i) When some important repair work is involved to make the job acceptable.

   ii) The repair work remain part of the accepted product quality.

i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

All the above mentioned documents from item no. a) to item no. i) shall be submitted to Owner during Inspection & Testing of equipment as well as contract.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Owner's Engineer, his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

Contractor/sub-vendor should submit all relevant document duly approved by owner's engineer to the Inspection agency 20 days before the actual Inspection date. The document include drawings, data sheets, testing/Inspection procedure etc.

4.02.00 The Contractor shall give the Engineer/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection failing which the Contractor may proceed with test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of test reports in six (6) copies.

4.03.00 The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship, which is in his opinion, are not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

4.04.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Engineer/ Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the Engineer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the Contract.

4.05.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Engineer/Inspector or to his authorised representative to accomplish testing.

4.06.00 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at customer hold points and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

5.00.00 **ARCHIVING**

In addition to the requisite number of hard copies as specified, four (4) copies of all quality assurance documents, final inspection and test certificates etc. shall be made available to the Owner in Compact Disks before handing over of the plant.

VOLUME-II

SECTION-XVI

DATA AND DOCUMENTS TO BE FURNISHED BY THE CONTRACTOR/CONTRACTOR

28.03.09
CKIRAN PANDA
WPCPL

VOLUME-II

SECTION-XVI

DATA AND DOCUMENTS TO BE FURNISHED BY THE CONTRACTOR/CONTRACTOR

1.0 The Contractor shall fill-up the tables in the Volume-III of this specification completely in line with the instructions therein and sign each page. Besides, the absence of an unambiguous response to any item shall be treated as a point of no deviation from the tender specification and will thus remain contractually binding with the Contractor.

2.0 In addition to the above requirement the Contractor shall also submit the following data/documents. (*) means "Yes", however to be furnished post contract.

SL. NO.	ITEM	WHETHER REQUIRED
1.	Documents in support of the successful performance record of plant & equipment, similar to those being proposed now, which have been supplied & installed by the Contractor in the past.	Yes
2.	Similar documents as above from the Contractor's sub-vendors (for sub-vendors to be selected after the award of contract).	(*)
3.	Contractor's calculation with supporting documents to prove the proposed plant's availability as guaranteed/stated (this shall include quantitative data of break down losses, planned maintenance outages and derating losses, as against the design margins, redundancy and buffer storages offered).	(*)
4.	Contractor's Quality Assurance/Quality Control document as relevant to his Proposal prepared on the basis of Quality Plans submitted by Purchaser	Yes
5.	Contractor's total plan (schedule, duration & frequency) on the regular maintenance work of the proposed plant, also describing how the employer's personnel will be trained and utilised in the work.	(*)
6.	Contractor's proposed manpower schedule for the regular and emergency operation /maintenance of the plant.	(*)
Note :	The Contractor shall furnish a proposed maintenance program/schedule as called for here to enable assessment of preventive maintenance. The program shall indicate details such as interval between outages, duration of outage, man-hours required for outage, and the basis of such a program. A proposed shift working pattern to meet above outage program shall also be furnished.	(*)

SL. NO.	ITEM	WHETHER REQUIRED
	The Contractor shall also furnish a typical maintenance schedule for plant and other equipment detailing information such as time required, timing of the activity, nature of activity etc.	Yes
7.	Contractor's complete list of all technical deviations.	Yes
8.	**Contractor's complete list of all deviations from/on**	
	a) Commercial requirements of this bid.	Yes
	b) Conditions of contract.	Yes
9.	**Contractor's proposal drawings as follows**	
	a) Overall plant area layout showing the	(*)
	i) Ash dump area.	
	ii) Water intake and outfall areas,	
	iii) Effluent discharge points,	
	iv) Rail-tracks and roads connecting the plant site.	
	v) Nearest power transmission line.	
	b) Plot plan showing all buildings, outdoor plants & equipment, as well as the coal stock pile, fuel oil storage area, transformer yard/switch yard, stores, work shop, green areas, reservoirs, drainage & other pits, effluent treatment areas, oads, railtracks, temporary storage areas & buildings required during erection and also all future provisions if applicable.	During offer stage as far as practicable. However, detail during contract stage.
	c) **Equipment layout drawings for**	
	i) All floors of the power house	Yes
	ii) Boiler area	Yes
	iii) Ash handling plant	(*)
	iv) Coal handling plant	(*)

SL. NO.		ITEM	WHETHER REQUIRED
	v)	Demineralisation plant	(*)
	vi)	Raw water storage and treatment plant	(*)
	vii)	Raw water intake and pump home	Yes
	viii)	Raw water pipe line route	(*)
	ix)	Fuel oil handling plant	(*)
	x)	CW pump house	(*)
	xi)	Intake water pump-house	(*)
	xii)	Fire water pump-house	(*)
	xiii)	Layout Plan & section of 400KV switchyard with proposed bus configuration	Yes
d)	**Schematic drawings/one-line diagrams for**		
	i)	Power Cycle piping systems (including drains & vents).	Yes
	ii)	Cooling water Systems (CW as well as auxiliary cooling water systems).	Yes
	iii)	Compressed air systems	Yes
	iv)	Auxiliary steam systems, including the water & steam system for the auxiliary boilers.	Yes
	v)	Fuel oil handling systems	Yes
	vi)	Ash handling plant	Yes
	vii)	Coal handling plant	Yes
	viii)	Demineralising plant	Yes
	ix)	Raw water reservoir and treatment plant	Yes
	x)	Raw water intake and Pump House	Yes
	xi)	Raw water pipeline	Yes

SL. NO.		ITEM	WHETHER REQUIRED
	xii)	Water balance diagram for the entire plant water system including drainage/effluent flow.	(*)
	xiii)	Single line diagram (SLD) of electrical Power distribution system.	Yes
	xiv)	SLD of 400 KV Switchyard with detail bus-configuration, metering and protection scheme	Yes
	xv)	MV and LV system	(*)
	xvi)	D.C and A.C emergency system	Yes
	xvii)	Tripping logic/scheme for Generator, Generator Transformer, Unit Transformer and Station Transformer	(*)
	xviii)	Any other diagram indicated in Section-XVIII and as required	(*)
	xix)	Process flow diagram of the proposed waste water treatment showing total water recycle and scheme of zero discharge	(*)

Note : (Any terminal points, so far a applicable for the Contractor, shall be shown in the above drawings).

e) Heat balance diagrams for the power cycle system showing TG gross heat rate, power generation, auxiliary power consumption and all relevant parameters (pressure, temperature, enthalpy & flow rate) for the following conditions (with 0% and 3% make-up) :

i)	Turbine VWO	Yes
ii)	100% TMCR	Yes
iii)	80% TMCR	Yes
iv)	50% TMCR	Yes
v)	Best efficiency condition	Yes
vi)	Maximum power generation condition when top H.P. heater is out.	Yes
vii)	60% hp-lp bypass condition with and without turbine on house load	Yes

SL. NO.		ITEM	WHETHER REQUIRED
	viii)	All the above heat balance diagrams with any over pressure (from rated value) condition if applicable.	Yes
f)	**Steam generator unit performance chart with design coal as well as worst coal for**		
	i)	100% BMCR	Yes
	ii)	100% TMCR	Yes
	iii)	80% TMCR	Yes
	iv)	50% TMCR	Yes
	v)	All HP heaters out condition	Yes
	vi)	60% BMCR	Yes
		The above chart shall provide the complete heat balance information, fuel consumption, boiler efficiency, flow rate, pressure and temperature at all the essential points of the furnace and its draught plant, and also of the feed water and steam systems.	
g)		All correction curves needed to establish the guaranteed performance value from the corresponding figures obtained during the Acceptance Test, including the correction curves due to :	
	i)	Ambient wet bulb temperature	Yes
	ii)	Dry bulb temperature	Yes
	iii)	Humidity	Yes
	iv)	Fuel properties/composition	(*)
	v)	Na_2O content in ash/Sulphur content in coal	(*)
	vi)	Raw water analysis values	(*)
	vii)	Supply frequency	Yes
	viii)	Supply voltage	Yes

SL. NO.	ITEM	WHETHER REQUIRED
	h) **General Arrangement drawing and sectional drawing for**	
	i) Turbine assembly	Yes
	ii) Furnace	(*)
	iii) All other major equipment	(*)
10.	A complete list of the Internationally accepted codes & standards which the Contractor will follow in the design, material selection, manufacturing, erection, tests at works and tests at site for all major plant & equipment as well as piping, cabling, steel structures etc.	Yes The list shall be prepared stating the codes and standards for each individual plant item.
11.	A list of statutory regulations which the Contractor's proposed plant will follow and for which the Contractor shall prepare all documents needed to obtain the approval of the statutory bodies.	Yes
12.	A bar-chart for the Contractor's proposed design, manufacturing, procurement and delivery activities.	Yes
13.	A bar-chart for the Contractor's proposed site activities up to commercial operation of the units.	Yes
14.	Write-ups to describe the following as applicable to the proposed plant :	
	a) Safe shut-down procedure in the event station becomes disconnected from the transmission system.	(*)
	b) Electrical system studies with A.C and D.C system analysis to substantiate the satisfactory operation of the electrical systems and plant	(*)
	c) Provision for safe unloading of the plant in the event of simultaneous failure of the running and standby BFP and conden sate extraction pumps from full load operation.	(*)
	d) Condenser maintenance provisions, with maximum permissible TG load during such maintenance. Also the procedure of condenser tube withdrawal	(*)
	e) Brief description (mentioning the national/international standard and code of practice followed) of the control, interlock and safety features provided in the following systems :	

SL. NO.		ITEM	WHETHER REQUIRED
	i)	Turbo-generator island (including start-up, governing, load rejection, trip etc. and the various protection systems).	Yes
	ii)	HP-LP bypass system	Yes
	iii)	Furnace (including start-up & shut down, burner management, air damper control, metal temperature control, etc.).	Yes
	iv)	Draught plant.	Yes
	v)	Coal feeder and milling plant	Yes
	vi)	Power Cycle steam, feed water and condensate system.	(*)
	vii)	Fuel oil (HFO & LDO) system	(*)
	viii)	Coal handling plant	Yes
	ix)	Ash handling plant	Yes
	x)	Demineralising plant	(*)
	xi)	Raw water treatment plant	(*)
	xii)	Effluent treatment plants	Yes
	xiii)	Circulating water and other water systems.	Yes
	xiv)	Compressed air supply system.	(*)
	xv)	Electrical power distribution system including MV and LV system and D.C and A.C emergency system	Yes
	xvi)	400 kV system	Yes
	xvii)	Cabling, Grounding and lightning protection systems	Yes
	xiii)	All other electrical systems indicated is Section-XVIII and as required	(*)

SL. NO.	ITEM	WHETHER REQUIRED
f)	Details of the furnace air-preheater, describing the basis for design, material selection and construction, as well as its control, protection and safety feature and past performance record of similar air-preheaters (supplied by the Contractor) working in other projects using similar fuels.	Yes
g)	**Similar details as above for**	
	i) Flue gas particulate extraction equipment (e.g. ESP)	(*)
	ii) Coal mills	Yes
	iii) Coal crushers (Primary & secondary)	(*)
	iv) Bottom ash clinker grinders	(*)
	v) Coal stacker & reclaimer.	(*)
	vi) Turbine surface condenser and its air extraction system.	Yes
	vii) Condensate Polishing Plant	(*)
	viii) Zero Effluent Discharge Scheme	Yes
h)	Write-up to justify the requirement/non-requirement of a condensate polishing unit for the proposed plant.	Yes
i)	Write-up on the proposed coal handling plant highlighting the type of covered coal storage for protection from the rain water, and the procedure for reclaiming coal from this stock at the specified rate.	Yes
j)	Write-up on the proposed procedure of emergency emptying of the power house coal bunkers and the subsequent handling of the coal emptied from the bunker.	Yes
k)	Write-up on the proposed procedure of overhauling the following equipment :	
	i) Generator stator	(*)
	ii) Feed water heaters	(*)
	iii) Boiler feed water pumps & drives	(*)
	iv) Coal mills & drives	(*)
	v) Outdoor transformers	(*)

SL. NO.			ITEM	WHETHER REQUIRED
		vi)	Long vertical pumps (e.g, C.W pumps, Raw water pumps etc.)	(*)
		vii)	Power house switchgears	(*)
	l)	i)	Write-up on the proposed method of protecting the leading edge of the LP moving blades of the steam turbine.	(*)
		ii)	Campbell Diagrams for LP bladings	(*)
	m)		Write-up on the turbine gland seal design and gland sealing system design offered, with past performance record.	Yes
	n)		Description of the boiler feed pump drive unit and the start-up, cooling, thrust balancing, leak-off handling and shaft sealing arrangement for the pump and its drive (if applicable)	Yes
	o)		A description of the condensate make-up and dump system (with provision to avoid direct contamination of the DM water in the condensate storage tank) and also the condenser hot-well and deaerator storage tank level control system.	(*)
	p)		A write-up on the arrangements proposed to meet the specified limits on noise level	(*)
	q)		Description of foundation system adopted for buildings, structures and equipment	Yes
	r)		Description of major building and structures	Yes
	s)		Information on RC chimney and its method of construction	Yes
	t)		Description of Vibration isolation system for TG and other machine foundations	Yes
	u)		Write-up on turbine washing procedure, forced (quick) cooling system and preservation system in idle period	(*)
15.			Availability, Reliability and Maintainability plan indicating the major activities and deliverables	Yes

SL. NO.		ITEM	WHETHER REQUIRED
16.		A list of plant items, whose life will be shorter than 30 years, including item like mill wearable parts, etc. with the estimated/ guaranteed life for each item as well as the required time and estimated cost for replacement.	Yes
17.		A write-up and a list of plant effluent/environmental pollution monitoring equipment (with brief specification) to be provided by the Contractor.	Yes
18.		Complete list of all tests to be carried out, with code/standard followed and brief description of test procedure, for :	
	a)	Tests at works	(*)
	b)	Tests during erection & commissioning.	(*)
	c)	Subsystem performance tests.	(*)
	d)	Operational & flexibility tests	(*)
	e)	Reliability demonstration tests	(*)
	f)	Acceptance tests	(*)
	g)	Extended performance tests	(*)
19.	a)	A list of all valves in essential service (including all power cycle system valves and the valves on the circulating water and other cooling water lines, D.M. water lines, various effluent piping, ash lines, compressed air lines, vacuum systems etc.) particularly mentioning the body & trim materials, type of bonnet, type of valve operator, gland packing used, the use of integral bypass, and type of ends (flanged/welded/screwed).	(*)
	b)	The list shall also include all safety valves for the steam generators and their set pressures & relieving capacities.	(*)
20.		Characteristic curves (capacity vs. TDH, Power, efficiency and NPSH) for the following pumps:	
	a)	Boiler feed pumps at various operating speeds	Yes
	b)	Condensate extraction pumps	(*)
	c)	CW Pumps	Yes

SL. NO.		ITEM	WHETHER REQUIRED
	d)	Intake water pumps	(*)
	e)	Auxiliary CW pumps	(*)
	f)	Closed cycle DM cooling water pumps	(*)
	g)	Fuel oil unloading pumps	(*)
	h)	Condenser air extraction pumps	(*)
21.		Characterstic curves for the following fans at various speeds and damper positions	(*)
	a)	ID fan	
	b)	FD fan	
	c)	PA fan	
	d)	Cooling tower fan	
22.		Vibration analysis results for condenser and feed heaters under worst operating conditions	(*)
23.		**Data to be furnished on Control & Instrumentation offered**	
	a)	Plant Operational Philosophy	Yes
	b)	DCS System Architecture Drawings.	Yes
	c)	Description and write-up of control and interlocking system	Yes
	d)	Proposed general arrangement of Panels, Consoles, System Cabinets, instrument Power Supply Panels	Yes
	e)	Scheme for power supply distribution to equipment/systems	Yes
	f)	Manufacturer's catalogues of instruments, control gadgets and other accessories.	Yes
	g)	Scheme for steam & water analysis system.	Yes
	h)	Scheme for machine monitoring system.	Yes

SL. NO.		ITEM	WHETHER REQUIRED
	i)	Schematic Drawings of offsite PLC system and hook-up with DCS.	Yes
	j)	P&IDs of all main, auxiliary and offsite systems	Yes
	k)	Software documentation.	Yes
	l)	As built documentation	Yes

Note : For Data and Documents to be furnished during contract stage please refer Section-XIX.

24. **AC SYSTEM** (*)

Compressor

Make : **Type :** **Model no. :**

Evaporating temperature and condensing temperature of each compressor:

Compressor capacity at rated speed:

Power consumption:

Motor rating of each compressor:

Condenser & Chiller

Heat exchange rate :

AHU

Dehumidified air qty. :

Power consumption & fan motor rating:

Split/Packaged Units

Make : **Type :** **Model no. :**

Capacity at design conditions:

Power consumption:

Cooling Tower

Make : **Type :** **Model no. :**

Cooling capacity:

Water flow rate:

SL. NO.	ITEM	WHETHER REQUIRED

CW/CHW Pumps

Make : **Type :** **Model no. :**

Capacity & Head :

Power consumption :

Motor rating :

25. **VENTILATION SYSTEM** (*)

Evaporative Cooling Unit & UAF Unit

Capacity & Static Pressure of Fans :

Overall dimensions :

Total power consumption :

Saturation efficiency :

Fans

Make : **Model no. :** **Type :**

Capacity :

Static pressure :

Total efficiency :

Power consumption & Motor rating :

Limit Load :

Filters

Make : **Model no. :** **Type :**

Material :

Module size :

Efficiency :

Face velocity :

SL. NO.	ITEM	WHETHER REQUIRED (*)
26.	**DE/DS System**	
	Fan :	
	Make : **Model no. :** **Type :**	
	Capacity :	
	Static pressure :	
	Power consumption & Motor rating :	
	Bag Filter	
	Make : **Model no. :** **Type :**	
	Capacity :	
	Filter Bag Material :	
	Air to cloth ratio :	
	Pressure drop :	
	Overall dimensions : **Nozzles :**	
	Make : **Model no. :** **Type :**	
	Material :	
	No. of nozzles (system wise) :	
	Pumps :	
	Make : **Model no. :** **Type :**	
	Capacity :	
	Head :	
27.	Brief description of all other plant & equipment (not covered above).	(*)

SL. NO.	ITEM	WHETHER REQUIRED
28.	**List of spares required**	
	a) Consumable spares (for day to day maintenance, inspection & overhaul of plant & equipment requiring regular attention).	(*)
	b) Overhaul spares (for planned overhauls to ensure the required availability and efficiency of the plant).	(*)
	c) Strategic spares (generally high cost and/or long lead-time spares required infrequently, may be once in the plant's life time).	(*)
29.	Manufacturing drawings for those spare parts going out of production beyond three (3) years of plant operation	(*)
31.	Engineering and master drawing schedule indicating when the drawings and data will be submitted for review	(*) Within four (4) weeks from the date of issue of notice of proceed

General Notes : In addition to above Contractor to comply with the requirement as indicated in Section-XII.

WARDHA POWER CO. PVT. LTD.

6 X 600 MW COAL BASED POWER PLANT

Clause No. 1.0.0 to 4.0.0 not used

5.0.0 DETAILED SCOPE OF ERECTION, TESTING AND COMMISSIONING (MECHANICAL)

5.1.0 General

5.1.1 The scope of work shall include all activities at site including placing of equipment on foundation, leveling and alignment, grouting of foundation, other miscellaneous minor civil work such as dressing/chipping of foundation surfaces as required, scraping, drilling, reaming, honing, edge preparation assembly & preassembly, inspection & testing by inspecting authority wherever required, refractories and insulation work, minor rectification, welding, cutting, site adjustments and all other incidental activities.

5.1.2 The contractor shall furnish all labour (supervisory, skilled, unskilled and administrative) all consumable materials, transport vehicles, mobile cranes, hydraulic jack, required erection tools & tackles & equipment, precision levels including micro levels, dial and other gauges, surface plates, straight edges, testing equipments, special tools like vacuum cleaners, blowers, radiography and stress relieving equipment, pumps and other equipment necessary for hydrotesting, compressed air testing and all other necessary implements in sufficient numbers as may be required for timely and efficient execution of the contract. The materials supplied shall be of the best quality, the specification and quality of which have to be approved by Engineer.

5.2.0 Supervision during Erection

The Contractor shall be required to provide, at a proper time, the necessary supervisory engineers, supervisors and other supervisory personnel duly qualified and in sufficient number for transportation, erection, pre-commissioning and post commissioning check up, start-up, testing and trial operation of plants and equipment.

The Contractor shall keep a competent representative who will be Resident Engineer and shall remain as 'In-Charge' of contractor's work site and also remain answerable to the Owner for all activities of the contractor at site. Before his placement at site, the contractor shall submit his bio-data to the Owner for his approval.

The Resident Engineer shall supervise the work of all men of the contractor working at site. He shall work in complete harmony and co-operation with Owner's engineers and manufacturer's engineers working at site. All statutory rules and labour laws prevailing in the area must be

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observed by the Contractor. All safety measures against occurrence of accidents must be taken effectively. Resident Engineer shall not be withdrawn without written permission of the Owner. If any of the Contractor's personnel is found unsuitable for the job, the contractor shall remove him forthwith and a suitable replacement shall be posted at site within a reasonable time. No compensation for withdrawal of unsuitable or unqualified person(s) from site or for posting suitable person(s) to site at any stage of the project shall be allowed by the Owner.

5.3.0 Sequence of Erection Work

5.3.1 All packing cases and packages shall be opened in the presence of the Engineer or his authorized representative. Timber packing cases shall be carefully opened to avoid damage to materials or timber. Nails and packing strips should be pulled out with suitable appliances and kept separately in a container and not thrown away at random. All timber of packing cases shall have to be sorted out and stored properly at a suitable place, as directed by the Engineer. From time to time packing materials, timber, nails and strips shall be delivered back to the Owner or otherwise disposed off, as directed by the Engineer.

The Timber reclaimed from the packing cases or any other material shall not be used by the contractor for rendering facility in the erection work or any other job, without prior permission of the Owner. All timber and packing materials shall remain the property of the Owner.

5.3.2 Each material after stripping from boxes or received loose, shall be carefully inspected, checked with shipping list and identified with erection drawing, if necessary. Any short supply and/or damaged part shall be reported forthwith to the Owner in writing. The contractor shall be completely responsible to make all necessary arrangements, application and follow procedure to process claim on underwriters, obtain replacement repair/rectify and modify, as required on all such damaged/defective/ lost equipment and material at no extra cost to the Owner in order to execute the work in satisfaction to the Owner/Engineer within the stipulated contract time.

Once the materials are inspected, the same shall be preserved properly and adequately protected from theft and deterioration or damage by rain, storm, dust, water, tampering by casual visitors or workers. The Contractor shall prepare and maintain stores, ledgers and bin cards for all materials in his custody.

5.3.3 Carrying out all repairs to damages that might have occurred during transit and in subsequent storage and modifications and rectification work and replacement of all lost parts, are under the Contractor's Scope.

5.4.0 Erection

5.4.1 Erection shall be carried out in the manner and in sequence as may be directed by respective equipment manufacturer's supervisory engineers and the Owner's engineer.

5.4.2 As erection proceeds, each assembled part before being boxed up with a view to erecting it finally, shall be inspected and approved by the concerned supervisor. Should any defect be found out during such inspection, the contractor shall make it good as per directives from Owner's engineer.

5.4.3 The pressure parts coming under IBR shall be erected in conformity with provisions of the Indian Boiler Regulations. Welding, post weld heat treatment and other non-destructive testing will be conducted by the contractor as required by the code and as instructed by the Engineer. All welding for piping and vessels coming under the purview of IBR shall be done by certified welders duly qualified under the provisions of IBR Procedures of all welding shall be approved by Engineer, before hand. Contractor shall arrange suitable stress relieving equipment with automatic recording devices.

5.4.4 All necessary radiography will be included in the scope of work of the Contractor. Contractor shall furnish all instruments, isotopes, films, etc. for conducting radiography and equip himself fully. Necessary operators of all testing equipment shall be provided by the Contractor.

Dark-room facilities with air-conditioners for storing and processing radiography films and equipment, as necessary, shall have to be arranged by the Contractor.

5.4.5 The equipments shall be placed on respective foundation or support, leveled and aligned with precision measuring instruments, checked for proper clearance between moving and stationary parts wherever applicable and grouted on the foundation.

5.4.6 All fabrication and engineering work incidental to erection, like scaffoldings, structural framings for pre-assembly, transport and erection, etc. shall have to be done by the Contractor at his own cost. The structural steel required for such work shall be arranged by the Contractor. Also, any fabrication work like cutting, grinding, welding, straightening, filling, reaming, drilling, threading, fitting up, etc., which in the opinion of the Engineer are incidental to the erection at site, shall have to be done by the Contractor. Any defect in the fabrication shall have to be rectified by the contractor at his own cost.

5.4.7 All piping work shall be done as per Vendor's certified drawings. For details refer specifications.

5.4.8 Welding shall not be carried out on wet surfaces and shall be protected from high winds.

5.4.9 All pressure vessels should be directly placed on the foundation in fully fabricated form.

5.4.10 Particular attention shall be given towards removal of tackles and other forms of distortion.

5.4.11 Holes in plate work to assist in erection should be avoided. Lugs required for erection shall be removed and projections of weld shall be chipped and ground flush.

5.4.12 Misalignment in vertical joints shall not exceed 10% of plate thickness or 1.5 mm, whichever is larger. Misalignment in horizontal joints shall not exceed 20% of upper plate thickness with a maximum of 3 mm for plate thickness above 8 mm and a maximum of 1.5 mm for plate thickness below 8 mm.

5.4.13 All equipment shall be safeguarded from wind or other external causes by providing suitable steel cables/guys until completion of erection.

5.4.14 Welding sequence shall be adopted in such a way so as to minimize distortion due to weld shrinkage and shall be got approved from the owner's engineer prior to commencement of work.

5. 4.15 All materials such as welding electrodes, gaskets, bolts, nuts, etc. shall be of reputed make and conforming to relevant Indian standards. Prior approval of Engineer will have to be obtained before commencement of work. Manufacturer's test certificates shall have to be provided when called for.

5.5.0 Safety Regulations

5.5.1 When going to or from place of work in the Plant only the prescribed walkways, paths or crossovers shall be used. Railroad crossing warnings shall be heeded.

5.5.2 Crawling on, over or under removable equipment shall generally be prohibited.

5.5.3 All persons are to stay clear of lifts being made by overhead cranes.

5.5.4 For overhead work, proper signs shall be placed below and, when conditions justify, a watchman shall be stationed to warn employees in the vicinity.

5.5.5 Work on or above crane runways shall not be undertaken without the Engineer's permission. Whenever it is necessary to do any work on or above the crane runways, the Contractor shall furnish a flagman stationed on the floor.

5.5.6 Only scaffolds which meet the requirements of governing laws shall be used in the project.

5.5.7 Work in the area of electric wires and cables shall generally be avoided.

5.5.8 All burning and welding equipment shall conform to, and be used in accordance with, regulations governing such equipment. No burning or welding shall be done at any place on the site until location where such work is to be done is approved.

5.5.9 Adequate fire protection shall be available before work shall proceed.

5.5.10 All warning signs shall be observed.

5.5.11 Use of explosives shall comply with all regulations.

5. 5.12 Proper care shall be taken in the use of compressed air.

5.5.13 Contractor shall require his employees to wear hard hats at all times when they are in an area where they are in danger from falling objects.

5.5.14 Goggles shall be worn whenever there is a possibility of flying particles or splashing corrosive fluid.

5.5.15 When working around caustic or acid solutions, workman shall wear gloves, goggles and protective wear.

5.5.16 When ladders are the means of access to a platform, they shall be firmly secured top and bottom and the ladder rails shall extend at least one meter above the top landing. When a ladder cannot be secured, a man shall be stationed at the base.

5.5.17 Safety belts shall be used by men working in high places when no handrails or other guards are in place.

5.5.18 All accidents resulting in injury, shall be reported to the Engineer promptly. The report shall contain the following :

a) Name of the employee and identifying information
b) Whether injury involved caused loss of time or not
c) Occupation of injured
d) Date of accident
e) Time of accident
f) Place of accident
g) Nature of injury
h) What injured was doing at the time of accident
i) Detailed description of accident
j) Whether applicable safety equipment was being used
k) Whether an unsafe act was being committed
l) What action is being taken to prevent recurrence of a similar accident
m) Injured man's comments

5.5.19 Proper Treatment of Injured

a) All employees shall be instructed by Contractors to report immediately for treatment of any injury, no matter how trivial.
b) Contractor shall ensure that proper treatment of injuries is immediately available either as such or in the form of constantly available transportation to a source of such treatment.
c) Contractors shall ensure that stretchers are available near all areas in which their men are working and that the location of stretcher is well marked.

5.5.20 Contractor shall be solely responsible for the dissemination of all safety regulations including those written here, those promulgated by Owner and those dictated by good practice, and shall ensure that all his employees and those of his sub- contractors are conversant with the same.

5.6.0 Inspection

5.6.1 After completion of erection and/or installation and before start up, each plant and equipment and all its appurtenances shall be thoroughly cleaned and then inspected in the presence of Owner's engineer for correctness, soundness and completeness of installation and acceptability for start-up.

5.6.2 All works to be carried out by the contractor shall be subject to inspection by the Owner's Engineer. The work shall be carried out as per applicable specifications, codes of practice, drawings and instructions of Engineer. The Contractor shall provide necessary facilities, instruments, personnel, etc. for carrying out the inspection as above and shall comply with the instructions given.

5.6.3 A check list in triplicate will be furnished for the approval of Engineer wherein all items to be checked and necessary instructions will be listed. Inspection and checking shall strictly follow this check list. On completion of the joint inspection and checking, two (2) copies of the check list will have to be handed over to the Engineer. The check lists after checking will have to be jointly signed by the Contractor's supervisor and the Engineer to ensure that all inspection and checking have been properly carried out. However, such endorsement shall not relieve the Contractor from the responsibility in ensuring proper erection and cleaning.

During inspection all clearances, alignment and important measurements and adjustments as may be directed shall be noted by the Contractor for future reference and guidance. Two (2) copies of such notes shall be delivered to the Engineer.

5.7.0 Cleaning

5.7.1 The Contractor shall observe strict cleanliness during execution of the work and shall be in possession of vacuum cleaner for cleaning the

internals of machinery under installation. They shall check that all the finished surfaces are greased and covered and all pipes and duct ends are covered with plastic or suitable type of cap during storage.

5.7.2 The Contractor shall clean inside the internal surfaces of all piping before erection by wire brushing and air blowing. In case of small diameter piping for cooling and lubrication, cleaning will have to be done by pickling if so required. The inside of all equipment shall be thoroughly cleaned before they are installed.

5.7.3 Before boxing up, the Contractor shall examine carefully to ensure that no foreign materials, such as welding rod ends, metal chips, rope, working tools or other materials are left inside the equipment, piping, duct.

5.7.4 The Contractor shall steam blow the piping after erection to the satisfaction of the Owner. The temporary piping for this purpose will be supplied by the Contractor. The contractor shall also provide all labour for execution of the work including dismantling of temporary piping, strainers, valves and instruments required for conducting the cleaning work.

5.8.0 Pre-commissioning testing

5.8.1 After alignment of all equipment, alignment tests shall be carried out by the Contractor to check level, clearance, eccentricity, etc. .All measurements will be witnessed and acceptance will be certified by the Engineer.

5.8.2 Hydro testing shall be conducted for all pressure parts after installation as required pressure. All necessary blanking arrangement necessary for such hydro testing shall be furnished by the Contractor. The hydro testing of pressure parts under the purview of IBR shall meet the requirements of IBR. All necessary test pumps, temporary piping, etc. shall be supplied by the Contractor.

5.8.3 After the hydrostatic tests, the contractor shall carry out thorough flushing of all lines to ensure removal of foreign materials like welding rods, metal chips, etc. to the satisfaction of the engineer. During the gross flushing, the velocity of water shall be maintained as near as possible to that at outlet to match the inlet quality. After the flushing of the lines, all the water shall be drained and the cleaned piping surfaces shall be dried by blowing air or by any other approved method. The different piping shall be cleaned as mentioned here under :

a. Miscellaneous equipments Cooling Water & Service Water Piping
All the equipment of the Cooling Water, Service Water Piping, etc. shall be cleaned by gross flushing of the lines with water.

b. Condensate and Feed Water Piping
The condensate and feed water piping shall be gross flushed with water. After gross flushing, the lines will be alkali flushed with suitable chemicals. After the alkali flushing, the lines will be

thoroughly rinsed with DM water to remove all traces of the chemicals.

c. DM Water Line
The demineralized water line from DM Plant to the unit shall be gross flushed with filtered water and then with DM water.

Cleaning sequences and the temporary arrangements for the same shall be developed by the Contractor and got approved from the engineer. All the materials like piping valves, etc. shall be provided by the Contractor and also the installation and dismantling of the temporary arrangements shall be carried out by him.

d. Turbine Oil Piping
The turbine oil piping shall be pickled and neutralized and flushed with the same grade of lubricating oil that is to be used.

Cleaning sequences and the temporary arrangements for the same shall be developed by the Contractor and got approved from the engineer. All the materials like piping valves, etc. shall be provided by the Contractor and also the installation and dismantling of the temporary arrangements shall be carried out by him.

5.8.4 All the pressure vessels and storage tanks like deaerator storage tank, blow down tank, etc. shall be cleaned mechanically, manually and then water flushed in a manner similar to the pipings by the Contractor.

5.8.5 The ducting work and boiler setting will be usually examined for leak tightness. In case any leakage is found during test run of the boiler, it shall have to be set right to the satisfaction of the Engineer

5.8.6 The safety valves coming under the purview of IBR shall be set and tests conducted to the satisfaction of the Inspector. Other safety valves shall be set and tested to the satisfaction of the Engineer.

5.8.7 Supply of all instruments, temporary piping, instrument calibration, pumps, etc. required for testing shall be under the scope of the Contractor.

5.8.8 Modification/rectifications as felt necessary by the Engineer/Inspector shall be carried out at no extra cost to meet the guarantee and other technical particulars.

5.8.9 Following pre-commissioning tests shall be carried out on the Boiler Unit

.a. Hydrostatic Test of Pressure Parts
On completion of erection of the pressure parts of the steam generator, the unit with its fittings and mountings in position shall

be subjected to hydraulic test pressure in accordance with Indian Boiler Regulation.

Water used for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the steam generator shall be drained and the non-drainable parts shall be suitably preserved.

b. Test of Leak Tightness
After complete erection of the steam generator, before first firing for drying the setting, the Contractor shall carry out tests to check leakage in the boiler settings either by smoke bomb or by pressurizing the furnace. All the instrumentation pneumatic piping shall be checked and tested to ensure leak tightness.

c. Alkali Boilout and Steam Blowing
At the appropriate stage of commissioning sequence of the plant, the Contractor shall carry out the alkali boilout of the steam generating tubes, headers and drum for removal of mill scale, oil, grease, debris, etc. After boilout, the cleaned surfaces will be suitably preserved by the Contractor. The preservation procedure shall be carried out by the Contractor whenever the steam generator will remain shutdown for more than the stipulated time, till the plant is taken over by the Owner.

After completion of alkali boilout, the superheaters and the steam lines shall be steam blown to clear mill scale, debris, foreign material, etc. A target suitable material will be positioned on the temporary blow off pipe to assess the effectiveness of steam blowing. Steam blowing shall be done in phases.

The clearance as to the satisfactory completion of steam blowing shall be given by the Engineer. All temporary arrangements and schemes for steam blowing, alkali blowout and preservation procedures shall be developed by the Contractor and got approved from the Engineer.

5.8.10 The turbine units shall be tested as per manufacturer's procedure approved by the Owner.

5.8.11 The shell and water boxes shall be hydrostatically tested in accordance with HEI Standards and PTC 19-21.

5.8.12 The safety valves coming under the purview of IBR shall be set and tests conducted to the satisfaction of the Inspector. Other safety valves shall be set and tested to the satisfaction of the Engineer.

5.8.13 Supply of all instruments, temporary piping, instrument calibration, pumps, etc. required for testing shall be under the scope of the Contractor.

5.8.14 Modification/rectifications as felt necessary by the Engineer/Inspector shall be carried out at no extra cost to meet the guarantee and other technical particulars.

5.9.0 Start-up & Trial Runs

5.9.1 Test Run

a) Following the satisfactory completion of inspection, testing and cleaning of a unit, the plant will be placed in trial run. During this period, all adjustments and repairs, as required, shall be made by the Contractor. The plant may be shutdown, if necessary, to carry out such adjustments and repairs. On completion of satisfactory trial operation, the plant will be placed under initial operation.

b) Prior to trial run of any equipment, the following shall be checked:-

i) Proper installation of the drive and equipment on the foundation.
ii) Proper alignment of drive and the equipment.
iii) Proper connection of supports, hangers, piping, valves, instruments & cable connections.
iv) Freeness of the rotors of drive and equipment.
v) Healthiness of lube oil system, changing and filling, as necessary.
vi) The healthiness of interlocks and protections for the equipment.
vii) Calibration of instruments.
viii) All other feature applicable to the equipment.

c) Prior to trial run of an equipment, the drive motor shall be checked and tested by the Contractor. Following steps in motor testing shall be followed

i) Checking and cleaning of bearings, changing and filling of lubricants.
ii) Cleaning, drying and varnishing of windings and if necessary, measurement of air gaps.
iii) Insulation test, drying out and, if necessary, high potential test.
iv) Checking of interlocks, setting of limit/torque switches, etc.
v) Rotational check and reconnection, if any.
vi) No load test run for a minimum period of eight (8) hours at rated voltage to check out bearings and other associated parts. During test run, hourly record of currents on all the three phases shall be maintained and careful watch shall be maintained on the equipment for any abnormal sound, temperature of bearing, vibrations, etc.

Owner will provide required number of operators in shifts, if required for trial operation of equipment under supervision of Commissioning/Start-up Engineer. All other labours for starting, trial operation, repairs and adjustments shall be supplied by the

Contractor. Requirement of Owner's operators, if any, shall be indicated by the Contractor well in advance.

5.9.2 Before the plant is put on trial operation, the Contractor will be required to carry out checks on the performance of the various equipment and controls of the Steam Generation Plant. The checks shall include the following :

a. Checks on the operation of all controls and isolating air and gas dampers.
b. Check on the operation of all variable speed drives throughout their respective range.
c. Check operation of all motorized isolating valves, both local and from remote.

5.9.3 Turbine Generator

a. After completion of all necessary activities as mentioned above, the turbine shall be rolled and the setting of governing system, lube oil system and other controls and protections shall be carried out by the Contractor.
b. After setting all the turbine controls and protections, generator drying out shall be carried out.

5.9.4 Turbine Auxiliaries

After no load trial run of the motor, each rotary equipment shall be coupled and shall be subjected to a trial run, the duration of which shall be mutually agreed.

The objective of the trial run shall be to ascertain that the following are within the permissible limits :

a) Vibration and noise level
b) Bearing vibration and temperature
c) Performance of the lube oil systems
d) Motor winding temperature
e) Any other parameter considered necessary

5.10.0 Loading the unit and reliability run : covered in Section - XI

5.11.0 Performance Guarantee Test : covered in Section - XI

5.12.0 Testing

5.12.1 Hydro testing shall be conducted for all pressure parts after installation at required pressure. All necessary blanking arrangements necessary for such hydro testing shall be furnished by the Contractor. The hydro testing of boiler shall meet the requirement of IBR and all necessary test pump, temporary piping, etc. shall be supplied by the Contractor.

5.12.2 Boiler safety valve setting and other tests shall be conducted to the satisfaction of Boiler Inspector. All other safety valves shall also be set and sealed.

5.12.3 Performance testing of the Steam Generating Unit after the unit has run for sometime, shall be conducted as per ASME power test code (PTC-4.1) on steam generating units, latest edition. All supervisory personnel, labour, etc. shall be supplied by the Contractor. It shall include the following.

a. Test at maximum continuous evaporation with the specified fuel to determine the guaranteed steam generation efficiency (Predicted Performance). The Contractor shall have to get the test methods approved by the Owner.
b. Test to determine the minimum stable load carrying capacity of the steam generating unit with coal fuel without oil support.
c. Test with specified fuels to determine capability of maximum continuous rating.
d. Steam temperature at super heater outlet between 100% and 60% of maximum continuous rating.
e. Test on each mill with the specified fuel to determine the maximum output, fineness, response to load change and power consumption.
f. Tests to determine leakages and effectiveness of insulation.
g. Tests on fans to determine capacity, pressure and power consumption under different load conditions. The fans may be tested for the parameters specified within the vendors works. In case the fans are supplied from India, from a shop without adequate test facilities, site testing as specified will be conducted after installation.
h. Test to determine efficiency of electro-static precipitator at maximum continuous rating and with one field in each path of ESP is out of operation.
i. All controls like combustion control, draft control, steam pressure reducing and desuperheating, various level controls, pH control etc. will be checked at site for their set points and adjusted wherever necessary.
j. All instruments necessary for guarantee tests shall be supplied by the Contractor and calibrated before test as per code.
k. The Contractor shall make necessary changes and corrections without any extra cost to the owner to meet the guarantees and other technical particulars covered by this specification, if any of the above tests at site show that the equipment has failed to prove the performance, in accordance with General Terms and Conditions of the Contract.

5.12. 4 The tests to be carried out on STG shall include the following

a. Material analysis and testing.
b. Hydrostatic pressure test of the turbine casing, chests, valves and valve bodies, oil pumps, pressure vessels, piping, etc.
c. Dynamic balance tests of rotating parts at applicable over speeds and to determine the vibration level.

The bearing housing vibration will be as per VDI DIN 2056 & shaft vibration as per VDI DIN 2059 as applicable for group T.

The Contractor shall analyze the rotor unbalance response for the complete shaft system i.e. turbine generator coupling. The torsional & transverse critical speed analysis also shall be carried out & the reports submitted. The allowable vibration limits on the bearing points of turbine, on the top of foundation block shall be furnished & the same shall be indicated on the foundation drawing.

d. Leak Test and Dye Penetrant Tests for non-pressurized parts like oil tank, etc.
e. Radiographic and magna flux examination of materials and welds as per design requirement.
f. Ultrasonic test of castings and forgings.
g. Determination of capacity, efficiency and characteristic curve of all pumps and motors.
h. Calibration test of standard orifices, nozzles, instruments, etc.
i. Overall mechanical and electrical inspection as per approved quality plan.
j. Overspeed at around 110% of rated speed for Mechanical Overspeed test and adjustment on emergency governor. Also 112% of rated speed for Electronic overspeed test.
k. Bearing run and oil pump sets test.
l. Functional checks and adjustment of speed governor and control devices.

5.12. 5 The generator and its accessories shall be subjected to all the routine tests including the following tests and test procedure shall be as per the codes and standards adopted for the equipment.

a. Measurement of DC cold resistance of stator and rotor winding.
b. Insulation resistance of startor winding (before and after high voltage test), rotor winding and embedded temperature detector.
c. High voltage test.
d. Phase sequence test.
e. Determination of open circuit characteristic.
f. Determination of short circuit characteristic.
g. Over speed.
h. Determination of efficiency by separation of losses method. i. Vibration.
j. Impedance test for rotor winding.

5.12. 6 Mechanical run test shall be carried out at shop for minimum four (4) hours or till inspector is satisfied & strip test for checking bearing and other internal parts conditions.

5.12. 7 Contractor shall indicate his quality assurance programme which shall be jointly agreed with Owner/consultant.

6.0.0 ELECTRICAL ERECTION

6.1.0 GENERAL

6.1.1 This section of specification is intended to cover complete and efficient erection, testing and commissioning and putting into successful commercial operation of all electrical equipment included in this package inclusive of supply of all hardware, erection tools, implements & materials, labour, administrative, supervisory personnel, etc. as necessary.

6.1.2 The work involves timely procurement and transportation to site in properly packed condition of all hardware, materials and miscellaneous items as indicated in the specification and drawings and required to complete the erection of equipment, cabling and grounding work under this specification.

6.1.3 Scope will also include dispatch of all materials & equipment properly packed, transportation, delivery & receipt at site, properly protected storage, handling of material within site area, complete assembly, erection and connection, testing and commissioning, putting into successful and satisfactory commercial operation of the complete power plant, trial run, performance guarantee tests, upto handing over to Owner under scope of this specification.

6.1.4 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS codes of Practice and Indian Electricity Act. In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

6.2.0 SPECIFIC REQUIREMENTS - MATERIALS

6.2.1 The batteries for the DC system shall be stationary storage type, consisting of high performance lead acid plante cells along with accessories with the cells assembled in polypropylene/hard rubber container. Freestanding type wooden racks with acid resistance type paint shall be provided. The batteries shall be installed in single/double tier and single/double row arrangement.

6.3.0 SPECIFIC REQUIREMENTS - SERVICES

6.3.1 The Contractor shall be fully and finally responsible for proper erection, safe and satisfactory operation of plant and equipment under his scope of work to the entire satisfaction of the Owner.

6.3.2 The work shall be executed in accordance with the directions, instructions, approved drawings and specifications.

6.3.3 The Contractor shall, when requested by the Owner, perform extra work and furnish extra materials not covered under his scope of work.

6.3.4 All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved. The erection work shall be supervised by competent supervisors preferably holding relevant supervisory license from the Government.

6.3.5 The Contractor shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering. Finished work shall be suitably covered to keep it clean and free from defacement or injury. For protection of his work Contractor shall provide fencing and lighting arrangement, connect up space heaters and provide heating arrangement as necessary or directed by the Owner. Contractor shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to Contract.

6.3.6 Contractor shall insure all his workman against accidental injury/ death. The Contractor shall also takeout insurance policies which would cover the risk of losses/damages of his tools & tackle and material/equipment which is in his custody as also loss/ damages to any personnel.

6.3.7 All safety rules and codes as applicable to work shall be followed without exception.

6.3.8 The Contractor shall at all times work in close coordination with the Owner's supervising personnel and afford them every facility to become familiar with erection and maintenance of the equipment.

6.3.9 The Contractor shall submit at such times and in such forms as may be requested by the Engineer, schedule showing the programme and the order in which the Contractor proposes to carry out the work with dates and estimated completion time for various parts of the work.

6.3.10 Such schedules shall be approved by the Owner prior to starting the erection. The Contractor shall adhere to this approved programme for all practical purposes. If for any reason the work is held up, the Contractor shall bring it to the attention of the Owner in writing without any delay.

6.3.11 During the progress of work the Contractor shall submit monthly progress report and such other reports on erection work and organisation as the Owner may direct.

6.3.12 The Contractor shall furnish all erection materials, hardware and consumables required for the complete installation. The Materials shall include but not limited to the following :

a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials, cleaning cloths, cotton waste etc.

b) Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats,

sills, shims ferrules, socket, PVC sleeve, cotton thread, adhesive/non adhesive PVC tapes etc.

6.3.13 Supply of steel, cement, sand, stone etc. required for execution of the Contract shall be the responsibility of contractor.

6.3.14 The Contractor shall provide all tools, tackle, implements, mobile equipment such as crane, trailers, scaffoldings, ladders, welding machines, gas cutting, bending machine, hand crat, chain pulley blocks wire clues, hydraulic jack / motorised jack, wooden slipper, drill machine, hand/hydraulic compression tools for cable termination, vacuum cleaners box spanner of various size etc. which are required for transportation, handling and erection of the plant and equipment.

6.3.15 Special erection tools, if any, furnished by the manufacturer along with the equipment may be used by the Contractor. Such tools shall be returned in good conditions to the Owner on completion of work.

6.3.16 The major testing equipment that are required to be provided by the Contractor are listed below :

a) Power operated Meggar of 2.5kV, 5kV & 10kV grade for Insulation testing.
b) Hand operated Meggar of 500V & 1 KV grade for Insulation testing.
c) Hand driven earth resistance Meggar of range 0-1/3/30 ohms.
d) Tong testers of suitable ranges.
e) High potential test set suitable for 400kV, 11kV, 415V and 220V (D.C.) systems.
f) Contact Resistance measuring set for Micro-ohms.
g) Torque Wrench of various sizes.
h) Current Transformer Primary injection set.
i) Relay testing and checking bench including phase shifter, secondary injection set, meters etc.
j) Multi meters, test lamp, field telephone with buzzer set, walkie-talkie, spirit level, continuity tester, db-meter, phase sequence tester, different gauges etc.

6.3.17 Other testing equipment as required shall also be arranged by the Contractor.

6.3.18 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

6.3.19 The equipment furnished in dis-assembled condition at site shall be assembled all those parts, mount and wire-up loose equipment, fittings and accessories and complete all connections by the Contractor.

6.3.20 The Contractor shall design, fabricate and supply the supporting structures, base frame, holding down bolts etc, as required, of all equipments.

6.3.21 All erection work shall be carried out in strict compliance with manufacturer's instructions and shall include all necessary adjustments, checks and measurements.

6.3.22 All internal wiring of the equipment which has been left incomplete because of shipping split or which requires minor modifications shall be carried out by the Contractor.

6.3.23 The Contractor shall record results of all erection tests and measurements. The Contractor shall submit copies of those test results to the Owner for his reference and record.

6.3.24 Cable installation work shall mean supply and erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches, tunnels, overhead trays, in conduits etc. dressing and clamping, jointing inclusive of supply of necessary jointing kits, lugs, glands, ferrules, tapes etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.

6.3.25 Grounding installation work shall mean supply and erection of grounding materials, jointing/brazing/welding, connection and painting, testing of ground conductors.

7.0.0 **INSTRUMENT INSTALLATION & ERECTION:** covered in WPCPL-TPP-VOL-II-SECTION XIXC_C&I-I2_C&I ERECTION.

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SCHEDULE II

TECHNICAL SPECIFICATION

VOLUME # 3

(CIVIL, STRUCTURAL& ARCHITECTURAL)

Project	6 x 600 MW THERMAL POWER PLANT PROJECT AT NARIYARA, CHATTISGARH, INDIA	
Owner	KSK Power from knowledge	**Wardha Power Company Private Limited, India**
Owner's Consultants		**DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI**
E P C Contractor	SEPCO	**SEPCO Electric Power Construction Corporation, China**

薛利 1/4/09
(XUE LI)

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SECTION-XVII

CIVIL, STRUCTURAL & ARCHITECTURAL WORK

曹彦丽
2009. 3.14

14.03.2009

VOLUME-II

SECTION-XVII

CIVIL, STRUCTURAL & ARCHITECTURAL WORK

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SECTION-XVII

CIVIL, STRUCTURAL & ARCHITECTURAL WORK

A. GENERAL

1.00.00 INTRODUCTION

This specification covers design, engineering and construction of Civil, Structural and Architectural works for the proposed 6 X 600MW Thermal Power Plant near Nariyana Village in Janjgir-Champa district of Chhatisgarh, India. The scope of works covers design/engineering and construction/fabrication/erection of complete Civil, Structural and Architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the contract.

This section lists Codes and Standards to be adopted in design and construction. Documents to be submitted have also been brought out in this section along with the procedure to be followed for the same.

Land for the project will be acquired by the Owner and handed over to the Contractor for development and implementation of the Power Station and associated facilities.

The Contractor has to provide a list of Civil / Structural sub-contractors along with bid document which shall be reviewed and approved by the Owner if the credentials of such contractors meet the selection criteria. Contractor must engage the Civil Agency from the approved vendor list only. Owner reserves the right to delete/add/modify the contractor list based on their current order book and their resource mobilization capabilities.

However Contractor shall obtain the permission from Owner before placing the order on any such approved civil agency.

The scope of civil, structural and architectural work comprise complete design, engineering, preparation of general arrangement drawings and construction drawings and construction, fabrication / erection including supply of all materials, consumables, tools, tackles, temporary works, temporary storage sheds, temporary colony for labour /staff and supply of labour for all buildings, foundations, super structures and infrastructure, miscellaneous related services and facilities required for completion of the power plant, all in strict conformance with the specifications, including revisions and amendments thereto, as may be required during the execution of the work including all incidental items not specifically mentioned but reasonably implied or necessary for the completion and proper functioning of the plant.

All materials including cement, reinforcement and Structural steel etc. shall be supplied by the Contractor.

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1.01.00 The work shall be carried out according to the design/drawings to be developed by the Contractor, and approved by the Owner. For all buildings, facilities, systems, structures, foundations etc., necessary layout and details shall be developed by the Contractor, keeping in view the statutory and functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance as per the best industrial practices and to the complete satisfaction of the Owner. Certain minimum requirements are indicated in this specification for guidance purpose only.

The structural design shall be aimed to provide a safe, sound, durable & serviceable structure. The execution drawings shall be self-explanatory giving all the details and notes as per the standard engineering practice. The execution drawing shall also give the bill of quantity of each item of work covered by it.

The Contractor has visited the project site & conducted independent survey/ studies/ investigation required for the works under the scope of these specifications and fully appraised themselves of the prevailing conditions at the proposed site, climatic conditions including monsoon patterns, soil conditions, local conditions & site specific parameters and shall include for all such conditions & contingent measures in the bid, including those which may not have been specifically brought out in the specification.

The scope of Civil /Structural & Architectural works of the Power Plant includes Design, Engineering, Construction, Fabrication, Erection and Finishing jobs of following works but not limited to :-

a) Power House Building including Turbo generator foundation, TG pedestals and top deck, control and switchgear room/building, Coal bunker bay including stainless steel lining (5 mm thick, 409 grade) to complete inside surface of bunker hopper, flue gas duct support and foundation, cable galleries, service buildings, ESP control room building, all equipment foundations, All structural steel works, RCC paving in power block (BTG) or any other area as required including **plinth protection** of all buildings.

b) Boilers, ID, FD, PA fans, ESP, BFW pumps, tanks, start-up boiler house, AHP control room, Abulation, Hydrogen Generation Plant and all other equipment and three flue RCC chimney of 275.00 m high.

c) Transformer yard including transformer foundations, firewalls, oil pit, transformer tracks, chain link fencing, RCC Paving, gravel filling, anti weed treatment etc.

d) 400 kV Sub-station structures, Switchyard relay building, transmission towers, foundation, superstructures, Chain Link Fencing, Crushed broken stone layer, anti weed treatment for top layer of soil etc.

e) Raw water reservoir (of earthen construction) & Raw water /Fire water pump house with approach channel and fore-bay, gates and stop logs, trash racks maintenance facilities, switch gear/MCC rooms.

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f) Complete Coal handling system including track hoppers & main control building with MCC room, conveyor tunnels, crusher house, transfer tower, pent house, drive house, grizzly hopper, conveyor gallery, trestles, control room, loco shed, stacker & reclaimer, coal stock pile, bulldozer store house, water sprinkler system etc.

Entire Coal Stock Yard area of 15 days storage capacity, shall be excavated to average 250mm depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered and rammed and compacted with 10 tonne roller.100 mm thick river sand cushion layer shall be placed over compacted sub grade, soling shall be laid over sand cushion, joints filled with river sand. Over boulder soling, 75 mm thick lean concrete (1:4:8) shall be spread. Final layer shall be minimum 150 mm thick RCC slab of M20 grade concrete with double layer reinforcement. Slope is to be maintained through all layers. The coal stack area shall be graded with suitable slope for draining the surface by longitudinal drains that shall be of RCC trenches with graded gravel packets at about 1.5 m intervals on the sides to trap coal dust. Weep holes shall be provided in the trench walls at the locations of filter pockets for collecting surface water in the longitudinal drains for discharging into the mains surface drain to be provided by the Contractor by side of the road. RCC Retaining wall 1m depth to be provided around the crushed coal pile to prevent coal spillage into the drain. Necessary control joints in the grade slab shall be considered to avoid temperature and shrinkage cracks in the slab. The design of coal stack area should take care of loads arising due to dozer movement and shall be designed to sustain coal water pressure.

g) Induced draught cooling tower and cold water basin, Cooling Tower Switchgear room, C.W. Pump House including covered approach channel and fore bay, gates and stop logs, trash racks maintenance facilities & Control room, C.W. Pump & Misc. Pumps and C.W. conveying system to plant.

h) Demineralisation Plant including DM plant building, DM water storage tanks and foundations, neutralization pits, Chemical lab, etc.

i) Ash disposal Area, dykes, decanting wells (PVC casing-12 nos.), NP3 pipes, Ash Slurry pipeline from power plant to Ash dump area.(as per the sketch attached herewith

j) Complete Ash Handling System for both fly ash and bottom ash, including Silos for dry bottom ash located near ash dyke and Fly Ash located near coal yard & high concentration slurry disposal in to ash dyke, ash separator pit with separator baffle walls.

k) Civil /Structural & Architectural works of the Power Plant Misc. MCC & Control Rooms

l) RCC paving in BOP area including **plinth protection** of all the buildings

m) Fuel Oil Handling Plant including storage and day tanks, tank foundations, RCC dykes and dyke walls, fencing, Fuel oil pump house etc.

n) Complete Air Compressor House and equipment foundations. DG Building and equipment foundations.

o) Boundary Wall, Gates, Fencing, Concrete Plant Roads as per IRC 15 & 58-2002 and both side RCC surface storm water drain with Pre-cast cover.

p) Sanitary, Plumbing & Drainage (separate storm water, sanitary, sewerage & industrial effluent) System, Guard Pond.

q) Fire fighting pump house and complete system.

r) Workshop & store, Road and Railway Weighbridge, Auto Garage, Gate House complex, Security room & Time office, Admin. Building, Car Parking, Fire Station, Water Tank, First Aid Centre, Cycle & Scooter Stand, Canteen & Recreation building, open shed for storing materials and other auxiliary facilities etc.

s) Effluent Treatment Plant, Environmental Monitoring Room, Reverse Osmosis Plant.

t) Water Treatment plant along with Clarifier, Clarified Water Storage Tank, Clarified Water Reservoir and Pump House, WTP Control Lab room etc.

u) Oil water separator pits in relevant areas like Day Tank, Boiler areas etc.

v) Various settling pits / basins, All Trenches / Pipe & Cable Bridge.

w) Topographical Survey, as required & Site Grading work as per site, Vastu & layout requirements.

x) Soil investigation work on all work areas/fronts.

y) All temporary work such as construction site office and canteen, construction stores, residential accommodation for Contractor's staff and labour, construction power and water etc.

z) All electrical grounding system.

Other civil /structural/architectural works not listed above but required to complete the project as per Owner's opinion.

The design criteria and Technical Specifications to be followed for design and construction of civil, structural and architectural work are included hereunder.

Clause 2.00.00 lists Codes and Standards to be adopted and the principal structures of the plant and briefly describes the basic concept, requirements and features pertinent to each documents to be submitted have also been brought out in this section along with the procedure to be followed for the same.

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2.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/Technical Specifications as appropriate. The latest editions/revision of following codes and standards along with addendums/ amendments, if any, shall be followed. However all the design and detail engineering shall be based on Indian Standards/codes, equivalent or more stringent international/Chinese standards/codes.

2.01.00 General

a) Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards

b) National Building Code of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Works.

e) IS-1256 : Code of Practice for Building Bylaws.

The Contractor desires to design the structures as per Chinese Standards. However it shall comply with Indian standards and International standards as listed in Technical Specifications, which shall be checked by the Owner and the Contractor shall incorporate the same.

2.01.01 Earthwork

a) IS-1498 : Classification and identification of soils for General Engineering purposes.

b) IS-3764 : Safety Code for excavation work.

c) IS-7293 : Safety Code for working with construction machinery.

2.01.02 Concrete

a) IS-269 : Ordinary Portland Cement - 33 Grade.

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b) IS-383	:	Coarse and fine aggregate from natural sources for concrete.
c) IS-432	:	Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
d) IS-455	:	Portland Slag Cement.
e) IS-456	:	Code of Practice for Plain and reinforced concrete.
f) IS-460	:	Test Sieves (all parts).
g) IS-516	:	Methods of test for strength of concrete.
h) IS-1199	:	Methods of sampling& analysis of concrete.
i) IS-1489	:	Portland Pozzolona Cement.
j) IS-1566	:	Hard drawn steel wire fabric for concrete Reinforcement.
k) IS-1786	:	High strength deformed steel bars and wires for concrete reinforcement.
l) IS-1834	:	Hot applied sealing compounds for joints in concrete.
m) IS-2386	:	Methods of test for aggregates for concrete (all parts).
n) IS-2502	:	Code of practice for bending and fixing of bars for concrete reinforcement.
o) IS-3370	:	Code of practice for concrete structures for storage of liquids (all parts).
p) IS-3414	:	Code of practice for design and installation of joints in buildings.
q) IS-4948	:	Welded steel wire fabrics for general use.
r) IS-6909	:	Specification for super sulphate cement.
s) IS-6452	:	High Alumina Cement for Structural use.
t) IS-7320	:	Concrete slump test apparatus.
u) IS-7861	:	Code of practice for extreme weather concreting (all parts).
v) IS-8041	:	Rapid Hardening Portland Cement.

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w) IS-8112 : 43 grade ordinary Portland Cement.

x) IS-10262 : Recommended guidelines for concrete mix design.

2.01.03 **Foundations**

a) IS-1904 : Code of practice for design and construction of foundations in Soils : General requirements

b) IS-2950 : Code of practice for design and construction of raft foundations.

c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).

d) IS-2911 : Code of practice for design and construction of pile foundation.

e) Standard Specification and code of Practice for Road Bridges Section VII : Foundation and substructure by Indian Road Congress (IRC).

f) IS-9795 (Part-I) } : } } Cofferdam

g) IS-10084 (Part-I) } : }

2.01.04 **Loading**

a) IS-875 : Code of practice for design loads (other than earthquake) for building and structures.

b) : Code of Practice for Road Bridges (All Sections) : Indian Road Congress (IRC).

2.01.05 **Masonry**

a) IS-712 : Building limes.

b) IS-1077 : Common Burnt Clay Building Bricks.

c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

d) IS-1528 : Methods of sampling and physical tests for refractory materials.

e) IS-1597 : Code of practice for construction of stone masonry (all parts).

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f) IS-2212 : Code of practice for brickwork.

g) IS-2116 : Sand for masonry mortars

h) IS-2185 : Concrete masonry units.
(all parts - Hollow and Solid concrete blocks).

i) IS-2250 : Code of practice for preparation and use of masonry mortars.

j) IS-2572 : Code of practice for construction of hollow concrete block masonry.

k) IS-2691 : Burnt clay facing bricks.

l) IS-3414 : Code of practice for design and installation of joints in buildings.

m) IS-3495 : Methods of tests of burnt clay building bricks.

n) IS-4441 : Code of practice for use of Silicate type chemical resistant mortars.

o) IS-4860 : Acid Resistant Bricks.

2.01.06 **Doors, Windows and Ventilators**

a) IS-399 : Classification of commercial timbers and their zonal distribution.

b) IS-883 : Code of practice for design of structural timber in building.

c) IS-1003 : Timber panelled and glazed shutters (all parts).

d) IS-1038 : Steel doors, windows and ventilators.

e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

f) IS-1361 : Steel windows for industrial buildings.

g) IS-2835 : Flat Transparent sheet glass.

h) IS-1948 : Aluminium doors windows and ventilators.

i) IS-1949 : Aluminium windows for industrial building.

j) IS-2191 : Wooden flush door shutters (Cellular and hollow core type).

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k) IS-2202 : Wooden flush door shutters (solid core type).

l) IS-3103 : Code of practice for Industrial ventilation.

m) IS-3548 : Code of practice for glazing in buildings.

n) IS-3614 : Fire check doors.

o) IS-4021 : Timber door, windows and ventilator frames.

p) IS-4351 : Steel door frames.

q) IS-6248 : Metal rolling shutters and rolling grills.

2.01.07 **Roof and Flooring**

a) IS-2204 : Code of practice for construction of reinforced concrete shell roof.

b) IS-3201 : Criteria for the design and construction of precast trusses and purlins.

c) IS-2210 : Criteria for Design of R.C. shell structures and folded plates.

d) IS-809 : Rubber flooring materials for general purposes.

e) IS-1195 : Bitumen mastic for flooring.

f) IS-1196 : Code of practice for laying bitumen mastic flooring.

g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors.

h) IS-1237 : Cement concrete flooring tiles.

i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles.

j) IS-2114 : Code of practice for laying in situ terrazzo floor finish.

k) IS-2571 : Code of practice for laying in situ cement concrete flooring.

l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping.

m) IS-5766 : Code of practice for laying burnt clay brick flooring.

n) IS-1197 : Code of practice for laying of rubber floors.

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o) IS-2441 : Code of practice for fixing ceiling coverings.

2.01.08 **Waterproofing**

a) IS-1322 : Bitumen felts for waterproofing and damp proofing.

b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.

c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.

d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.

e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.

f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.

h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

2.01.09 **Soil Engineering**

a) IS-1498 : Classification and identification of soils for general engineering purposes.

b) IS-1892 : Code of practice for sub-surface investigation for foundations.

c) IS-2131 : Method for standard penetration test for soils.

d) IS-2720 : Methods of test for soils (all parts).

2.01.10 **Water Supply, Drainage and Sewerage**

a) IS-404 : Lead pipes

b) IS-458 : Precast Concrete pipes (with and without reinforcement)

c) IS-651 : Salt glazed stoneware pipes and fittings.

d) IS-771 : Glazed fire-clay sanitary appliances (all parts).

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e) IS-774 : Flushing cisterns for water closets and urinals (other than plastic cisterns).

f) IS-783 : Code of practice for laying of concrete pipes.

g) IS-1172: Code of basic requirements for water supply, drainage and sanitation.

h) IS-1626 : Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing.

i) IS-1742 : Code of practice for building drainage.

j) IS-2064 : Code of practice for selection, installation and maintenance of sanitary appliances.

k) IS-2065 : Code of practice for water supply in buildings.

l) IS-2470 : Code of practice for installation of septic tanks (all parts).

m) IS-3114 : Code of practice for laying of Cast Iron pipes.

n) IS-4127 : Code of practice for laying of glazed stoneware pipes.

o) IS-12251 : Code of practice for Drainage of Building Basement.

p) IS-1200 [Part XVI] : Method of measurement : Laying of water and sewer lines including appurtenant items.

q) IS-1536 : Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

r) IS-1537 : Vertically cast iron pressure pipe for water, gas and sewage.

s) IS-3486 : Cast iron spigot and socket drain pipes .

t) IS-5329 : Code of practice for sanitary pipe work above ground for buildings.

u) IS-3076 : Low density polyethylene pipes for potable water supplies.

v) IS-1538 : Cast iron fittings for pressure pipes for water, gas and sewage.

w) IS-1230 : Cast iron rainwater pipes and fittings.

x) IS-1729 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

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y) IS-784 : Pre-stressed concrete pipes.

z) IS-1726 : Cast iron manhole covers and frames.

aa) IS-5961 : Cast iron grating for drainage purposes.

bb) IS-5219 [Part-I] : Cast copper alloys traps : `P' and `S' traps,

cc) IS-772 : General requirements for enamelled cast iron sanitary appliances.

dd) IS-775 : Cast iron brackets and supports for wash basins and sinks.

ee) IS-777 : Glazed earthenware wall tiles.

ff) IS-2548 : Plastic water closet seats and covers (all parts).

gg) IS-2527 : Code of practice for fixing rainwater gutters and downpipes for roof drainage.

2.01.11 **Paving and Road works**

a) IRC-58-2002 : Guidelines for the design of plain jointed rigid pavements for highways.

b) IRC-15-2002 : standard specifications and code of practice for construction of concrete roads.

c) : Specifications for Road and Bridge works – Ministry of transport roads wing (MOST) surface

d) IS-73 : Paving bitumen

b) IS-702 : Industrial Bitumen

c) IS-1201 thru' 1220 : Method of testing tar and bituminous materials.

d) Practice followed by Indian Road Congress (all parts).

2.01.12 **Earthquake Resistant Design**

a) IS-1893 : Criteria for earthquake resistant design of structures.

b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

2.01.13 **Chimney**

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a) IS-4998 : Criteria for Design of R.C. Chimneys.

2.01.14 **Structural Steelwork**

a) IS-800 : Code of practice for general construction in steel.

b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line, towers.

Part-I : Load and permissible stresses.

Part-II : Fabrication, Galvanizing, Inspection and Packing.

c) IS-806 : Code of practice for use of steel tubes in general building construction.

d) IS-808 : Dimensions for hot rolled steel beams, channels and angle sections.

e) IS-813 : Scheme of symbols for welding.

f) IS-814 : Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.

g) IS-816 : Code of practice for use of metal arc welding for general construction in mild steel.

h) IS-817 : Code of practice for training and testing of metal arc welders.

i) IS-818 : Code of practice for safety and health requirements in electric and gas welding and cutting operation.

j) IS-819 : Code of practice for Resistance spot welding for light assemblies in Mild Steel.

k) IS-822 : Code of procedure for inspection of welds.

l) IS-919 : ISO system of limits and fits.

m) IS-1024 : Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.

n) IS-1161 : Steel tubes for structural purposes.

o) IS-1182 : Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.

p) IS-1200 : Method of measurement of steelwork and

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[Part-VIII]		ironwork.
q) IS-1239	:	Mild steel tubes, tubular and other wrought steel fittings (all parts).
r) IS-1363	:	Hexagonal head bolts, screws and nuts of product Grade 'C' (all parts).
s) IS-1364	:	Hexagon head bolts, screws and nuts of product grades A and B.
t) IS-1365	:	Slotted counter sunk head screws.
u) IS-1367	:	Technical supply conditions for threaded steel fasteners.
v) IS-1608	:	Method for tensile testing of steel products.
w) IS-1730	:	Dimensions for steel plates, sheets, strips and flats for general engineering purpose.
x) IS-1731	:	Dimensions for steel flats for structural and general engineering purposes.
y) IS-1852	:	Rolling and cutting tolerances for hot rolled steel products.
z) IS-1977	:	Structural steel (Ordinary quality)
aa) IS-2016	:	Plain Washers
bb) IS-2062	:	Steel for General structural purposes.
cc) IS-2633	:	Methods of testing uniformity of coating of zinc coated articles.
dd) IS-3613	:	Acceptance tests for wire-flux combinations for submerged-arc welding.
ee) IS-3664	:	Code of practice for Ultrasonic Pulse echo testing by contact and immersion methods.
ff) IS-3757	:	High strength structural bolts.
gg) IS-4000	:	High strength bolts in steel structures.
hh) IS-4759	:	Hot dip zinc coatings on structural steel and other allied products.
ii) IS-5334	:	Code of practice for Magnetic Particle Flaw detection of welds.

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jj) IS-7215 : Tolerances for fabrication of steel structures.

kk) IS-7280 : Bare-wire electrodes for sub-merged arc welding of structural steels.

ll) IS-7318 [Part-I] : Approval test for welders when welding procedure approval is not required - Fusion welding of Steel.

mm) IS-8500 : Structural steel micro alloyed (medium and high strength qualities).

nn) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.

oo) IS-11592 : Code of practice for selection and design of belt conveyor.

pp) AWS D.1.1 Structural Welding Code.

2.01.15 **Painting**

a) IS-348 : Specification for French Polish.

b) IS-427 : Specification for Distemper, dry colour as required.

c) IS-428 : Specification for Distemper, oil emulsion, colour as required.

d) IS-1477 [I & II] : Code of practice for painting of ferrous metal in buildings.

e) IS-2338 [I & II] : Code of practice for finishing of wood and wood based materials.

f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers.

g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.

h) IS-2932 : Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.

i) IS-2933 : Specification for enamel, exterior - a) undercoating, b) finishing.

j) IS-5410 : Specification for cement paint.

2.01.06 **Bridge and Culvert Work**

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a) Indian Road Congress (IRC) Bridge Codes (all parts).

b) Indian Railway Standard Bridge Rules.

3.00.00 **LAYOUT**

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and existing Survey of India benchmark. If the Contractor uses the grid, benchmark and reference pillar made by others, he shall satisfy himself of the accuracy of the reference marks. The Contractor shall accurately set out the position for holding down bolts and inserts. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and benchmark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy be found, it shall be immediately brought to the notice of the Engineer-in-Charge for any rectification/ modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.

The contractor shall construct and maintain pillars for grid, references and benchmarks and maintain them till the completion of the construction. Contractor shall construct a key bench mark pillar which shall have North and East co-ordinates in addition to the Mean Sea Level in such a manner and such a location the same would remain forever and useful for expansion works etc.

He shall also help the Owner with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Owner's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Contractor shall take into account the cost of these in quoting their price.

4.00.00 **SITE DEVELOPMENT**

4.01.00 **Clearing & Grubbing**

Clearing and grubbing within all areas where excavation, fill or other construction is planned shall be completed prior to start of such work.

4.02.00 **General Grading and Excavation**

4.02.01 **Plant Grade**

Plant roads adjacent to all major structures of the plant area has been fixed 150 mm below the main power house floor level and the plant grade level is 150 mm lower than the plant roads adjacent to it unless otherwise decided by the Owner.

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The area grading of the plant shall be based on approved plot plan, layout of the buildings and the drainage scheme of the area. According to Vastu, the South side of the plant shall be higher than the North and West side of the plot shall be higher than the East. The grading shall be carried out to achieve these slopes and the site should slope from South West corner to North East corner. Other Vastu requirements also shall be met by the contractor and shall be noted by the contractor that any issue related to Vastu is not negotiable. (Refer the Vastu document attached herewith.) The grading of the area within Green Belt shall be part of Contractor's scope.

The ground shall be sloped away from the building walls at a pitch of approximately 1% to provide surface drainage. Drainage system shall be planned is such a way that its gradient follows the natural slope of the ground as far as practicable.

Water required for construction purpose shall be ARRANGED BY THE CONTRACTOR and stored in an underground tank. From the underground tank water shall be pumped to an overhead tank for further distribution by gravity to various distribution points.

4.02.02 Slopes

Slopes of embankments and around excavated areas shall be one vertical to one and half horizontal unless other slopes are warranted after detailed soil investigation and/or space, availability.

However, the successful Contractor should decide the safe side slopes of embankment based on the properties of soil i.e., fill materials and other site conditions. However, side slopes should not be stiffer than as stated above.

4.02.03 Temporary Protection of Slopes

Slopes around excavated areas shall be protected from rutting and scouring by suitable method. Surfaces surrounding such excavated areas shall be graded away from the excavation. Slopes of embankment shall be similarly protected during construction. Surface water shall not be permitted to flow uncontrolled down any embankment slope.

Where job conditions require the temporary use of excavation slopes steeper than the slopes recommended for the particular type of soil, prior approval shall be obtained from the Engineer for cutting of such slopes and such protective means as directed by the Engineer shall be used.

4.02.04 Disposition of Excavated Materials

All reusable material shall be handled to an appropriate stock pilling area for future reuse or placed directly in the fill . Disposal of any excess soil shall be the

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responsibility of the contractor and such location shall be got approved by the Owner.

Stock piles shall be established down wind of the excavations (based on prevailing winds).

4.02.05 **Requirements for fill & backfill**

Fill material shall meet the requirements of the job specification and / or as decided by the Owner.

4.02.06 **Dewatering**

Excavation for all facilities will be performed in the dry as far as practicable. The Hume pipes, if any, may have to be laid under water to facilitate proper dewatering and drainage.

Where excavation is carried below the ground water surface, a dewatering system shall be installed with sufficient capacity to maintain ground water elevation a minimum of 600 mm below the working surface of the excavation. The water discharge from the dewatering system shall be directed away from the excavation and towards the drainage system in the area where practical. In no case shall it be discharged on the ground surface within 60 meters of the excavated areas.

4.03.00 Drainage

4.03.01 **Ditches**

All plant storm water drains shall be of rectangular RCC construction and to be provided on both sides of the plant roads. All plant effluent drainage shall be through buried concrete pipes (NP3 minimum) unless otherwise specifically required.

Drainage ditches till the time of construction work is over and final drainage scheme is developed, shall be installed along roads and parking areas to provide drainage of surface water and to ensure stability of the facilities. Ditches may be lined or unlined depending on grades. Unlined ditches shall have maximum grades of 1.0% and normal minimum of 0.5% where topographic is inadequate, an absolute minimum of 0.25% grade may be used. Where grade exceed 1%, the ditches shall be lined with brickwork (1:6) with pointing for grades between 1 and 3% and with concrete (1:5:10) for grades between 3 to 5%.

4.03.02 Closed Conduits

After the final drainage scheme is developed, the final drainage will be done by Closed Conduits over and above open ditches where grades are in excess of the maximum listed in clause no. 4.03.01. Conduits shall be preferably of concrete Hume pipe of class NP-3 with a minimum diameter of 200 mm. Velocities shall be limited to a maximum 3.5 meter/sec. where possible. Where velocities exceed 3.5 meter/sec. proper anchorages must be provided to ensure against displacement. Hume pipe

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crossing roads and railway lines shall be of class NP-3 and NP-4 respectively unless noted otherwise.

4.03.03 **Manholes**

Manholes shall be RCC below ground level and brick masonry above ground level. Manholes shall be located at all bends, changes in slope, alignment and change in size of pipe. Maximum spacing of manholes shall preferably be 100 meter.

4.04.00 **Sanitary Facilities**

4.04.01 **Sewer Lines**

Sewer Lines shall be of cast iron and/or vitrified clay pipe and shall be sloped to provide a mean velocity of 600 mm/sec. flowing full or half full and should follow the natural gradient as far as practicable.

4.04.02 **Manholes**

Manholes shall be RCC below ground level and brick masonry above ground level and flow troughs shall be formed in the base concrete.

4.04.03 **Centralized Sewage treatment Plant, Septic tanks, soak pits**

Centralized Sewage treatment plant is to be provided by the Contractor for Power Plant. Contractor has to consider the sewage load for all Power Plant toilets and other relevant areas. Centralized Sewage treatment Plant shall be designed by Contractor considering above loads. Contractor shall have to provide complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Extended Aeration method of sewage treatment shall be used. Contractor shall also provide pump house and piping for re-use of treated water as per requirement. Manual on Sewerage and Sewage treatment (published by Central Public Health Environment Engineering Organization, Government of India/equivalent) shall be followed for design purpose.

ALL THE WORKS PERTINENT TO TOWNSHIP ARE EXCLUDED FROM THE CONTRACTORS SCOPE

For construction stage, sufficient number of Septic Tanks and Soak Pits shall be provided at suitable locations to cater for the design population of the different site offices vis-à-vis estimated maximum number of construction employees during peak construction period on a use factor of 100 liters per person per day. Suitable connection from toilets to septic tank, shall be made conforming to IS : 651. or equivalent

4.04.04 **Steel Tank**

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The design of steel tank including the tanks locations, dykes and drainage shall be governed by the requirement of the appropriate state or central Government regulations. The steel tank may be supported on R.C.C. ring wall foundation filled with well-compacted sand with sand-bitumen cone at top. Differential settlement criteria should fulfill the requirements of the relevant IS Code

4.05.00 **Yard Work**

4.05.01 **Parking Areas**

4.05.01.01 **Type of Parking**

Parking facilities shall be provided as per the approved plot plan for plant personnel and visitors. Provision shall be made at suitable locations within the fenced plant area for parking of minimum 30 passenger vehicles in addition to mobile plant equipment, heavy vehicles, fire engines and ambulance etc.

4.05.01.02 **Pavement & plinth Protection Requirements**

Paving requirements for parking areas shall be equal to those specified for feeder roads or as decided by the Owner during detail engineering stage.

However, paving under the boiler (BTG area -- (A) axis to Chimney), ash area (BOP),Transformer Yard area, shall be done with 150 mm thick cement concrete of grade M20 with reinforcement over a lean concrete (1:3:6) of 75 mm thickness. Paving for coal stockyard shall be of 230mm thick soling followed by, 75 thick plain cement concrete of M10 grade, and 150 mm thick RCC slab of grade M-20 with sufficient reinforcement. An aesthetically pleasing paving shall be provided from the road to administration buildings with heavy duty inter locking tiles.

1.00 m wide **Plinth Protection** of 100 mm thickness of plain cement concrete (PCC) of grade M20, over 230 mm thick boulder soling surrounding all plant and non-plant buildings shall be provided by bidder.

4.05.02 Water Lines

Water lines may be designed as rigid or flexible conduits as may be necessary. Water lines may be placed in trenches or in fill. When placed in trench, the width of trench shall be 300 mm greater than the size of pipe upto 300 mm nominal diameter and 400 mm greater for pipes in excess of 300 mm diameter. The bottom of the trench or the surface of the fill shall be accurately graded and shaped to accept the water line.

Selected backfill material shall be placed on both sides of the pipe to an elevation 200 mm above the top of pipe for lines upto 300 mm in diameter and to not less than 150 mm above the horizontal center line of pipe having a diameter in excess of 300 mm. Compaction of the backfill shall be in accordance with the recommendations of the Soil Report and as directed by the Owner.

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For underground road crossings, pipes shall be laid through R.C.C. Box Culverts, NP-3 Hume pipes as required.

Lean concrete of the preparation of 1:4:8 may be used in lieu of back fill to support the pipe where access is limited and might result in improper compaction of the fill. A minimum arc of contact of 120° shall be maintained when lean concrete support is used.

4.05.03 Steam Lines

Steam Lines shall be designed by the Contractor. Anchor blocks and supports required to transmit line forces to the soil or to structures shall be designed accordingly by the Contractor.

4.05.04 Electrical Conduits

Electrical cable runs and supporting structures for overhead cable runs shall be designed by the Contractor. Underground cable runs may be installed in trenches or on fill as may be decided by the Contractor. When installed in trenches, suitable supports for the cables and the drainage arrangement of the trenches along with the design of the trench shall be the responsibility of the Contractor. To suit site condition cable trench / cable bridge shall be provided. For underground road crossing R.C.C. Box Culverts shall be provided. For overhead road crossing minimum 8M clearances between the bottoms most member of the Cable Bridge and crest of the road shall be maintained. **Cable trenches shall be provided with integrated slope for effective collection and quick bail out of water by providing intermediate dewatering pits**

4.05.05 Fire Lines

Fire lines shall be laid out by the Contractor. Buried lines shall be installed in accordance with procedures outlined for water lines in clause no. 4.06.02. However, above ground pipe lines supported by concrete pedestals is preferable to avoid leakage problems with the buried pipe lines satisfying the norms of TAC.

4.05.06 Sanitary Sewer System

The sanitary sewer system shall be designed in accordance with the requirements of "Sanitary Facilities" – clause no. 4.04.00. Buried lines shall be installed in accordance with procedures outlined for water lines in clause no. 4.06.02.

4.05.07 Storm Drainage System

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The storm drainage system shall be designed in accordance with the requirements of clause no. 3.02.00, meteorological data and other relevant conditions as laid out in this specification. Rainwater down comers shall be of cast iron with a minimum nominal dia of 150 mm.

Layout of storm water drainage shall be as per approved plot plan drawing. The storm water drainage shall be designed considering intensity of rainfall as 80 mm per hour or as per meteorological data. To meet Vastu requirements, it is essential that the drain network shall have a slope from South to North and West to East which means that the complete network would lead the water towards the North –East corner of the plot where Rain Water Harvesting System would be located. If the geo-technical conditions permit a suitable arrangement of PVC pipes filled with gravel shall be provided along the network of drains so that the balance water only would be collected at North-East Corner and the storm water would be harvested through out the plant area which would in turn help the development of greenery. Storm water run off drainage shall be direct run off from roof drain and yard areas to the proper drainage collection basins or to natural drainage as appropriate. Surface run off coefficient for paved and unpaved areas shall be assumed as 0.9 and 0.6 respectively. The final discharge will be connected to Water Harvesting System.

Reinforced Cement Concrete (RCC) drains with pre-cast cover at top shall be provided on both sides of the plant roads. R.C.C. Box Culverts / Hume pipe culverts (NP-3 conforming IS: 458) shall be provided at road crossings considering appropriate surcharge. Minimum non-silting velocity of 0.6 m/sec shall be maintained.

4.05.08 Service Water/Drinking Water Reservoir

Provisions for overhead reservoir/tank shall be made by the Contractor over Power House Building and other Auxiliary Buildings of suitable & adequate size for service water and drinking water purposes.

4.05.09 Boundary Wall & Gates

Plant boundary wall shall be of Fly Ash bricks (if mandatory due to local regulations) masonry with G.I. Barbed wire fencing on top. Boundary wall shall conform to the requirements of BPE norms for vital industrial undertakings. It will be 3.0-metre high masonry wall from **Finished Ground Level** over which 600mm high barbed wire fitted and fixed to embedded bifurcated steel angles shall be provided with RCC coping. Layers of G.I barbed wire be four nos. for each bifurcation. 300/350mm thick brick wall laid in 1:4 cement sand mortar shall be used in boundary wall.

At the main entrance and front side of the Power Plant, aesthetically appealing treatment shall be given to the boundary wall. At least three options shall be proposed by the Contractor / contractor for the approval of Owner.

Reinforced Cement Concrete (RCC) Plinth beam shall be provided. Suitable precaution shall be taken to cater for the future back filling of certain areas of plant. If necessary the wall will be stepped up at a later date. The design of the gates shall be in accordance with the criteria established by the Contractor and duly approved by the Owner. The boundary walls shall be plastered and painted with Cement paint

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and the main entrance and the gate at main entrance shall be given aesthetically pleasing architectural treatment.

4.05.10 Lighting

Lighting requirements shall be specified by the Contractor and as approved by the Owner. Light poles shall be of steel pipes/structural steel/pre-cast poles as per standard developed by the Contractor including foundations.

4.05.11 Trench Covers

All trench covers including covers of storm water drains shall be of pre-cast concrete of grade M-25. The width of the covers and the lifting hooks shall be suitably engineered and provided depending on the method of lifting and facilities available in the project. As a guide the average weight of the trench cover shall be around 100kgs. The design of the covers shall be standardized as far as practicable.

4.06.00 Requirements During Construction

4.06.01 Temporary Building

Temporary buildings shall be provided for Owner's site office 500sqm, which shall be provided with false ceiling, electrical wiring, provision for computers and cables (the layout shall be as approved by WPCPL and provision for AC, without furniture), Contractor's site office, Cement godown, Open shed for storing machinery and materials and stores for storing TG material and other sophisticated materials and for labour hutments including sanitary and other facilities. The sizes and locations of the buildings shall be proposed by the Contractor and approved by the Owner. Based on design loads and soil properties, Contractor shall design foundations and foundations shall be placed on virgin soil. Floor slabs, when used, shall be placed on a sand bed and shall be isolated from the foundation walls.

Super-structure requirements shall be as established by the Contractor and duly approved by the Owner.

After the project completion, the use of the temporary buildings/structures shall be decided by the Owner. If however, the same are to be dismantled, then dismantling & removal of debris shall have to be done by the Contractor at no extra cost to the Owner.

Water required for construction purpose shall be ARRANGED BY THE CONTRACTOR and stored in an underground tank. From the underground tank water shall be pumped to an overhead tank for further distribution by gravity to various distribution points.

4.06.02 Temporary Storage Areas

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Contractor shall indicate area requirement and surfacing to be done for temporary Storage areas and same will be approved by Owner. Storage areas shall be level and accessible by road. Grade elevation shall be such as to prevent inundation by flood water.

4.06.03 Temporary Parking

Temporary parking shall be provided for construction personnel and construction machinery. The parking area shall consist of a compacted layer of 150 mm brick bats crushed stone or gravel with the surface sealed with asphalt. However, to suit condition and layout of plot plan, temporary parking facility may be provided at the permanent locations.

4.06.04 Roads and Drains

Temporary roads shall normally follow the right of way of permanent roads with first stage construction performed to provide temporary roadway

Construction drain as required for proper drainage of the areas shall be of earthen with side slopes as 1 vertical : 1.5 horizontal and shall generally follow the right of way of permanent drains.

5.00.00 TYPE OF CONSTRUCTION

5.01.00 Main Plant

The salient features of the major civil work are described in this specification and the salient features of architectural work are attached in Annexure-A. The detail list of all buildings/structures, services, finish schedule and facilities, plumbing & drainage work etc. to complete the Power Project shall be prepared by the Contractor based on the preliminary Plot Plan, Specification and the same shall be duly approved by the Owner. Each floor of STG building shall have 3 toilet blocks out of which one will be for ladies. Administration building shall have adequate numbers of toilet blocks in each floor with provision of separate ladies toilet blocks as per requirement of layout. Canteen building shall have two toilet blocks. Apart from above all control room buildings in BTG and BOP area shall have toilet blocks on each floor. Sufficient no. of toilets shall be provided to meet the requirement and also to meet the statutory requirements shall be provided by the Contractor. All independent buildings including security offices at each gate shall be provided with sufficient no. of toilets.

All the independent buildings such as Control & MCC Rooms / Pump Houses unless specified otherwise shall be RCC framed Structures with RCC roofs. The partition walls shall be of suitable thickness as per industrial standards and of clay brick /Fly Ash brick masonry.

5.01.01 CONSTRUCTION METHODOLOGY

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Construction and erection activities shall be fully mechanized from the start of the work.

All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.

Wherever controlled blasting is not possible manual chiseling has to be done.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

Pile installation equipment suitable for flushing with airlift technique shall be used for construction of bored piles.

Control Concrete to be used for all RCC works for the Power Plant. No volume batching shall be permitted. Entire concreting works are to be carried out with, fully automatic central mix, weigh batching and mixing plants capable of producing not less than 100 Cum/hr of mixed concrete as per IS: 4925; transit mixers, concrete pumps, hoists, etc. shall be used. Temperature controlled concrete (temperature not to exceed 23 degree C) shall be used for TG foundation any other foundation which is above 30 Cu M in single pour. TG Foundation columns shall be cast in single pour.

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.

All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydraulically controlled grouting equipment.

Concrete Roadwork shall be done using crawler or pneumatic tyred dozer with ripper attachments, vibratory roller minimum 8 to 10 t static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.70 MN / Sqm, smooth wheeled roller (8 to 10 t capacity) plate compactors, power rammers, motor grader, weigh batching plants with automatic control (Clause 602.9.3.2 of MOST specification), transit mixer, fixed form or slip form paver (Clause 602.9.3.3 of MOST

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specification),Concrete saw (Clause 602.9.3.4 of MOST specification)

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy-duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment; destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

5.02.00 **Work shop& Store, Gate house complex, Security office (at both the gates), Fire Station, First Aid Center etc.**

5.02.01 **Foundation**

Contractor is to design the foundation based on design load and soil properties. Floor slab shall be placed on a sand bed and shall be isolated from the foundation works.

5.02.02 Superstructure

The superstructure may be RCC/structural steel framed structure. The walls shall be 250 mm thick masonry walls. Other requirements of the superstructure shall be as established by the Architect of the Contractor and the same shall be duly approved by the Owner.

5.03.00 Workshop & store

5.03.01 **Foundation**

Foundation shall be designed as per design load and soil properties.

Floor slab shall be placed on a sand bed and shall be isolated from the foundation of walls.

5.03.02 **Superstructure**

R.C.C. framed structure with 230 mm thick masonry walls. Other requirements of the superstructure shall be as established by the Architect of the

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Contractor based on the guidelines established by the project requirement and duly approved by the Owner.

5.04.0 275 m high RCC Chimney

The RCC chimney shall be 275 meter high with three steel flue having adequate thermal insulation provision.

5.04.01 **Foundation**

The foundation shall be circular and shall be designed based on Soil parameters & design loads. The space up to grade elevation inside the periphery wall shall be filled with sand. The Chimney foundation shall be of concrete grade M-25 with minimum cement content of 365 Kg/Cum.

5.04.02 **Superstructure**

The shell (superstructure) shall be of min. concrete grade M-30 with minimum cement content of 400 Kg/Cum. The cement shall be 43 grade OPC. The profile of the shell should satisfy the requirements of aerodynamics taking into considerations of the interference effect with the chimney of the proposed extension unit. Aerodynamics treatment shall be followed, if required.
Opening in the shell shall be provided for duct work, access doors, ash channel and ventilation system etc. The maximum width of opening shall be limited to an angle of not more than 30° subtended at the center of the concrete shell.

The total plan area of the opening at a particular section shall not be more than 15% of plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of opening. The extra reinforcement around opening shall satisfy the requirements given in the following documents and the highest shall be provided.

a) IS 4998 (Part I)

b) ACI 307

c) Reinforced concrete chimney and tower by M.G Pinfold. The value of K1 as given in the book by M.G. Pinfold on page no. 186 shall be taken as 0.11.

Minimum half the number of extra horizontal bars in shell around the opening to continue for complete circle all round for both faces and both sides.

The Contractor's scope includes the design, supply, fabrication, installation and testing of the steel flues with insulation and expansion compensators including spares as required. The Contractor's scope includes the design, preparation of detailed fabrication drawings for the steel flues fabrication

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and installation. It shall be the Contractor's responsibility to test the supports, restraint points, stiffeners, expansion joints and insulated steel flues against vibrations and specified temperature variations. On no account will a leaky flue be permitted.

The lining material/stiffeners shall be fabricated from mild steel having an ultimate tensile strength of not less than 410 N/Sq.mm. and conforming to the requirement of IS: 2062 (Grade-A). The minimum thickness of the liner shall be 8 mm. A minimum corrosion allowance of 2 mm. shall be allowed for arriving at the desired thickness. All steel shall be of tested quality only.

The flue shall be semi-rigid insulated externally with mineral wool made from rock slag or fibrous glass bonded by a suitable resin binder conforming to IS: 8183 or equivalent with a maximum coefficient of thermal conductivity of 0.062 W/m deg. C at a mean temperature of 150 deg. C.

Two layers of insulation material each of a minimum thickness of 25mm shall be provided and all joints shall be staggered. The material shall have a minimum density of 80 kg/cum. for resin bonded glass wool insulation and 100 Kg./cum. for resin bonded rock wool insulation.

Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm. and all joints shall be staggered. The material shall have a minimum density of 200 Kg/m^3. This shall be protected by means of a stainless steel cladding, flashing and hood of grade 316 L stainless steel.

Flue shall be supported from top platform and restrains shall be provided at intermediate levels (at interval of not more than 40m). Portion of steel flue below expansion compensator shall be supported by steel structure. Expansion compensator shall be procured from any specialist manufacturer, such as SCANDURA LTS, PO BOX- 18,CLECHEATION, WEST YORKSHIRE, BD 193 UJ,ENGLAND or equivalent as approved by Owner. Ash hopper lined with cellular concrete, acid and heat resistant brocks shall be provided below flue duct entry level. The provision of port requirements shall also be taken into account. Contractor shall obtain approval from Owner regarding engagement of Specialized Agency (if any) for construction of 275 m high RCC Chimney with full details of credential of such Agencies, including details of the scheme for slip form shuttering etc. Supply and installation of rack and pinion elevator of min. 400kg of capacity of reputed make acceptable to the Owner. This elevator is to be installed on the outer shell. Lightning protection and grounding Systems shall be provided.

Lighting fixtures, grounding, aviation lights and other electrical requirements shall be supplied by the Contractor as per requirement.

Five numbers of external platforms excluding hood platform with minimum clear width of the platform as 1.00m shall be provided at an interval of approx. 40.00 m. These platforms shall be spaced approximately equally between the hood

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platforms and ground level. Suitable stairs shall be provided meeting the norms of IS Code. The liner hood shall be designed and fabricated from 6mm thick stainless steel sheets of AISI grade 316L.The general arrangement of chimney drawing shall be approved by the Owner before detail design is being made.

A steel staircase of 900 mm clear width shall be provided internally within the shell from the bottom to the top to provide access to all platforms. It shall be fabricated from MS rolled I or channel section stringers. Treads shall be of steel grating designed for self-weight and a live load of 500 Kg/m^2. Treads shall be provided with an approved anti-slip nosing set flush with the stair tread. Hand railing shall be provided for the stairs for the whole height. The staircase shall be supported on a steel frame work independent of shell with all members connected with suitable, bolted connections only. The supporting structure shall be painted as per the requirements of IS:1477 with 2 coats of zinc rich red oxide paint and 3 coats synthetic enamel paint of approved shade. The steel treads shall be hot dip galvanized.

5.05.00 **Switch Yard**

5.05.01 **General**

Switchyard will be located near the power house with dedicated evacuating line leaving the plant area.

5.05.02 **Foundation**

Foundation shall be designed by the Contractor based on design load and soil properties.

5.05.03 **Superstructure**

All switchyard superstructure shall be of hot dip galvanized mild steel. All connection shall be bolted / welded as required.

5.05.04 **Control Rooms(CHP, Main plant etc.)**

Control room shall be of RCC roof framed structure ,RCC roof with brick cladding.

5.05.05 **Fencing**

The switchyard, Transformer Bay and Fuel Oil Area shall be protected by galvanized chain link fencing on RC precast post with suitable material and human entry gate. A kerb wall at least 200mm from FGL shall be provided

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Height gauge shall be provided on the roads around switchyard. Gravel mulching (anti weed treatment) with Crushed stone aggregate of minimum thickness of 150 mm shall be provided as per the statutory requirement.

An effective system shall be proposed by Contractor for Owner's approval to drain off storm water collected in cable trenches in switchyard and other areas.

5.05.06 **Rain Water Harvesting System (RWHS)**

Rain water harvesting is a scheme where the roof water and surface water is collected and allowed to percolate into the ground. The basic purpose is to assist the ground water table stability. Also, it is a compulsory scheme as per the recommendations of the statutory/ environmental bodies.
A detail hyro-geological study of the plant ground water table and under ground permeable and impermeable layers have to made to arrive at the best location and design requirement of size, depth etc. of RWHS. Detail Soil Investigation report to be prepared for foundation design /engineering of the power plant can be used for information of details of underground geological formations. If it is felt, that further study is required for input of RWHS design, then Contractor has to carry out additional investigation and test without any extra cost to the owner.

RWHS shall mainly comprise of two open bottom Reinforced Cement Concrete (RCC) basins of M25 grade of Control Concrete. The roof water and surface water is collected through open storm water drain networks. The discharge outlet is then connected to the first open bottom RCC settling /collection basin, from where the roof water / surface water will percolate into the shallower depth of ground.

Then the over flow of settling/collection basin shall be fed into a RCC re-charging basin (M25 grade) by gravity or/pumping for percolation to a greater depth of ground. The size and depth of the bottom basin of the re-charging pit shall be suitably designed considering of amount of storm water expected from meteorological data. The bottom basin will consist of many numbers of 100mm dia PVC perforated pipes installed upto the sand strata (aquifer strata) depth from the basin bed level. The perforated pipes shall be wrapped with coir, so that the water is filtered while passing to the ground.

The RCC settling/collection basin & re-charging basin provided for the rainwater-harvesting scheme shall be provided with adequate handrails at the top bench. PCC (M20), 1000 mm wide footpath /walkway of 150 mm thickness over rubble soling of 230 mm thick shall be provided all-round for approach/ inspection/maintenance/safety purpose.

Contractor shall be responsible for successful operation of RWHS for two consecutive rainy seasons after commissioning of RWHS.

Detail Rain Water Harvesting System to recharge the ground water aquifer shall be prepared in consultation with Central Ground Water Authority (CGWA) / State Ground Water Board (SGWB) and a copy of the same shall be submitted with in three months to the Ministry of Environment and Forests(MOEF) Paryavaran

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Bhavan, CGO Complex, Lodi Road, New Delhi –110003.Owner will render reasonable assistance to the Contractor for this purpose.

The above defined scheme is just indicative .A specialized consultant or Agency who has done at least three projects of similar size shall be engaged by contractor for generation of Schematics and working drawings for the said scheme.

6.00.00 MAIN PLANT STRUCTURES/COMPONENTS

The description of some of the major structures/components for the power plant is given below :

a) Main power House Building and Auxiliary Buildings

The structure of the power house building shall be of structural steel framed super structure up-to top with roof truss and cast-in-situ R.C. slab/pre-cast RCC panels supported on MS Purlin. All structural components as applicable will be of welded fabrication and the field connections will be with high tensile bolts and/or welding as determined in design stage.

Floors will have cast-in-situ R.C. slabs. The turbine hall roof will be made of cast-in-situ R.C. slabs over steel purlins and truss. Side cladding shall be of permanent color coated sandwich (insulated) metal sheet. Polished Granite stone flooring shall be provided at operating floor of Power House and cast-in-situ IPS flooring shall be in rest of the areas of Power House building.

The turbine generator foundation & top deck will be a reinforced concrete structure, isolated from the building foundation and superstructure.

Other plant and non-plant auxiliary buildings such as various pump houses, compressor building etc. shall generally be of R. C. framed structure with R. C. roofing and plastered brickwork cladding. Necessary windows/ louvers will be provided for natural lighting and ventilation. Double door shall be provided in all control rooms areas. The ingress of water thru' R.C.C cable trench within the buildings shall be avoided. Auxiliary plant building(s), as applicable, shall have a monorail and a maintenance bay with sufficient headroom for operation of Escort etc. All control rooms shall be given false flooring and false ceiling. Two doglegged staircases shall be provided on either side of main TG building. STG building, Admin Building and the front side of compound shall be given aesthetically pleasing architectural treatment. Contractor shall submit some schematics giving no. of choices for these these structures for Owner's approval.

All pressurised room shall be provided with Ceramic tiles with Acrylic Emulsion paint.

b) Induced draught cooling tower

The scope of this work shall consist of, but not limited to, the design and construction of reinforced concrete Induced Draught Cooling Towers, including basin, sumps,

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partition walls, fan deck, columns etc and all integral parts of IDCT including piling works ,if any, cold water basin with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with sluice gates and removable screens as specified elsewhere, hoists & monorails, primary and secondary hot water distribution troughs, fill support systems including columns & beams, drift eliminators (if required), testing of cold water basin for water tightness, external stairs, cage ladders, handling facilities at fan deck level with walkway platform and CW channel, platforms, walkways as specified or required for operation and maintenance, access doors, GI handrails, steel fittings, fixtures, inserts including fabrication, galvanizing and erection of associated steel work and other chemicals on the completed structures etc. all complete as per functional requirements and as per directions of Owner. Cooling tower basin shall be designed in accordance with IS:3370.Structure of cooling tower coming in contact with water /water vapour shall be designed with limited crack width of 0.2mm and with reduced stresses in reinforcement as per relevant IS codes.

The scope of work under this specification shall also include providing engineering design and drawings, all labour, supervision, materials, shuttering and scaffolding, construction equipments including tower cranes, hoists, batching plants etc. tools and plant, supply and transportation of all incidental items not shown or specified but reasonably implied for successful completion of the work. The nature of the work shall generally involve foundation/piling, excavation, dewatering, shoring and strutting, backfilling around underground structures and plinth filling, sand filling, disposal of surplus soil, concreting of grade as specified, formwork, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint filters, drainage and other ancillary items connected with cooling towers as approved. The surface protection that would include all inner face of IDCT, column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channels etc. This list is indicative and the scope shall also include the preparation and supply of all working drawings required for this work.

c) **Roads and Drains**

Layout of Road shall be as per approved Plot Plan. All Project Roads in side the Power Plant shall be concrete roads designed for 30 years of life with minimum traffic growth of 1%. The sub-grade shall be prepared and designed/decided as per traffic load, CBR value, locally available best quality suited material and in accordance with IRC 58-2002,IRC 15-2002 & SPECIFICATIONS FOR ROAD AND BRIDGE WORKS by Ministry of Surface Transport –Roads Wing (MOST) and other relevant IS/IRC Codes of practice. Soaked CBR value shall be taken unless otherwise mentioned in the Soil Investigation Report for design of plant roads. Sub grade shall be well compacted, such that soaked CBR value% shall be 10 or more and modulus of sub-grade reaction k, should attain minimum value of 5.50 kg/ Sqcm /cm or more. Design shall be done considering single axle load of 20 ton with a load safety factor of 1.1. Sub base shall consist of layers of 150 mm thick Granular Sub-base (GSB), 100 mm thick Wet mix macadam (WMM)& 100 mm thick Water Bound Macadam (WBM).

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A 100 mm thick dry lean concrete (DLC) shall be laid over these sub-base layers. PCC of M-30 grade with designed thickness shall be put over DLC. An impermeable plastic sheeting 125 microns shall be provided between PCC and DLC layer. Suitable contraction joints (spacing to be considered equal to 3.50m), expansion joints and longitudinal joints shall be provided as per IRC-58-2002 . The inside edge of paved surfaces at inter-sections shall have a minimum radius of 9 M. Vertical curves shall be as flat as practicable and shall have a minimum sight distance of 150 M.

Concrete Approach Road from NH-200 to the Power Plant Main Gate having an approximate length of 600 m shall have carriageway width of 14.00 m with 1.00 m wide shoulder on either side and RCC covered storm water surface drain on both the sides. The Concrete roads within the plant area shall be so laid out as to provide access to all the plant buildings and facilities. The major plant roads shall be 7.00 (seven) M wide. Double lane road of width 7.0 M shall have 1.5 M wide shoulder on the either side of the road. Single lane road shall be of 4.0 M width with 1.0 M shoulder on the either side of the road. All the plant concrete roads shall have covered RCC storm water surface drain on both the sides all along. Pre-cast concrete kerbstone shall be provided on either side of the road painted as per specifications. Main access roads shall comply with the best specification out of the loading class AA and 70 R of IRC specification.

RCC rectangular section surface storm water drain of adequate depth and width to be provided on all along the length of the plant roads on either side. The thickness of sidewalls and bottom slab of RCC drains shall be minimum 150mm or as per design considerations whichever is higher. Double layer reinforcement shall be provided for sidewalls and bottom slab. All surface storm water drains shall be covered with perforated pre-cast RCC slabs of minimum 50 mm thickness with provision of open able galvanised steel grating covers at about 4.00m intervals.

Surface drainage on site shall consist of overland and open channel flow. Roads crossing over trenches shall be constructed with reinforced concrete box culverts to pass the design flow. Culverts and other road structures shall be designed to accommodate class AA loading as specified by IRC.

The longitudinal bed slope of plant main drains shall not be flatter than 1 in 650. The plant yard shall be provided with gentle slope towards these open drains. In the transformer yard, boiler areas, where it may not be possible to provide open drains, or buried RC Hume pipe (NP-3) drains connected to catch pits may be provided. The clear water drains from the power house, oil bearing drains from various areas and storm water drainage system will be completely segregated from each other to form three different streams. The drainage network for storm water drains will consist of branch drains connected to the main trunk drains.

Effluent in power plant area is to be discharged to centralised Effluent Treatment Plant. Both the roads and drains are to be constructed in two stages. During the construction stage the water bound macadam roads without DLC and PCC shall be used. Any damage to these roads during the construction stage shall be finally repaired and DLC and PCC shall be laid before the plant becomes operational. Similarly, during construction stage, the open drains may be kept unlined and water

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accumulated in the pits excavated for foundations, trenches, tunnels etc. will be pumped into them. The buried pipe drains with catch pits and manholes and lining for the open drains will be constructed on completion of the underground construction work for the plant.

Service and Maintenance Road having a width of 4.00 m along Ash Slurry pipe line shall be Asphalt road. This road starts from gate no-2 and leads up-to Ash Dyke Area which is approximately 2.00 Km from Power Plant.

d) Surface Treatment

Boiler Area

The entire area (from (A) axis to Chimney) will be paved with cement concrete with reinforcement and sloped to drains. Immediately adjacent to these areas concrete roads shall be provided as required for access to equipment.

Transformer Areas

Oil cooled equipment, such as transformers, will be located within concrete basins filled with gravel. The individual basins will be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

Drains will be adequate to remove full discharge from deluge system used for fire control. Transformer Yard will be paved with cement concrete with nominal reinforcement.

Induced Draught Cooling Tower Area

Plinth protection will be provided for 2 m around each cooling tower structure. Remaining area will be graded with earth.

e) Sanitary Sewerage System

Effluent shall be discharged to centralised Sewage Treatment Plant.

f) **Raw Water Reservoir**

Raw Water reservoir of required depth shall be provided with earthen embankment. For earthen embankment, 1000 microns HDPE lining along its base and sides shall be provided. HDPE liner shall be placed over 200 mm thick consolidated/compacted granular filling. Protective layer of pre-cast concrete block having a size of 300mm X 300mm X50 mm thick of grade M25 (with 1:3 mortar pointing at joints) to be placed over 25 mm thick cement sand mortar (1:4) under bed. Outer slopping side (down

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stream side) of the embankment shall be provided with suitable slope protection system against rain-water erosion protection of acceptable quality.

For Earthen Embankment, the heat sealing shall be done by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the HDPE film to be heat sealed. On the plywood, a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the 1000 microns HDPE film, with 150 mm overlap is to be stretched. On the overlapped 1000 microns HDPE film another cellophane tape is to be placed to prevent the heat sealer from sticking to the 1000 microns HDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of the joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

For earthen embankment the installations shall present a neat appearance and shall be checked for water tightness. The following shall be specifically checked :-

a) 1000 microns HDPE film against mechanical damage if any.

b) Laying of HDPE films.

c) Method of jointing (Heat sealing).

d) End sealing or, anchoring of HDPE films.

e) Laying and joints of cover tiles.

Raw Water Reservoir shall be tested for water tightness as per the provisions of relevant standards..

The Contractor shall carry out Blasting / Excavation for the entire reservoir of 1,200,000 Cu. M capacity. Contractor shall construct the reservoir for 6,00,000 Cu. M capacity with two compartments. Contractor shall consider the space availability, Structural stability, provision for expansion to the fullest capacity in future by the Owner and the plot plan requirements while deciding upon the dimensions of the reservoir,

7.00.00 QUALITY AND WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those, which normally require unskilled persons.

Regarding quality of Civil/ Structural works the Specification of Field Quality Assurance (FQA) and Field Quality Plan (FQP), are attached in other Annexure of this Technical Specification. Contractor shall strictly adhere to the all requirements

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mentioned in FQA and FQP Specifications. The FQA and FQP Annexure are integral part of Technical Specification and in turn shall be integral part of Contract.

Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge planning and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Owner, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by any other agency. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work such removal and re-erection, if required, shall be carried out by the Contractor without any delay and any extra cost on this account shall be borne by the Contractor.

9.00.00 DOCUMENT SUBMISSION

Design and Construction documents pertaining to all Civil, Structural and Architectural works that will be required to be submitted to Owner/ Owner's Consultant for their review/approval have been brought out under following clauses. Approval of these documents by the Owner/Consultant shall not relieve the contractor of his responsibility for any design/construction error, mistakes and fulfillment of contract requirements. All drawings shall be of standard sizes & in metric system and shall be made in Auto cad (Latest). All documents shall be prepared in MS Office/PDF, as applicable. Weekly/Monthly progress/ quality reports shall be submitted by contractor to the Owner as per the mutually agreed format or the format, which shall be recommended by the Owner.

9.01.00 Design Document

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Design Document shall comprise Mechanical/Electrical assignment Drawings, design data, design assumptions & references, detailed structural analysis (including computer out put, if any) & design calculations and design drawings for all buildings / structures & misc. services/facilities including plumbing, drainage etc. The drawings shall also include general plot plan, arch. Floor plan/elevations/cross-sections/perspective view in colour, finish schedule etc. Contractor shall propose no. of choices detailing the architectural treatment to Administrative Building, STG building and compound wall. Various plans, perspectives and elevations shall be submitted detailing the architectural treatment. Quantities of steel and RCC shall be provided with all RCC/Structural drawings.

The bidder/Contractor should provide elevation, birds eye view, 3 D perspectives and walk through schematics for following three

- Complete Power Plant
- STG building
- Administrative building

Design calculations and drawings as decided by the Owner shall be submitted and reviewed only after approval of corresponding Mechanical/Electrical/System general arrangement drawings. If Owner requests for any further details and supporting calculations, the same shall be provided by the Contractor unconditionally with out any additional cost to the Owner. Any delay in providing or substantiating the technical data by the Contractor as requested by the Owner /Owner's engineers to undertake review of the drawings/calculations, shall be accounted to Contractor any any justification by the Contractor in delay of the works there of shall not be entertained by Owner. The contractor shall submit approved GA drawings along with three (3) copies of design documents (except design drawings), four (4) copies of design drawings for comments/approval of the Owner/Consultants. Comments, if any, shall be duly taken care of by the Contractor and revised design calculations & drawings shall be resubmitted, whenever so instructed by Owner/Consultants, for further comments/approval. On the final approval of the drawing and design, Contractor shall submit six (6) copies of the drawing with one Soft Copy and four (4) copies of final design calculations to Consultant for distribution. Generally review of the documents/drawings will be made by the Owner/Consultants as detailed in the construction agreement. However the Contractor should give schedule mentioning the dates for submission of miscellaneous drawings/documents to Owner/Consultants for prior approval.

9.02.00 **Construction Document**

Based on final design drawings, detailed drawings for construction will be prepared by the Contractor. For reinforced concrete structures and foundations detailed bar bending schedules in approved format shall accompany each detailed drawing. For structural steel work detailed fabrication drawing along with bill of materials will be prepared by the Contractor.

Six (6) copies each of selected detailed drawings/ fabrication drawings as decided by Owner shall be furnished to Owner/Consultants for their review.

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Procedures for submission and approval of Construction Documents other than stated above shall include design of temporary works like sheet piling for deep excavation works, slip form method of concreting for chimney etc. and any other item stated elsewhere in this specification.

The contractor shall submit six (6) copies of the final drawings along with one RTP to Owner/Consultants.

'As built' drawings shall be prepared by the contractor after completion of construction/erection incorporating necessary changes, if any done during execution. The contractor shall submit two (2) copies and one RTP of the 'As- built' drawings to Owner/Consultants.

All documents/drawings shall be submitted in CDs/Soft Copies to Owner and Consultant.

The finishing items shall be indicated up to painting, flooring, etc. Contractor shall provide similar details for all buildings in scope.
As a part of documentation, Contractor shall submit the hard copies of all the test protocols, joint inspection reports, handing over protocols, pour cards etc, in duplicate to the Owner along with the final bill.

10.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer-in-Charge in accordance with the construction method accepted by the Engineer-in-Charge and to be followed by the Contractor. A programme of work is to be submitted for the Engineer-in-Charge's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer-in-Charge progress reports for periods of working as specified by the Engineer-in-Charge showing upto date progress on all important items of work. L1 and L2 schedule for all works is to be submitted by the Contractor.

11.00.00 MISCELLANEOUS

Contactor shall take/provide/comply with but not limited to the following :

- Statutory Clearances from all applicable Authorities & the certificates to be submitted to the Owner.
- Copies of all studies, reports and investigations to be submitted to the Owner.
- Construction Methodology is to be prepared on same line of Clause no-5.01.01, mentioned earlier and to be submitted to the Owner's Engineer for his approval.

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- All Statutory regulations/Factory Act/Water Act/Pollution Control Norms/ Explosive Act/Rules of TAC/Any other state or central govt. rules, regulations as applicable to be complied with.

- Provisions of Safety, Health & Welfare to be maintained at site.

- Quality Assurance Plan (QAP) is to be submitted for approval of Owner and established as per satisfaction of Owner's Site Engineer for the whole project work before start of any Construction, Fabrication& Erection activity at site.

- Establishing of Field Quality Laboratory Testing Equipment as per enclosed list (refer Annexure for QAP attached herewith) with equipment criteria mentioned there.

- Maintaining of Quality work at site as per FQP norms (refer Annexure for FQP attached herewith) with proper testing, inspection etc.

- Design Basis Report (DBR) for the full civil, structural & architectural work to be submitted to Owner/Consultant for approval.

- Setting up of site testing laboratory for various tests with necessary equipments.

- Contractor shall submit the details of major equipment being mobilized for timely completion the project and get approval of the same from Owner's Engineer. Owner reserves the right to add / delete / modify equipment mobilization list as per his requirement.

- Setting of concrete batching plant of adequate capacity (not less than 100 Cum /hr) and the transit mixtures for conveying concrete for construction works.

- Contractor shall submit the details of key personnel and their profile both at HQ and Site Establishment to Owner. Detailed Manpower deployment schedule to meet the completion schedules of the project shall be submitted by the Contractor to the Owner at the start of project construction.

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B. SPECIFIC DESIGN REQUIREMENT [CIVIL]

1.00.00 INTRODUCTION

This section outlines following :

a) A brief description of Soil Characteristics.

b) Various loads to be considered in design.

c) Design considerations for Reinforced Concrete Structures.

d) Design considerations for Foundations.

e) Concrete Roads.

2.00.00 SOIL CHARACTERISTICS

The preliminary Soil Investigation of the project site will be provided by the Owner. It is the Contractor's responsibility to acquaint himself with the soil conditions at site before firming up the design parameters. The successful Contractor is to take up detailed soil investigation work on all the work areas/fronts as per relevant codes and approved plot plan. The review and approval of the soil investigation report and its recommendation for type of foundation to be adopted, shall be made by the Owner/Consultants.

The Geo-Technical investigation report shall be used as a guidance only. The Owner does not take any responsibility about the accuracy and applicability of the geotechnical data furnished.

The responsibility of correct assessment / interpretation and understanding of the existing substrata conditions lies with the Contractor. Any variation in the data between the one furnished in the soil investigation report and to that found during additional geotechnical investigation / execution of work at site will not constitute a valid reason in affecting the terms and conditions of this bid and nothing extra shall be paid on this account. The Contractor shall fully satisfy himself about the nature of substrata expected to be encountered, type of foundation to be adopted, the position of ground water table etc. prior to submission of the bid. For detailed engineering and foundation design, the successful Contractor will have to carry out detailed Geo-Technical investigation in all the work areas/fronts without any additional cost to the Owner with prior permission and approval of the Owner to establish the sub-strata conditions and to decide the type of foundation to be adopted, construction methods, any special requirements / treatment called for / remedial measures for subsoil / foundations etc. prior to the commencement of the detailed design / drawings.

2.01.00 **Excavations**

In case excavation works required to be carried out below ground water table, dewatering to be resorted by applying suitable method, with no extra cost and time implication to the Owner.

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2.02.00 **Aggressiveness of soil and ground water to concrete**

If in the soil report, chlorides and sulphates contain in the soil and ground water exists above permissible limits, the protection of underground structures shall be made as per codal provisions/requirements, with prior approval from the Owner.

3.00.0 **LOADS**

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements. For any structure which carries Indian Railway loading or is situated in the vicinity of railway lines, the design has to conform to the Indian Railway Standard specifications and approval must be obtained from Railway Authority including the clearances etc. All structures shall be designed to sustain within the stress limitation as specified in the Code, all dead loads plus assigned live, equipment, wind, seismic or other design loads.

a) **Dead Loads**

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load.

b) Live Loads

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary. Hung loads shall be based on minimum loading equivalents of 100 Kgs/Sq.m for piping and 50 Kgs/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

i) **All Buildings (Except in Coal Handling Plant area)**

Roofs	:	150 kg/Sq.m plus hung loads, if any.
Stairs & Platforms	:	500 kg/Sq.m
Corridors	:	500 kg/Sq.m

ii) **Power House Building**

a) **Ground Floor**

Unloading Bay	:	3000 kg/Sq.m
Other areas	:	1500 kg/Sq.m

b)	**Mezzanine Floor**	:		1500 kg/Sq.m plus hung loads.
c)	**Operating Floor**			
	Turbine Hall Roof of turbine floor	:		75 kg/Sqm.
	Corridor A	:		600kg/Sqm
	Corridor B of heater Platform	:		1000kg/Sqm
	I) T.G. Lay down area	:		3000 kg/Sq.m plus hung loads
	II) Other Area	:		2000 kg/Sq.m plus hung loads
	Other Areas	:		1500 kg /Sq.m plus hung loads
d)	Cable Spreader Floor	:		1000 kg/Sq.m plus hung loads
e)	Other floors	:		1500 kg/Sq.m plus hung loads
f)	Anchoring of conductors on A row columns	:		2000Kg per conductor per phase. 1000 Kg shielding wire
g)	Deareator Level Floor	:		1000 Kg/sqm
iii)	**C.W. Pump House**			
	Pump Floor		:	1750 kg /Sq.m
iv)	**Store/Workshop**			
	Ground floor	:		1500 kg/Sq.m
v)	**Switch yard control room**	:		750 kg/Sq.m

vi) **Cooling Tower**

Roof fandeck slab	:	750 kg/Sq.m
Covers for hot water channels, H.W. Distribution Basin	:	300 kg/Sq.m

vii) **Coal Handling Plant Area**

The following minimum live loads shall be adopted for design of buildings/structures.

• Flat roof	:	Accessible roof - 250 kg/Sq.m (150 Kg/Sq.m for LL and 100 Kg/Sq.m for dust load) Non-accessible roof - 175 kg/Sq.m (75 kg/Sq.m for LL and 100 k/Sq.m for dust load)
• Inclined roof (including roof for TP's and conv. galleries)	:	As per IS 875 for live load plus 50 kg/Sq.m for dust load
• All building floors & stairs	:	500 kgSq.m
• Toilet rooms	:	200 kgSq.m
• Walkways of conv. galleries	:	500 kg/Sq.m or a concentrated load of 300 Kg. at centre which ever is critical
• MCC floor	:	1000 kg/Sq.m
• Equipment load	:	As applicable
• Tunnels under road culverts and its allied structures including concrete pipes	:	Class "A" or class "70R" as per IRC standard whichever is higher or load due to bulldozers
• Underground basement, tunnel, trenches etc.	:	A surcharge of 2.0 T/Sq.m in addition to other loads e.g. earth and water pressure etc.

- Covers for channel : Trench cover at entry to building and road crossing shall be designed for a live load of 10T at centre. Trench covers at other locations shall be designed with a surcharge 1 T/Sq.m or a concentrated load of 1T at centre whichever is critical.

- Channels at road crossing to entry to buildings : - Do -

- Reclaim Hopper/ Tunnels in Coal storage area : The loading shall be highest of the following:

  i) Two bulldozers (maximum capacity indigenously available) operating side by side without any Coal heap over reclaim tunnel

  ii) Two bulldozers operating side by side over a Coal heap of 4.0 m.

- Rail loads : As per IRS including latest amendments.

c) **Equipment Loads**

i) Loadings (both static and dynamic) of major equipments including boiler, turbine-generator, boiler feed pumps, feed water heaters, deaerator, PA, FD, ID fans, Coal mill, Coal crusher etc. will be obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above must proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air and gas duct loadings will include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

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iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for more critical condition.

d) **Wind Loading**

Wind loading will be in accordance with Indian Standard Code IS-875 for a basic wind speed of 39 m/sec. up to a height of 10 metres above mean ground level. Appropriate probability factor, terrain, height and structure size factor, and topography factor shall be considered as per IS-875.
Design wind speed (Vz) =Vb x K1 x K2 x K3.
Risk coefficient (K1) = 1.07
Corresponding mean probable design life 100 years & Return period 50 years
Terrain Factor (K2)= as per table 2(open terrain category 2)
Topography Factor (K3) as per IS: 875 (PART-3) - 1987

Wind pressure of 0.5 k Pa shall be adopted by the Contractor for structural design.

e) **Seismic Loading**

.The lateral forces will be established in accordance with the recommendations of IS-1893(Latest edition). The site falls in Zone-II as identified in the map in IS-1893. Importance factor shall be taken as 1.5 in general. Seismic Intensity (Z) = 0.1.Provison contained in IS:4326 shall also be considered.

Contractor shall adopt 7 Degree seismic intensity for structural design as per Chinese code

f) **Temperature Loads**

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average

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annual variation in temperature. The average maximum annual variation for this purpose will be taken as the difference between the mean daily temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

g) Crane Loads

Crane girders and accessories shall be designed to accommodate the maximum wheel loads for the size and design of crane selected.

A vertical load of 25% of the nominal wheel loads shall be added for impact.

A horizontal lateral load equal to 10% of the sum of the hook load and the crab weight shall be assumed to act simultaneously at the top of each rail at right angles to the runway.

A horizontal longitudinal load equal to 5% of the wheel loads shall be assumed to act at the top of the rails parallel to the runway.

Seismic loading, where applicable, shall be considered in the design and rail clamps shall be provided to prevent derailing under seismic loading.

h) Elevator Loads

Elevator support systems shall be designed to accommodate the capacity load of the elevator plus the weight of the cab and accessories.

A vertical load equal to 100% of the above shall be added for impact.

Each elevator shall be designed to accommodate the applicable seismic loading.

i) Differential Settlement

All necessary precautions shall be taken in the design of foundations to ensure minimum differential settlement both within a single structure and between structures. This should be in conformity with the IS : 1904 or IS : 13063 whichever is applicable.

Each major structure shall be independent of adjoining structures. Eccentricity of load shall be minimized to the degree possible.

Special precautions shall be taken at pipe and other penetrations of structural walls to ensure uniform movement of the structure and the

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mechanical and/or electrical facility. Flexible connections shall be used where practical.

j) Special Concentrated Loads

All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously the structure or component shall be checked for both conditions of loading and shall be designed for the more critical condition.

Pipe thrusts resulting from thermal expansion shall be established by the Contractor. Such loads shall be considered in the design of structures and components.

Jet forces resulting from guillotine type pipe ruptures shall be considered in the design if of high magnitude. Jet force to be considered shall be equal to the product of the pipe across section and the internal design pressure applied on an area equal to the pipe cross section.

Lay down areas in the shall be investigated for concentrated loading resulting from equipment components to be stored during erection and maintenance operating. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

k) Soil Loads

Soil pressure / Safe Bearing Capacity as applicable to be used for design of structures shall be taken care of during detail design.

l) Surcharge Loads

Surcharge resulting from foundation loading of adjoining structures shall be fully considered in the design of building substructures.

Surcharge for road side drains, cable trench, if any, is to be considered as applicable during detail design.

In addition to earth pressure & water pressure, a surcharge of $1T/M^2$ on adjacent ground shall be taken. Covers for trenches and pits shall be designed for a minimum uniform live load of $400kg/m^2$ or one 75 kg center point load whichever is critical. For trenches exposed to vehicular traffic, the requirements of code of practice of roads & bridges shall be complied with.

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Surcharge resulting from the application of temporary construction loads also shall be considered in the design of substructures with allowable stresses permitted to exceed nominal design limits by one third.

m) Hydraulic Loads

The circulating water system and appurtenances shall be designed to withstand maximum internal hydraulic pressures which may occur during operation. Static, dynamic and water hammer loading shall be considered singly or in combination.

The tunnel may have to be designed for operation internal pressure with no backfill to be in position. This shall be determined later.

n) Temporary Construction Loads

Relevant construction loads shall be fully considered in the design of all structures.

3.01.00 **Stability of Structures**

a) The minimum factors of safety against overturning, sliding and hydrostatic uplift shall be 1.5, 1.5 and 1.25 respectively.

b) Stability of structures will be investigated for loading conditions during construction. Lower factors of safety will be used for construction loading conditions.

However, the factors of safety given in relevant IS codes shall also be taken care of.

Design criteria for Coal Handling structures

The following minimum live loads shall be adopted for design of buildings / structures :

a)	Flat Floor	:	Accessible roof - 250 Kg/m^2 (150 Kg/m^2 for L.L. & 100 Kg/m^2 for dust load) Inaccessible roof - 175 Kg/m^2 (75 Kg/m^2 for L.L. & 100 Kg/m^2 for dust load)
b)	Inclined roof (including roof of Canopy. Galleries)	:	As per IS-875 for live load plus 50 Kg/m^2 for dust load
c)	All building floors & stairs	:	500 Kg/m^2

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d)	Toilet rooms	:	200 Kg/m^2
e)	Walkways of Conv. Galleries	:	500 Kg/m^2 or a concentrated load of 300 Kg at centre whichever is critical
f)	M.C.C. Floor	:	1000 Kg/m^2
g)	Equipment Load	:	As applicable
h)	Tunnels under road, culverts: & its allied structures including hume pipes		Class 'A' or Class '7OR' as per IRC standard whichever is higher or load due to bulldozers
i)	Underground basement, tunnel, trenches etc.	:	A surcharge pressure of 2.0 T/ m^2 in addition to other loads e.g. earth and water pressure etc.
j)	Covers for channel	:	As per Cl. No. 3.02.0 (i) above of this section.
k)	Channels at road crossing to entry to building	:	-Do-
l)	Reclaim Hopper / Tunnel & Tunnels Crushed Coal storage area	:	The loading shall be highest of the following : i) Two bulldozers (maximum capacity indigenously available) operating side without any coal heap over reclaim tunnel and surroundings and uncrushed coal storage areas. ii) Two bulldozers operating side by side over a coal hip of 4.0M.
m)	Rail loads	:	As per I.R.S. including latest amendments.
n)	Other loads	:	As per IS-875 or as decided by the Engineer.
o)	Seismic Loads	:	7 Degree seismic intensity will adopt for structural design as per Chinese code. For design purpose the values as per IS-1893 (Latest Edition) shall be considered. Importance factors for all buildings shall be considered as 1.50. In addition, provision contained in IS:4326 shall also be considered.
p)	Wind Load	:	Wind pressure of 0.5 kPa shall be adopted for structural design as per Chinese code.
q)	Monorail / Hoists etc.	:	An impact factor of 1.10 shall be

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considered in design.

For EOT crane : Impact factor for vertical loads shall be 1.25.

r) Rainfall Data : Intensity of rainfall shall be considered as 80 mm/hr or as per meteorological data and the same shall be approved by the Owner/ Consultants.

s) Under ground drainage : Proper drainage system shall be provided in the coal stock yard with prior approval from the Owner.

4.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES

a) Reinforced Concrete Structures shall be established in accordance with the requirements of IS-456 & IS-875 for all possible combination of loads, e.g. dead load, live load, equipment load, crane loads, wind or seismic loads, soil loads and surcharge loads.

b) The min. grade of concrete shall be provided as per Table 5 of IS - 456.

i) M-20 : Structural Concrete - Standard for pavement around building including that for plinth protection work.

ii) M-25 : Structural Concrete - Standard for foundation and Superstructure unless a higher grade is required from specific design consideration.

iii) M-35 : Special Concrete Structures , TG pedestal etc.

iv) M-10 : Mud mat.

v) M-7.5 : Fill Concrete.

c) Reinforcing bars will be as per IS-432 (Grade-I) for Mild Steel and as per IS-1786 for High Strength Deformed bars. Usage of steel from the manufacturers SAIL, TISCO or RINL shall only be permitted.

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d) The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456.

e) Concrete tanks/water retaining structures will be designed in accordance with the recommendation of IS-3370. Reinforcing steel will be arranged to control shrinkage cracks.

f) The chimneys will be of reinforced concrete structure with steel flues. Height of chimney shall be 275.00 M. Flue shall be supported from top platform and restrains shall be provided at intermediate levels (at interval of not more than 40m). All internal platforms, supporting liners, shall be supported on R.C.C. shell of the chimney. Access doors at grade level and external platform levels shall be provided for access into the shell at finished grade level and for access to external platforms. The clean out doors shall also be provided in the steel liners. The platform structures shall be painted for acid and heat protection. Apart from aviation warning light the top fifty metres of the external surface of the wind shield shall be painted in alternate band of red and white colour and in line with aviation requirements. This paint shall have acid and heat resisting properties. The chimney roof slab shall be of reinforced concrete treated for water proofing and protected by a layer of acid resistant tiles laid in acid resistant mortar. Suitable personnel access door and truck entry door shall be provided. A personnel access hatch In the roof slab, liner hatches, rainwater drainage system, flue acid drainage system bird screens/louvres on ventilation openings shall also be provided. There will be structural steel internal stairways for access to platforms and upto top of chimney. Arrangement shall be provided for measuring concentration of particulate matters, NOx and SOx in the flue gas for monitoring and taking necessary measure for pollution control. It will also have necessary arrangement for earthing. Natural Ventilation System will be provided to keep inside of chimney free from flue gas. Stack elevator will be provided to run along inside surface of windshield. Contractor to provide suitably lighting arrestor, aviation lighting provision on chimney according to ICAO regulations/requirements. Owner to carry out Wind tunnel test and results shall be shared with the Contractor for consideration in the Design of Chimney. Contractor shall be invited to witness the wind tunnel test.

If Contractor designs the Chimney as per Chinese code, the Contractor should ensure that it is equivalent to or more stringent than IS 4998(Part 1):1992. Chimney shall also be analyzed as per ACI 307. Finally the Chimney shall be designed for worst response under the wind load resulting from all the above methods.

4.01.00 **Additional design criteria for structures in CHP Area**

The contractor shall have to consider the following design criteria during design of structures in CHP area in addition to other design parameter mentioned elsewhere in this specification.

a) All underground R.C.C. basements like structures with provision of water proofing treatment including Tunnels subjected to subsoil/liquid pressure shall be designed as per IS-456. Similar structures without water proofing treatment shall be designed as with limited crack width of 0.1mm section as per IS-3370.

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All structures under the influence of Railway load shall be designed strictly in accordance with stipulations contained in Indian Railways Bridge Rules & relevant codes.

b) The underground walls/raft of basement/tunnel shall be designed adopting sound engineering practice. The minimum thickness of various components shall be as follows irrespective of method of design adopted:

Wall of depth from	0 - 5 m	:	300 mm
Wall of depth from	5 - 10 m	:	500 mm
Wall of depth from	10 - 15 m	:	700 mm
Base Slab of u/g basement and roof of tunnel		:	500 mm

c) Dispersion of loads (arising out either of Railway load, Dozer load surcharge or any other load) through soil and coal shall be considered 2 vertical : 1 horizontal or 1 vertical : 1 horizontal whichever is critical.

d) For design of R.C. structures, bulk density and angle of repose for coal shall be considered as 1.0 MT/Cu.M and 30 Deg. respectively.

e) For deep underground structures, minimum clear cover for outer reinforcement shall be 40 mm unless otherwise stated.

f) Wherever deemed necessary, stipulations of ACI, AISC and British Codes shall be used in the design as per direction of Engineer as a supplement to IS Codes.

g) All hoppers shall be designed under the following load conditions:

i) The hopper is full up to it's full capacity with top surface horizontal at grating level.

ii) The hopper is partially empty with the highest level of coal at grating level and making an angle of 37 Deg. with horizontal.

The above conditions are to be analysed for the case where the whole content of coal within the hopper is supported by the hopper only without taking support from paddle feeder platform (in case of Track Hoppers).

The hopper shall also be designed for lateral coal pressure, frictional forces during filling and emptying and forces due to impact and falling of arches of coal within the hopper etc.

h) The crusher foundation shall be R.C.C. analysed both for static and dynamic load condition as per IS: 2974. The top deck shall be minimum 1.0 m thick. The amplitude of vibration under normal running condition shall not exceed 100 Micron and under 2 (two)

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missing hammer condition or severe maintenance condition (whichever is critical) shall be limited to 200 Micron.

The Crusher Foundation may also be supported on suitable heavy duty vibration isolators having viscous dampers supported on building steel frame. The top RCC deck in such case also shall not be less than 1.0 M.

4.02.00 **Induced Draught Cooling Towers (IDCT)**

Cooling tower basin shall be designed as with limited crack width of 0.2 mm section in accordance with IS-3370. Super-structure of cooling tower coming in contact with water/water vapour shall be designed with limited crack width of 0.2 mm and with reduced stresses in reinforcement as per relevant IS codes.

5.00.00 **FOUNDATION DESIGN**

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456.

Structural concrete for foundation work shall be M-25, unless a higher grade is required from specific design consideration.

5.01.00 **Foundations (For Main Plant Structures)**

Foundations for the main plant structures are those for Power House building columns, Boiler and ESP columns, Bunker columns, R.C.C. Chimney etc. The columns for above structures, except for chimney, shall be of structural steel. Top of RCC foundation for the steel columns shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. The column base as well as the column sections up to 150 mm above finished floor level shall be encased in concrete. Foundation levels of some columns will have to be suitably lowered to accommodate underground services, pits, trenches, etc.

Foundation for Chimney shall be circular in shape and designed to resist forces and moments, caused by vertical loads and by wind or seismic loads, based on static and dynamic analysis done for these structures. The foundation sections shall be sized and reinforced adequately for circumferential and radial moments and shear stresses.

5.02.00 **Heavy Equipment Foundations**

Loadings (both static and dynamic) of major equipments such as turbine-generator, boiler feed pumps, PA, FD & ID fans, coal mill, coal crushers etc. are to be obtained from the manufacturer's certified drawings of the specified equipment. Where design of structures supporting minor equipment other than

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those included above must proceed but the exact load data is not available, the loadings will be estimated from similar jobs or catalog data.

For static and dynamic analysis of machine foundation following data will be furnished by the equipment manufacturer.

a) Loading diagram showing static and dynamic loads and points of application of loads.

b) Operating speed of m/c.

c) Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.

d) Location of C.G. of machines in all three axes.

e) Mass Moment of Inertia.

f) Allowable amplitude/velocity of vibration at machine bearing points.

g) Temperatures in various areas during operation.

Design of foundations for major equipments shall be done in accordance with relevant parts of IS-2974. While designing following aspects shall also be taken care of.

i) The turbine generator, crusher and large fan foundations will be isolated from adjacent structures for vibration control.

ii) The turbine generator pedestals will be designed to meet the manufacturer's deflection criteria and other recommendations.

iii) Natural frequencies of structures and components shall be away from the running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. For design of foundation of large fans etc. provision shall be kept in the foundation for addition of mass/area for retuning of the foundations, if required at a later date.

Contractor shall provide foundation isolation procedures but shall not provide viscous dampers.

Detailed static and dynamic analysis shall be carried out for all other equipment foundations. The static analysis shall include all operating conditions load cases and abnormal loads like short circuit and seismic forces. Unbalance loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more conservative shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. Transient analysis shall be carried out for the short circuit condition with an appropriate force function. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall be

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satisfied. RCC design shall be done by the working stress method for all machine foundations (Limit state design method may be accepted as an option, subject to Owners approval). A fatigue factor of 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS: 2974 as well as IS: 456. However minimum reinforcement in bottom face of the foundation raft resting on soil or pile shall not be less than 0.2% of effective cross sectional area of the raft. The minimum grade of concrete for TG foundation shall be M35.

In case steel helical springs are provided, the foundation arrangement shall be such that the spring units are located above the finished floor level by at least 200mm. The isolation efficiency of the foundation system comprising RCC deck and steel helical springs shall be at least 90%. The ratio of actual spring supported weight to the nominal spring capacity shall be at least 0.80. At least 3% to 5% of critical damping shall be provided in the form of viscous dampers.

The special requirements for concreting including grade, type of aggregate, use of admixture, temperature control, ultrasonic testing, etc., shall be as mentioned elsewhere in this specification.

All block foundations supporting rotating equipment resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer, whichever, is more stringent shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. Minimum Reinforcement in base raft in either direction shall be as follows:

i)	At bottom face	- 0.2% of gross cross-sectional area
ii)	At top face	- 0.12% of gross cross-sectional area

For the foundations supporting minor rotating equipment weighing less than one tonne or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.

Codes and Standards

Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below:

DIN : 4024	Machine foundations: Flexible supporting structures for machine with rotating masses.
DIN : 2089	Helical compression springs out of round wire and rod : calculation & design.

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DIN : 2096	Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.
VDI : 2056	Criteria for assessing mechanical vibrations of machine.
VDI : 2060	Criteria for assessing the state of balance of rotating rigid bodies.

5.03.00 **Switchyard Foundations**

Foundations shall be designed for the worst combinations of dead loads, live loads, forces due to wind/seismic, other relevant loading from service conditions, forces and moments caused by broken wire condition and loadings, due to thermal effects wherever applicable. The design of foundations and all R.C.C. trenches shall be carried out in accordance with the latest relevant IS codes and specifications.

Factor of safety against uplift in the design of foundations shall be 2.0 for normal and broken wire conditions and 1.5 for short circuit conditions, as is the normal practice.

6.00.00 **ROADS**

Geometric design of road shall be done in accordance with Indian Road Congress Standard IRC-73. The ruling gradient for roads in longitudinal direction shall be 1 in 20. Normally roads shall have much flatter gradient. Transverse camber of 1 in 40 shall be provided.

A detailed CBR test shall be carried out as per the procedure outlined in IS-2720 (Part-XVI). CBR test shall be carried out in remoulded soil samples under soaked condition.

Shoulders shall have sufficient load bearing capacity to support loaded trucks. A slope of 1 in 30 shall be provided on shoulders.

Concrete Approach Road from NH-200 to the Power Plant Main Gate having an approximate length of 600 m shall have carriageway width of 14.00 m with 1.00 m wide shoulder on either side and RCC covered storm water surface drain on both the sides. The concrete roads within the plant area shall be so laid out as to provide access to all the plant buildings and facilities. The major plant roads shall be 7.00 (seven) M wide. Double lane road of width 7.0 M shall have 1.5 M wide Shoulder on the either side of the road. Single lane road shall be of 4.0 M width with 1.0 M Shoulder on the either side of the road.

An Asphalt Service and Maintenance road having a carriage width of 4.00 M shall be provided through a separate gate on plant boundary, alongside the ash slurry pipe line up to the ash dump area.

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Pipe, slab culverts, or RCC box culverts, as suitable, shall be provided at road crossings for drainage, LP pipes, Ash pipes, cable trenches etc.. All culverts shall be designed for IRC class "AA" loading and checked for class A loading.

7.00.0 CIVIL DESIGN PARAMETERS AND DESIGN SOFTWARE

1) No increment in allowable bearing capacity is permitted for design of Chimney foundation.
2) 33% increment in allowable bearing capacity is permitted for structures where wind load is not predominant.
3) Turbine generator deck slab , foundation slab, chimney foundation shall be cast with concrete having temperature not more than 23^{o}C. This is needed to ensure minimum temperature cracks due to heat of hydration.
4) Clear cover to reinforcement of the concrete members should as per IS:456.
5) The limits of amplitude of vibration for machine foundation shall be as per VDI-2056 in absence of machine manufacturer recommendation.
6) Structural steel shall be used for pipe/cable racks and coal conveyor trestle/galleries and transfer tower shall also be in structural steel.
7) Software used in analysis of Power house structure and equipment foundation shall be internationally recognized and available such as STAAD Pro, SAP, ANSYS, etc.

8.00.00 ASH POND DESIGN CRITERIA

The embankment shall be designed to be stable under conditions to which they may be subjected, including external vertical loads, lateral loads, water pressure, seepage and draw down and seismic effects, for ultimate height of dyke. Any deviations shall be limited to the attached drawing. The Ash dyke shall be divided in to two parts for bottom ash and the Fly ash of capacity as defined in 15 / L of vol. 2, Section IV of Scope of Works and Terminal Points. . Contractor shall Design and Construct the Ash Dyke in the area adjoining the Main Plant and make provision for future expansion towards the West Side.

The upstream and downstream slopes of embankment shall be stable against the most adverse condition to which they can be subjected. The stability analysis shall be done for the most critical combination of external forces for different conditions as envisaged in IS : 7894.

There shall be no danger of over topping of earthen embankment. To ensure this, sufficient spillway capacity and adequate net Free Board shall be provided. In the Free Board, allowance shall be kept for long-term settlement of the embankment and foundation and surface waves which may form on the pond surface due to wind action.

Minimum free board shall be 1.5 M in storage lagoon as well as over flow lagoon. However, minimum water cover over the ash deposit shall be maintained to prevent fugitive dust pollution from ash ponds.

There shall not be 'sloughing' of d/s slop of embankment. The phreatic surface shall not meet the d/s face of embankment. To achieve this, adequate internal

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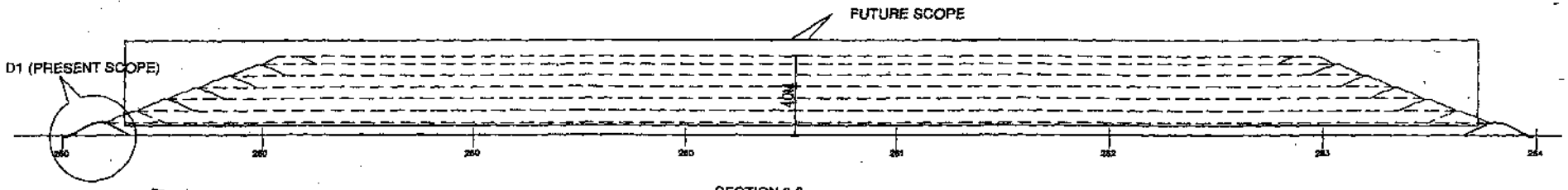

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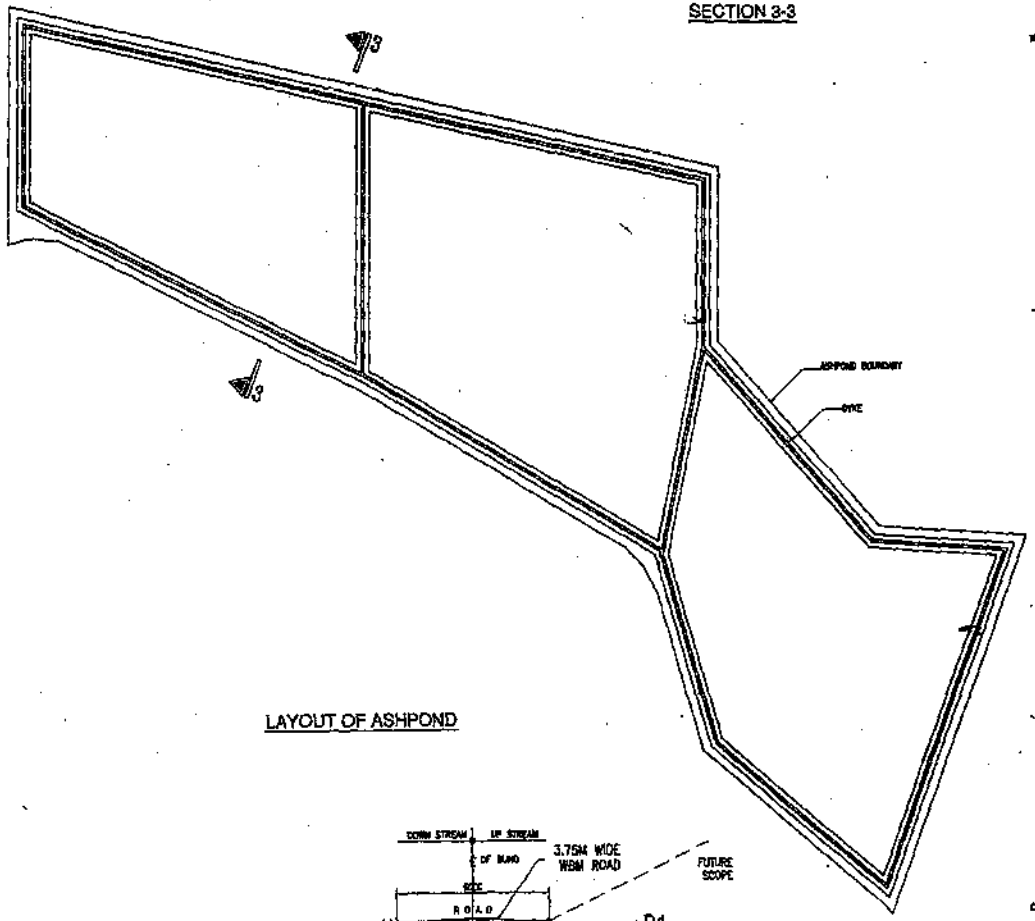
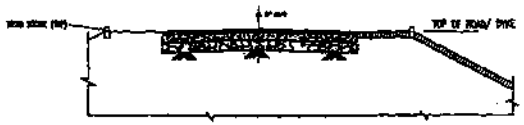


LAYOUT OF ASHPOND



TYPICAL
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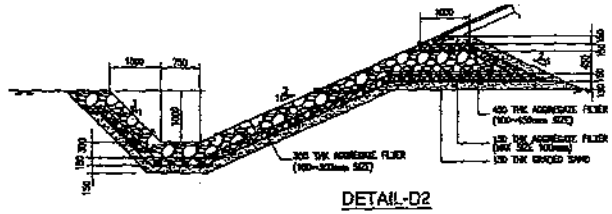
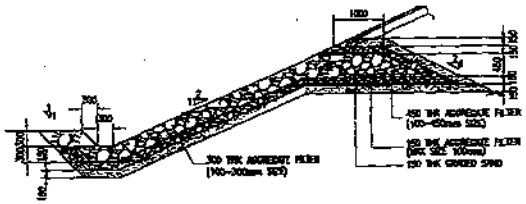
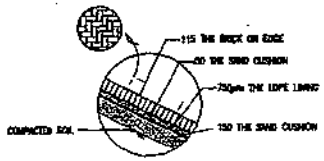


DETAIL-D2
(AT END POINT)

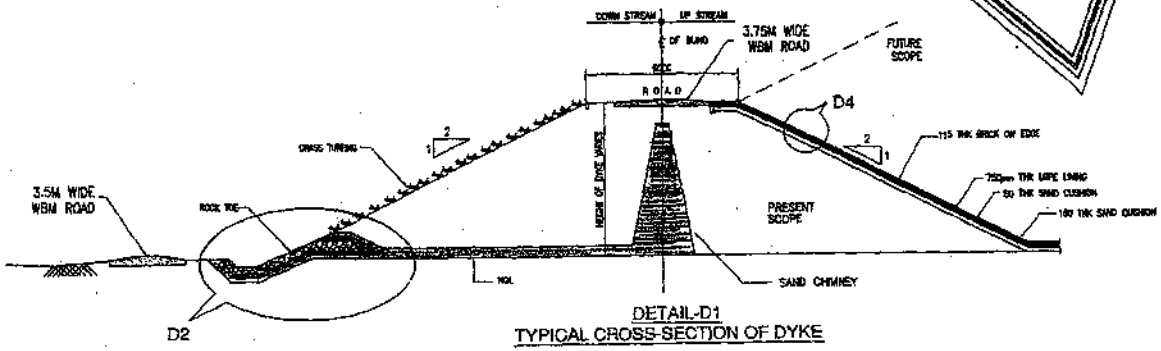


DETAIL-D2
(AT STARTING POINT)

NOTES:



DETAIL-D4



DETAIL-D1
TYPICAL CROSS-SECTION OF DYKE

attachment drawing

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drainage arrangement shall be provided in the form of vertical sand chimney and sand blanket of not less than 0.5 meter thickness and rock toe of minimum height one meter. Graded filter layers shall be provided between earth and rock toe, to avoid erosion of earth materials.

The embankment shall be safe against failure due to piping. The embankment shall be designed so as to keep the exit gradient less than 1 / 7. The exit gradient shall be calculated by drawing flow nets.

Both u/s and d/s slopes shall be properly protected against waves action and rain cuts.

The cross-section of embankment shall be designed for the most critical conditions. However, the following minimum requirements shall be adhered to :

a) Top width – Minimum 6 Metre.

b) Side Slopes – u/s and d/s not steeper than 2 Horizontal to 1 Vertical.

c) Free Board – Minimum 1.5 Metres.

d) Internal Drainage

(i) Sand Chimney – Min. 0.5 m thick upto one metre below dyke top.
(ii) Horizontal Sand Blanket – Min. 0.5 m thick connecting sand chimney with rock toe.
(iii) Rock Toe – Min. 1 m high and 1 metre wide at top, with side slopes of 1.5 horizontal to 1 vertical minimum.

e) Berms for every 5 metre height with minimum 3 meter width on upstream and downstream.

f) Slope Protection

i) Downstream Slope

Hand placed stone Rip-rap of minimum 300 mm thickness with graded filters below (Minimum 150 mm thick graded aggregates and min. 150 mm thick graded sand) the level 1 metre above HFL. Above the level one metre above HFL, turfing with turf sods. If the wave height is more than 1.0 metre higher thickness of rip-rap shall be provided in accordance with IS : 8237.

ii) Upstream Slope

Minimum 75 mm thick dry brick lining for the top 3 m height of dyke confined with brick masonry panel walls, at about 5 m c/c. The panel walls shall be properly anchored into the earthen dyke. Proper seating shall be provided at the bottom of the lining, adequately anchored into the dyke.

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g) Toe-Drain

A brick lined toe drain shall be provided all-round the dyke to drain out the seepage water from dyke and the rain water to the nearest natural water channel. This drain shall have a minimum bottom width of 300 mm and minimum depth of 300 mm with suitable bed slope for efficient drainage.

h) The lagoon shall be provided with 750 Microns thick LDPE lining of approved make.

i) Capacity of lagoon shall be based upon
   1. Life of plant.
   2. Rate of ash production per day.
   3. Concentration of ash slurry.

8.02.00 **WATER ESCAPE STRUCTURE**

The decanted water as well as the rain water collected in lagoon shall be over flown into the water escape structure. The water escape structure shall be made up of RCC. The size of the well shall be fixed in such a way that adequate length of spillway is available in order to limit the heading up of water over the well to 10 cm, during maximum slurry inflow into the lagoon. The size of well and the outflow pipes shall be fixed in such a way so as to have not more than 0.5 metre heading up of water in the lagoon considering rain storm of maximum rainfall intensity, recorded in the past 50 years period. The rainfall data shall be collected by the Contractor from the concerned Meterological Authorities.

The location of water escape structure shall be fixed at about 5 meters from the upstream toe of the ultimate stage dyke raising, so that the structure can be progressively raised commensurate with the dyke raising programme. The water escape structure shall be designed considering the ultimate level and ash slurry/water/ash load up to ultimate level, though the construction under the present scope will be limited to the level required for starter dyke.

Access shall be provided to the bottom of water escape structure through suitable rungs embedded in the wall.

For discharging of water from the water escape structure to the overflow lagoon, an RCC pipe drain of minimum internal diameter of 1000 mm and class NP_4 shall be provided. Suitable outer RCC lining of minimum 150 mm thickness shall be provided, to take care of the superimposed loads from the earth filling / ash filling upto the ultimate dyke/ash fill level for full length of the pipe. For preventing the erosion of materials from the dyke due to any seepage, suitable cut off collars (minimum of 3 numbers) shall be provided around the pipe. These cut off collars shall be of bentonite earth mixture in 1:1 proportion. The projections of the cut off collars from the external surface of the RCC lining shall be minimum 1000 mm and the thickness of cut off collars shall be minimum 500 mm.

The pipe shall have suitable gradient for efficient drainage of effluent into the overflow lagoon. The invert level of the pipe at the over flow lagoon shall be kept

at about 0.25 metre above the maximum water level in the over flow lagoon. Provision for steel stop logs in the Water escape structure shall be kept, in order to lower water level upto 2 metre depth in case of some emergency. The discharge capacity of the stop logs openings shall not be less than the maximum discharge possible through the pipes.

8.03.00 **FACTOR OF SAFETY**

The following factor of safety shall be followed in design.

I) Against normal operation condition – 1.5
ii) Against construction condition -1.3
iii) Against Earthquake – 1.0

8.04.00 **DESIGN SOFTWARE**

Design software used for the designing shall be GEO STUDIO-2004 from GEO-SLOPE INTERNATIONAL LTD of Canada.

C DESIGN REQUIREMENT [STRUCTURAL]

C 1.00.00 STRUCTURAL STEEL DESIGN

a) Structural steel design will be carried out as per the National Building Code with specific consultation to IS-800 unless noted otherwise. Design of structures in electrical substation will be as per IS-802.

b) Lateral forces along the length of the building will be resisted by bracings in horizontal and vertical frames. The transverse lateral load will be resisted by bracings action. Frame bracing will be used to assure stability of the structures.

c) Steel will conform to Grade-A of IS-2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness and welded construction steel conforming to Grade-B (killed) of IS-2062 shall be used except for crane girders where Grade-C (IS-2062) steel shall be used.

d) Shop connections will be all welded and field connections will generally be bolted unless specified otherwise. Field bolts, wherever provided shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 as per IS-1367 for all major connections. The bolted joints shall be designed for friction type connection and the H.T. bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams etc. will be done by 16 mm dia. M.S. black bolts conforming to IS-1363.

e) Welding shall be in accordance with the recommendations of IS-816 - Code of Practice for use of metal arc welding for general construction in mild steel and IS-9595 - Recommendation for Metal Arc Welding of Carbon and Carbon Manganese Steels. Built-up members will be fabricated using submerged arc welding procedure. All butt welds in

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plate girders and columns will be full penetration. All butt welds will be radiographically or ultrasonically tested as per relevant IS codes and standard practice. The bare wire electrodes for submerged arc welding shall conform to IS-7280. The combination of wire and flux shall satisfy requirement of IS-3613.

f) All structural steel members for Switchyard Structures shall be hot dip galvanised in accordance with IS-4759. The fasteners shall also be galvanised in terms of IS-5358. Galvanizing of steel structure shall be done after all fabrication work is completed. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts and nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS-1573. All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS-2633.

g) The painting system shall be appropriate to provide required protection to the steel structures against sea-coastal corrosive environment. The shop paint may be epoxy resin based zinc rich primer (DFT-50 Microns) such as "Epilac zinc Rich Primer" of Jenson & Nicholson (India) Ltd, or equivalent applied thoroughly and evenly to dry surfaces, which have been cleaned by sand blasting to SA 2½ grade minimum. The finish paint may be two coats (each of DFT 25 microns) of approved shade of chlorinated rubber paint such as "Jensolac Chlorinated Rubber Paint" of Jenson & Nicholson (India) Ltd, or equivalent. If the painting is done at site, shot blasting / sand blasting shall be done at site as per norms (norms shall be defined) and statutory requirements/ regulations shall be met with.

C 2.00.00 LOADS

Loads as defined under Clause 3.00.00 of Section-II: Specific Design Requirement (Civil) will be applicable. In addition following shall be considered.

a) **Elevator Loads**

Elevator support systems shall be designed to accommodate the capacity load of the elevator plus the weight of the cab and accessories.

b) **Coal and Coal Bunker Loads**

Coal Weight : 0.8 T/Cu.m for Storage volume calculation.

: 1.0 T/Cu.m for load calculation.

Angle of internal friction = 30 Deg.

C 3.00.00 STEEL FRAMED STRUCTURES

Steel Framed Structures will be analysed for all load combinations as stated hereinafter, definitions of Dead and Live loads for this purpose are :

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a) Dead Loads : Weight of building components and all permanent equipment.

b) Live Loads : Assigned design gravity loads used to represent moving loads, maintenance or construction loads with equipments disassembled as given in B. SPECIFIC DESIGN REQUIREMENT (CIVIL) for different floors of buildings.

While designing consideration shall be given to the following load combinations:

i) DL + LL + Equip

ii) DL + LL + Equip + Cb + CtLA± CS

iii) DL + LL + Equip + Cb + CtLB± CS

iv) DL ± EL (for DL only)

v) DL ± WL1

vi) DL ± WL2

vii) 0.75 (DL + LL* + Equip + Cb + Ct± EL)
(* Appropriate portion of LL which is considered for working out EL shall only be taken)

viii) 0.75 [DL+LL+ Equip + Cb + CtL1 ± (CS1+WL1)]

ix) 0.75 [DL+LL+ Equip + Cb + CtL1 ± (CS1+WL2)]

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

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WL1 = Wind load with internal suction of 0.2P, left to right

WL2 = Wind load with internal suction of 0.2P, right to left

EL = Earthquake load

Appropriate allowable increase in permissible stresses as per IS codes, may be taken except where as per above load combinations load factors are used.

The above load combination is based on the assumption that thermal stresses can be demonstrated to be negligible. Otherwise appropriate thermal stress increase shall be included for further worst combination.

C 4.00.00 SWITCHYARD STRUCTURES

Structures shall be provided to carry all conductors, insulators, isolating switches, circuit breakers and other items of switchyard included in the contract. Facilities shall also be provided for the termination of the incoming overhead transmission lines.

Steel for all switchyard structures, towers and gantries shall be hot dip galvanized. The structures shall be designed to ensure that the specified minimum phase, earth and erection clearances are maintained under all conditions. The strength and rigidity of the structures shall be such that the alignment of the apparatus which they carry shall not be affected by the static and dynamic loads the structures are subjected to.

Towers and gantries shall be designed for both normal and broken wire conditions as per latest IS: 802 [Part-1]. The sequence of applying tension during stringing shall also be taken care of in the design of structures.

Wind pressure on towers, gantries, conductors, insulators, strings and other similar structures shall be worked out considering IS: 802 [Part-1].

Switchyard structures shall be designed to withstand the worst combination of dead loads, service loads, wind induced loads or seismic loads, thermal stresses, and any other special loads like short circuit force etc. Permissible stresses for various steel towers shall be guided by latest IS: 802 [Part-1] stipulations.

When calculated deflections, under all permanent loads of any part of a structure, exceeds 6 mm or 1/220 of the span, whichever is less, a reverse camber equal to 1.5 times the calculated deflection shall be built into the unloaded structure.

C 5.00.00 PIPE AND CABLE RACK STRUCTURES

The pipe and cable rack structures shall accommodate the pipes/cables with proper access and adequate working space for erection and maintenance. These shall be designed to carry safely all the loads acting on them (DL, LL, WL, EQL, forces from pipe lines etc.). The structures shall be adequately rigid to carry the

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forces from the pipelines at anchor points without undue deflection so that the pipelines are really anchored at the anchor points.

C 6.00.00 STRUCTURES IN COAL HANDLING AREA

Steel structures shall be designed as per I.S-800. Deflection limits of structures shall be as per I.S-11592 (code of practice for selection of and design of belt conveyor).

C 7.00.00 WATER ESCAPE STRUCTURE AND ASH DYKE

Plot Plan indicates the total area identified for storage of Fly ash for 5 years (considering 50% utilization) & Bottom ash for 25 years. As Contractor has contracted for constructing Ash Dyke for one third of the ash volumes in one third of the identified area, SEPCO shall design the Ash Dyke accordingly with suitable depth below natural ground level (if necessary) and water escape structure shall be constructed matching with that depth.

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D)

SPECIFIC DESIGN REQUIREMENT FOR ARCHITECTURAL WORKS

1.00.00 GENERAL :

The architectural services shall cover finishing work of power house and all auxiliary buildings such as brick work, partition walls, roof waterproofing treatment, finishing of walls, floors and ceilings, fixing of doors, windows and hand railings, false ceiling, false flooring as required, potable water system, drainage and sanitation.

2.00.00 DESIGN REQUIREMENTS :

2.01.00 The contractor shall develop the final architectural layout of all the buildings as per the final approved equipment disposition and other layout considerations. These drawings shall need the approval of the Owner before construction. The contractor shall also have to submit perspective views if so desired by the Owner. Approval from statutory authorities, e.g. Factories Inspector, Explosive Inspector, Tariff Advisory Committee etc. shall be the responsibility of the contractor without any obligation to the Owner.

2.02.00 Architectural concepts of structures shall offer its own identity and will be aesthetically blended to give pleasing appearance. Functional needs of each building will be maintained but without entailing expensive architectural treatment. Special attention will be given to architecture of powerhouse and other important buildings. Contractor shall develop the architectural treatment of main entrance, compound wall, elevations of Admin. building, STG building which shall be to the satisfaction of the owner and shall be approved by the owner.

2.03.00 Generally flat R.C.C. roof with steel / RCC frame structure shall be provided for plant and other buildings. Cladding and partition walls shall be brickwork with cement, sand mortar, Cast-in-situ / Pre-cast R.C.C. roof slab covered with built-up waterproofing shall be provided. All air-conditioned areas like control rooms, administrative building shall be provided with false ceiling.

2.04.00 Facilities in building :

Facilities in each building will be developed on the basis of functional requirements. Circulation and safety will be considered in each case.

2.05.00 External and Internal Brick Work :

Generally 230 / 250 mm thick brick masonry using well burnt bricks or fly ash bricks (as decided by WPCPL during detailed engineering)in cement sand mortar 1:4 shall be used in all masonry structures 345 mm thick brick masonry using well burnt bricks in cement sand mortar 1:4 shall be provided in main power house transformer side wall and also between transformers.

2.06.00 Partition Wall :

Generally half brick thick brick wall in cement, sand mortar 1:4 with 2 nos. 8 mm diameter bars at every fourth layer shall be used in toilets. Glazed partition wall shall be provided for operator's cubicles so that clear view of the operating equipment is available. Vacuum sealed double glazing with suitable aluminum sections shall be provided between control room and turbine bay along the complete length of control room enabling operators to have a clear view of the STG.

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2.07.00 Anti - Termite Treatment :

Anti - termite treatment shall be done with insecticidal emulsion at the rate of 5 litres / m^2 as per IS : 6313 (Part – II) 1981 for all structures. Anti weed treatment shall be provided in the switchyard.

2.08.00 Damp Proof Course :

40 mm thick 1:2:4 plain cement concrete with one coat of hot bitumen (grade 80 / 100) conforming to IS : 73 shall be applied at 1.7 Kg / m^2 to all external brickwork at the plinth level in all structures.

2.09.00 Plastering :

a)	Internal	:	12 mm thick 1:4 Cement : Sand Plaster with neeru finish in 2 coats to all internal surfaces
b)	External	:	18 mm thick 1:4 Cement : Sand plaster to be laid in two courses to all external surfaces.
c)	Plaster of Paris Punning	:	2 mm thick plaster of paris punning shall be provided over internal plaster to all air conditioned areas and control rooms.

2.10.00 Floor Finish And Skirting :

a) Generally finish will be 40 mm thick heavy duty patent stone with ironite topping or equivalent on concrete slab. 125 mm high plain machine pressed cement tile skirting shall be provided.

b) For T.G. Operating floor finish will be Polished Granite Stone flooring. 125 mm high matching skirting tiles shall be provided.

c) For battery room, battery charger room, chemical laboratories, chlorination room etc. handling corrosive liquids, 40 mm thick acid and alkali proof tiles will be set with acid and alkali proof epoxy mortar under bed. Silica based epoxy mortar which is chemical resistant shall be used for dado upto 1. 5 m above floor level.

d) All areas of toilet, including W.C. and urinal shall have ceramic tile (matt finish) floor and Dado shall have glazed ceramic tiles of minimum 6 mm thickness up to 2200 mm height from floor level.

e) If the separate cable cellar is not provided for control cables, Control room of power house shall have 600 mm high false flooring with pedestals, stringer beams and floor panels made of high density particle board fully encapsulated with G.I. sheet of size 600 x 600 x 35 mm thick, top finished with 2mm thick antistatic vinyl tile flooring. False Floor shall be capable of withstanding 450 Kg point load and 1350 kg/sq.m. UDL. 2 mm thick 150 mm high PVC tile skirting shall be provided.

f) Floor / Staircase in areas prone to slippage due to oil spillage etc. shall be provided with anti-skid floor finish like brush-wash and chequered finish.

g) 1000 mm wide and 100mm thick PCC grade M-20 for plinth protection shall be provided all-round the buildings. The plinth protection shall be laid over well-compacted soil and base formed with stone/gravel of rubble for a thickness of 150mm.

h) Risers and treads of concrete staircase shall be provided with vitreous tile with matt finish or anti-skid tiles in white cement in general. Staircase upto Control room shall have polished granite stone finish.

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i) Office areas shall be provided with class 1 Vitrified tiles, make, shade and quality shall be approved by Owner.

2.11.00 Doors, Windows and Ventilators :

a) Doors shall be steel doors consisting of 40 mm thick 16 gauge double plated hollow flush door shutters with 18 gauge pressed steel door frame and shall be provided for plant and utility areas. The cavity shall be filled with mineral wool / glass wool insulation.

b) Fire proof doors shall be provided on division walls of cable spreader rooms and at all fire exit points as per recommendation of Tariff Advisory Committee. These shall be as per IS : 3614. Fire resistance grade of the doors shall be as per TAC requirements. However, minimum fire resistance grade shall be for 2 (two) hours.

c) Doors of control room, control equipment room, computer room, etc. shall be aluminum glazed doors. For control room, control equipment room, etc. glazed partitions with aluminum frame shall be provided between air-conditioned and non-air-conditioned areas and on the side of control room facing the operating floor to have a clear view. Glazed panel with aluminum framework shall also be provided as partition between two air-conditioned areas where clear view is necessary. All aluminum sections used shall be powder coated.

d) Doors of W.C. and showers shall be FRP (fiber reinforced plastic) doors with powder coated aluminium frames.

e) All doors in plant and utility areas shall be fitted with extra heavy duty door closures as per IS : 3564. Glass vision panel shall be provided in doors as system requires.

f) All windows and ventilators of power house and other buildings shall be Powder Coated glazed Aluminum windows and ventilators conforming to IS: 1361 and IS: 1038. All steel sections used shall be powder coated.

g) All toilet windows shall be adjustable glazed louvers with powder coated aluminum frames.

h) Administrative building shall have powder coated glazed aluminum windows and fully glazed powder coated aluminum framed main entrance door.

2.12.00 Rolling Shutters :

Rolling shutters with suitable operating arrangement (manual, mechanical and / or electric) according to sizes shall be provided in buildings to facilitate handling and transportation of equipment. M.S. rolling shutters shall be made of 18 gauge steel laths and shall have grills for ventilation of where necessary. Shutters for openings that is more than 5 m in height shall be electrically operated.

2.13.00 Glazing :

a) Minimum thickness of glazing in windows shall be 4 mm.

b) Glazing in control room between AC and non-AC areas shall be with doubly glazed wall panels with 6 mm thick float glasses hermetically sealed with 12mm air gap in between.

c) 4 mm thick clear glass shall be provided for open able windows and 6 mm thick wired glass for fixed portion of high level windows.

d) 6 mm thick float glass shall be provided for glazed doors.

e) Vision panels in doors shall have 4 mm thick clear float glass.

f) 3 mm thick translucent glass louvers shall be provided in all toilet windows.

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2.14.00 Hand Railing :

a) Minimum 1000 mm high railing shall be provided in all staircases (Steel and Concrete), corridors and around floor and roof cutouts at all elevations.

b) 32 diameter G.I. pipe hand railing and posts shall be provided in all areas unless otherwise noted.

c) Removable type hand-railing shall be provided in areas like loading / unloading bay, equipment handling platforms etc.

e) For main staircase up to control room stainless steel hand railing and posts shall be provided.

2.15.00 Stairs :

a) All stairs shall have not more than twelve (12) risers in one flight. Height of risers shall be 160 mm (maximum) for concrete stairs and 175 mm (maximum) for steel stair, however comfort of user should be kept in mind in all the cases. Width of treads shall be 250 mm (minimum) in concrete as well as in steel stair cases. Minimum width of stairs for RCC shall be 1500 mm. Minimum width of steel be 1200 mm. However the Owner and Contractor shall review these requirements with reference to the guidelines laid by Tariff Advisory Committee and National Building Code during detailed engineering.

b) M. S. Angle nosing shall be provided for edge protection in RCC stairs. Main staircase up to control room shall have molded nosing in stone matching with tread.

c) Fire Escape RCC staircases shall be provided in Power House building between each turbine unit. The width of the staircases shall be as per 2.15.00 a requirements.

d) Fire escape stairs shall be provided of width 1000 mm in suitable location as per Fire Regulation Rules.

2.16.00 Ramps :

a) Ramps shall be provided in front of all ground floor rolling shutters.

b) Generally 1:8 slope shall be given to ramp, 1:6 slope being maximum allowable.

c) Ramps shall have neat cement finish with checkered pattern for anti-skid.

2.17.00 Lifts And Elevators :

a) Lifts shall be provided in Power House up to Main Control Room.

b) Lifts shall not be considered as fire exits.

2.18.00 False Ceiling :

a) Mineral based false ceiling fixed to Galvanized Steel suspension framework (snap grid system) and suspended from steel / R. C. beams shall be provided in all air-conditioned spaces shall be of Armstrong make with Prima dune premier 99 or superior make tiles).

b) Illumination and A.C. ventilation grills in these areas shall match with the overall aesthetics.

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c) Toilets, Pantry, Rest Rooms shall have gypsum or mineral type false ceiling to reduce the high ceiling heights.

d) False ceiling used shall have good impact resistance, durability, high humidity resistance, fire performance shall be in accordance to British Standards BS : 476 as well as aesthetics.

e) Acoustic non – woven tissue or PE wrapped mineral wool pads shall be laid over false ceiling tiles in Main Control room, Administrative areas where good acoustic is required.

2.19.00 Under Deck Insulation :

50 mm thick under deck insulation with best quality Expanded Polystyrene (TF thermocol) blocks shall be provided in Main Power Building.

2.20.00 Roof :

a) Roof of power house shall either be pre-cast RCC units placed over M.S. purlins or cast-in-situ RCC slab.

b) Roof of pump houses and other building shall be cast-in-situ RCC slab.

c) For efficient disposal of rain water, the run-off gradient for the roof shall not be less than 1 : 100.

2.21.00 Roof Water Proofing :

The RCC roof shall be provided with pre-fabricated APP (atactic polypropylene) modified waterproofing membrane with non woven polyester reinforcement treatment of 4 mm thickness consisting 160 gsm polyester core coated on both sides with APP modified bitumen and finally finished with thermo fusible film. The treatment shall be laid over a coat of bituminous primer @ 0.27 L / Sqm (IS: 3384). 18 mm thick cement sand mortar (1:4) with chicken wire mesh interposed shall be laid over waterproofing treatment. The roof shall be finished with 22 mm thick cement concrete tiles. Waterproofing-treatment shall be over 75 mm thick foam concrete. 12 mm thick uniform or varying 1:4 cement sand plaster shall be laid on top of foam concrete cast-in-situ after it is fully cured and dried for providing smooth surface for laying of water proofing treatment.

The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation on under bed. The contractor shall give guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for ten (10) years. The mode of execution of the guarantee shall have to be acceptable to the Owner.

2.22.00 Roof Drainage :

The system shall be provided for removal of rain water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following :

a) Roof Drain Heads.

b) Rain Water Down comers.

c) Fixtures.

IS-1742 Code of Practice for building drainage shall be followed for this purpose.

Multiple drains (min.2 nos.) shall be provided for all roof areas.

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System will be designed to handle rainfall at a rate of 75 mm per hour and in accordance with stipulations of IS-1742.

Cast Iron rain water down comers conforming to IS : 1230 or HDPE rain water down comers conforming to IS : 4984 with water tight lead joints or medium class galvanized mild steel pipes conforming to IS : 1239 / IS : 3589 shall be provided to drain off rain water from roof. The numbers and sizes of down comers shall be governed by IS : 1742 and IS : 2527

Any roof more than 8.0 meters above grade shall have access from within the building for cleaning of roof drains.

Roof drains will conduct water to storm sewers. Rainwater conductor will generally be run outside buildings and conducted away from the building to a water course.

2.23.00 Painting :

a) External masonry surfaces of all buildings and compound wall shall have decorative water proof cement paint, 'Apex of Asian Paints over a coat of primer.

b) Acrylic plastic emulsion paint shall be provided for control room, control equipment room, computer room, UPS room and air-conditioned areas including entrance lobby.

All other areas shall be provided with Oil Bound Distemper (available for internal use) and white wash.

Internal surface of walls of rooms for pumps, machineries and maintenance shall be painted with washable painting of dark shade up to a height of 1.5 m above floor level.

c) Battery room and all other areas subject to chemical corrosion shall be painted with acid / alkali resistant epoxy paint over a suitable primer from top of dado.

d) All ceiling shall be painted with the same paint which has been used for walls and which shall be of white color.

e) All internal doors, ventilators, louvers, rolling shutters shall have two coats of synthetic enamel paint over a coat of red oxide / zinc chromate primer conforming to IS: 2074.

f) All woodwork shall be painted with two coats of polyurethane paint over a coat of approved primer.

g) All fire exits shall be painted in post office red / signal red color shade, which shall not be used anywhere else except to indicate emergency or safety measures.

h) Oil resistant paint shall be provided in oil equipment room, oil canal, fuel oil pump house etc.

i) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.

j) Colour schemes for all buildings

2.24.00 Water Supply And Sanitation :

Potable Water System for various buildings shall be connected to the drinking water and service water systems.

System will satisfy state and local plumbing codes.

Roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building.

Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply.

Extra heavy cast iron pipes with lead joints shall be used for sanitary work below ground.

Heavy cast iron pipes with lead joints shall be used for sanitary work above ground level.

Toilets shall be provided near work areas, but isolated from main areas. Unless otherwise shown in drawings or specified, the dimension of the toilet blocks shall be decided by the number of sanitary fixtures, which shall be based on number of users in accordance with IS : 1172. Minimum 3 toilets (2 number gents toilet, 1number ladies toilet) in TG building (at ground and operating floor), one in WTP area and one in compressor house to be provided. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings shall have minimum one toilet block each.

One ladies toilet also to be provided at CCR operating floor.

Toilets shall be provided with all necessary approved Indian Standard fittings. The finished floor of toilet shall have a drop of 15 mm from general finished floor level and shall have sufficient slope towards trap. Sufficient natural light and ventilation shall be provided as per requirement. Unless specified each toilet shall be provided with minimum one W.C. (water closet), two urinal, one washbasin, towel rail, mirror and liquid soap dispenser, glass shelves etc. Western / Indian closets shall be provided as specified in the drawing. Bath room also will be provided in DM plant toilet. A pantry shall be provided in Service building. Sunken slab to be provided in toilet area in above floors and suitable water proofing will be done before and after laying sanitary piping. A curtain wall (foyer) shall be provided in all the toilets

Sewage disposal shall be through septic tank and soak pit. Janitor's closet shall be provided for toilets in all major buildings.

Each toilet shall contain following minimum fittings :

		Auxiliary Building	Power House Building
*	Raised type W. C.	1 No.	2 Nos.
*	Squatting type W. C.	1 No.	2 Nos.
*	Urinals	1 Nos.	4 Nos.
*	Wash Basin	1 Nos.	4 Nos.
*	Shower	1 Nos.	2 Nos.
*	Bathroom Mirror, 610 mm X 453mm	1 Nos.	4 Nos.
*	Glass Shelves, 610 mm X 127 mm	1 Nos.	4 Nos.
*	Towel Rail 450 mm Long	1 Nos.	4 Nos.
*	Liquid Soap Holder	1 Nos.	4 Nos.
*	Toilet Roll Holder	1 No.	4 Nos.
*	Hand Dryer	1 No.	2 No.
*	Janitor	1 No	1 No.
*	Drinking Fountain	1 No.	4 Nos.

*	Septic tank including all accessories and laying of 150 mm diameter Extra heavy cast iron soil lines One Lot
*	Curtain wall (foyer) shall be provided.

The exact no. of fittings shall, however be finalized during detail engineering stage.

For Power House Building, toilet facility shall be provided on each floor on both sides of the building. The toilet in the administration building shall be provided with jaquar make CP fittings and Hindustan or superior make WC, wash basins etc. Administrative building shall be provided with separate ladies toilet facility wherever applicable.

For all manned structures toilet and drinking water facility shall be provided.

Potable water shall be supplied to basins, water closets, urinals, sinks, water coolers, showers and other plumbing fixtures. Soil and waste piping shall drain through traps to the yard sanitary sewer system.

2.25.00 Draining Out Water From Floors :

For all buildings, suitable arrangement for draining out water collected from equipment, blow downs, leakages, floor washings, fire fighting etc. shall be provided for each floor, complete up to station sewers.

2.26.00 Fencing :

Minimum 3.0 meter high fencing above toe wall shall be provided around switchyard, transformer yard, building transformer area, and other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 meter high PVC quoted galvanized chain link fencing of minimum 8 gauge (including PVC coating) of mesh size 75 mm and galvanized concertina for switchyard / transformer yard. Galvanized barded wires of a height of 0.6 meter shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauge. Steel entry gate shall be provided for all fenced areas. Top of toe wall shall be minimum 200 mm above the formation level.

2.27.00 Boundary Wall :

Boundary wall shall conform to the requirements of BPE norms for vital industrial undertakings. It will be 3.0 meter high masonry wall from Finished Ground Level (FGL) over which 600 mm high barbed wire fitted and fixed to embedded bifurcated steel angles shall be provided. Layers of G.I. barbed wire will be four nos. for each bifurcation. 300 / 350 mm thick laterite stone block wall laid in 1 : 4 cement sand mortar shall be used in boundary wall. The masonry wall shall be painted with cement based paint over external plaster and steel angles shall be painted with synthetic enamel paint over zinc chromate primer

2.28.00 Statutory Rules :

a) Contractor shall comply with all applicable statutory rules pertaining to Factories Act as applicable for the State, Rules of Tariff Advisory Committee (TAC). Water Act for pollution control etc.

b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 500 mm wide (in the main power house building), along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

c) Provision for fire proof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. shall be made according to the recommendation of Tariff Advisory Committee.

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d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

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5.00.00 SIZING OF NON PLANT BUILDINGS (Indicative)

ANNEXURE A

BUILDINGS DATA SHEET

MINIMUM SIZING OF BUILDING

SL.NO	Area	LENGTH (IN M)	BREADTH (IN M)	NO. OF FLOORS	FOR NO.OF UNITS	TOTAL NOS.	TYPE OF CONSTRUCTION DESIRED				
							FOUNDATION	FRAMES	ROOF	FLOOR	ENCLOSURE
1	T.G.HOUSE	As per Agreed by Owner/Bidder to suit O&M		3	6	1	RCC	STR. STEEL	STR. STEEL	RCC	SANDWICH PANEL
	COAL BUNKER BAY			-	6	1	RCC	STR. STEEL	STR. STEEL	RCC	BRICK WORK
	DEAERATOR BAY			-	6	1	RCC	STR. STEEL	STR. STEEL	RCC	BRICK WORK
2	ESP/ AHP CONTROL ROOM	35	16	3	3	2	RCC	RCC	RCC	RCC	BRICK WORK
3	ELECTRIC ROOM FOR CHP	35	25	2	3	2	RCC	RCC	RCC	RCC	BRICK WORK
4	ADMIN BUILDING (#)	25	50	2	6	1	RCC	RCC	RCC	RCC	BRICK WORK
5	SECURITY POST,TIME OFFICE (#)	16	8	2	6	1	RCC	RCC	RCC	RCC	BRICK WORK
6	SECURITY POST (#)	8	8	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
7	OIL PUMP HOUSE & TANK YARD	As Required.		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
8	BULLDOZER STORE HOUSE (#)	18	54	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
9	DM PLANT AND AUXILIARIES	As Required.		2	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
10	PRE TREATMENT PLANT	As Required.		-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
11	COOLING WATER PUMP HOUSE	60	30	-	3	2	RCC	RCC	RCC	RCC	BRICK WORK

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12	LOCO SHED (#)	20	15	-	3	2	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
13	AUTO GARAGE (#)	20	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
14	STORES (#)	150	60	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
15	WORK SHOP (#)	150	60	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
16	PLANT SERVICE BUILDING (#)	50	25	2	6	1	RCC	RCC	RCC	RCC	BRICK WORK
17	FIRE STATION (#)	40	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
18	AIR COMPRESSOR /DG ROOM	40	30	-	3	2	RCC	RCC	RCC	RCC	BRICK WORK
19	FUEL OIL PUMP HOUSE	25	10	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
20	WEIGH BRIDGE CONTROL ROOM	10	10	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
21	TOILET BLOCKS (TWO NOS) (#)	10	10	-	6	2	RCC	RCC	RCC	RCC	BRICK WORK
22	CAR PARK (#)	100	8	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
23	CYCLE & SCOOTER SHED (#)	100	8	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
24	PLANT AMENITIES AND CANTEEN (#)	25	60	1	6	1	RCC	RCC	RCC	RCC	BRICK WORK
25	TRACK HOPPER CONTROL ROOM	15	10	-	3	2	RCC	RCC	RCC	RCC	BRICK WORK
26	ENVIRONMENTAL MONITORING ROOM	10	10	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
27	RAW/FIRE WATER PUMP HOUSE	60	40	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
28	COOLING WATER TREATMENT ROOM	40	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK

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29	ELECTRIC ROOM FOR CW PUMP HOUSE	20	10	-	2	3	RCC	RCC	RCC	RCC	BRICK WORK
30	TRANSFER TOWERS	12	12	-	6	AS REQUI RED	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
31	CRUSHER HOUSE	30	20	-	3	2	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
32	R.O. PLANT	As Required.		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
33	GUARD POND	100	100	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
34	WASTE WATER TREATMENT	As Required.		-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
35	RAW WATER RESERVOIR	**Shall be as per the technical specification**									
36	BOILER AREA	As Required.		-	6	6	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
37	FLY ASH SILO	20	20	-	6	4	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
38	SWITCH YARD AREA	360	280	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
39	INDUCED DRAUGHT COOLING TOWERS	**Shall be as per the technical specification**									
40	TRACK HOPPER (TWO NOS)	As Required.		-	3	2	RCC	RCC/STR. STEEL	RCC/SHEE TING	RCC	BRICK WORK
41	**ASH POND (FLY ASH)**	**Shall be as per the technical specification**									
41	**ASH POND (BOTTOM ASH)**	**Shall be as per the technical specification**									
43	STACKER RECLAIMER DRIVER HOUSE	As Required.		-	3	2	RCC	RCC	RCC	RCC	BRICK WORK

44	SWITCH YARD RELAY BUILDING (#)	70	30	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
45	START UP BOILER HOUSE	As Required.		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
46	OPEN TRUCK PARKING	60	60	-	6	1				RCC PAVED	
47	SLURRY DISCHARGE PUMP HOUSE	As Required.		-	1	6	RCC	RCC	RCC	RCC	BRICK WORK
48	CONCENTRATOR	As Required.		-	1	6					
49	COAL WASHING WATER POND & PUMP HOUSE	20	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
50	COAL SETTLING POND	20	20	-	6	1					
51	RAW WATER DOSING PLANT	20	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
52	FIRE FIGHTING PUMP HOUSE	Incl. in Raw Water Pump House		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
53	HYDROGEN GENERATION PLANT	60	40	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
54	FLUE GAS DESULPHURISATION PLANT (FUTURE)	160	50	-	6	6					
55	AHP CONTROL ROOM (HCSD)	70	25	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK

Note:
1. The area indicated above is minimum requirement. In case of conflict, layout and area for plant equipment building shall be mutually agreed as per O & M requirement.
2. For non-plant buildings, area mentioned shall be provided. All Non-plant building are marked with '#'.

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ANNEXURE A

4.00.00 SCHEDULE OF INTERNAL AND EXTERNAL FINISHES :

	Internal Finishes				
Sl.No.	**Room Name**	**Floor**	**Skirting**	**Wall**	**Ceiling**
1	Turbine Hall and Unloading Bay	40 mm thick IPS flooring with Ironite topping	125 mm high machine pressed plain cement tile	Oil bound distemper over 12 mm thick internal plaster	White color OBD over 6 mm thick ceiling plaster
2	Panel and Switch gear Room	40 mm thick IPS flooring	125 mm high machine pressed plain cement tile	Oil bound distemper over 12 mm thick internal plaster	White color OBD over 6 mm thick ceiling plaster
3	Battery Room	Acid / Alkali resistant tile	1.5 m high Acid/Alkali resistant tile dado	Acid/Alkali resistant paint over 12 mm thick internal plaster above dado	Acid/Alkali resistant paint over 6mm thick ceiling plaster.
4	Electrical C & I Laboratory	Matt finish ceramic tile	2.1 m high glazed ceramic tile dado	Oil bound distemper over 12 mm thick internal plaster above dado	White color OBD over 6 mm thick ceiling plaster
5	Turbine Operating Hall, Passage & Lobby	40 mm thick polished granite stone of approved color.	125 mm high polished granite stone of matching color	Oil bound distemper over 12 mm thick internal plaster	
6	Control Room	As defined in Clause no. 2.10 e)	125 mm high 2 mm thick PVC of matching shade	Acrylic emulsion paint over 2 mm thick plaster of Paris punning over 12 mm thick internal plaster up to 100 mm above False ceiling. White wash above false ceiling	Armstrong make false ceiling with Prima dune Premier 99 or superior make tiles shall be used of approved color. 50 mm thick under deck insulation to be provided.
7	Shift-in-Charge Room	2 mm thick PVC tile over 40 mm thick IPS	125 mm high 2 mm thick PVC	Acrylic emulsion paint over 2 mm thick plaster of Paris punning over 12 mm thick internal plaster up to 100 mm above False ceiling. White wash above false ceiling.	Armstrong make false ceiling with Prima dune Premier 99 or superior make tiles shall be used of approved color. 50 mm thick under deck insulation to be provided.

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Sl.No.	Room Name	Floor	Skirting	Wall	Ceiling
8	Administrative building	Vitrified tiles of class I quality	125 mm high vitrified tiles of class I quality	Acrylic emulsion paint over 2 mm thick plaster of Paris punning over 12 mm thick internal plaster up to 100 mm above False ceiling. White wash above false ceiling.	Armstrong make false ceiling with Prima dune Premier 99 or superior make tiles shall be used of approved color.
9	Canteen Building	Non slippery ceramic tile	1.5 m high glazed ceramic tile dado	Oil bound distemper over 12 mm thick internal plaster above dado	Ceiling to be white color oil bound distemper
11	Security & time office building	Vitrified tiles of class I quality	125 mm high vitrified tiles of class I quality	Acrylic emulsion paint over 2 mm thick plaster of Paris punning over 12 mm thick internal plaster	Ceiling to be white color acrylic emulsion paint
12	Toilet (all)	Non slippery ceramic tile	2.25 m high glazed ceramic tile dado	Oil bound distemper over 12 mm thick internal plaster above dado	Aluminium board false ceiling
13	Pantry (all)	Non slippery ceramic tile	2.25 m high glazed ceramic tile dado	Oil bound distemper over 12 mm thick internal plaster above dado	12.5 mm thick gypsum board false ceiling of 'Gypboard' or equivalent. Ceiling to be white washed.
14	Stores & Workshop Building	40 mm thick IPS flooring with Ironite topping	125 mm high machine pressed plain cement tile	Oil bound distemper over 12 mm thick internal plaster	White color OBD over 6 mm thick ceiling plaster
15	Car shed	Heavy duty decorative paving tiles	-	RCC frame to be cement painted	Cement paint over external plaster
16	Cycle & Scooter shed	Heavy duty decorative paving tiles	-	RCC frame to be cement painted	Cement paint over external plaster
	Staircases				
1	Staircase to Control Room	Matt finish tile or anti skid tiles as approved by Owner.	125 mm high Polished granite stone	1000 mm high 38 mm diameter polished stainless steel hand railing	White wash on sides and soffit of waist slab over plaster
Sl.No.	**Room Name**	**Floor**	**Skirting**	**Wall**	**Ceiling**
2	Staircase (all)	Anti- skid tiles	125 mm high	1000 mm high	White wash on

		as approved by Owner. Patterned tiles of 1000 mm x 300 mm shall be provided fro admin building internal staircases	Polished Kota Stone	50 m diameter M.S. hand railing synthetic enamel painted.	side and soffit of waist slab over plaster.
	External Finishes				
1	External Wall	* Waterproof cement paint Apex of 'Asian paints' over 20 mm thick sand faced cement plaster from plinth level to top of parapet. * Neat cement punning over 20 mm thick external plaster from F.G.L. up to plinth level.			
2	Roof Water Proofing Treatment	The RCC roof shall be provided with pre-fabricated APP (atactic polypropylene) modified waterproofing membrane with non woven polyester reinforcement treatment of 4 mm thickness consisting 160 gsm polyester core coated on both sides with APP modified bitumen and finally finished with thermo fusible film. The treatment shall be laid over a coat of bituminous primer @ 0.27 L / Sqm (IS: 3384). 18 mm thick cement sand mortar (1:4) with chicken wire mesh interposed shall be laid over waterproofing treatment. The roof shall be finished with 22 mm thick cement concrete tiles. Waterproofing-treatment shall be over 75 mm thick foam concrete. 12 mm thick uniform or varying 1:4 cement sand plaster shall be laid on top of foam concrete cast-in-situ after it is fully cured and dried for providing smooth surface for laying of water proofing treatment.			
3	Roof insulation	75 mm thick foam concrete below roof waterproofing.			
4	Front of Admin. Building & STG building	Good quality heavy duty interlocking paving tiles of 'Duracrete' or equivalent.			

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5.00.00 Following I.S. Codes or Equivalent For the System shall be Followed :

Masonry and Allied Works :

1)	IS : 1609	:	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts.
2)	IS : 2212	:	Code of Practice for Brickwork.
3)	IS : 2250	:	Code of Practice for Preparation and Use of Masonry Mortar.
4)	IS : 5134	:	Bitumen Impregnated Paper and Board.
5)	IS : 1542	:	Specification for Sand for Plaster.
6)	IS : 1661	:	Code of Practice for Cement and Cement-lime Plaster Finish on Walls and Ceiling
7)	IS : 2394	:	Code of Practice for Application of Lime Plaster Finish.
8)	IS : 4101	:	Code of Practice for External Facings and Veneers.
9)	IS : 2645	:	Water Proofing Materials.
10)	IS : 712	:	Building Limes.
11)	IS : 1077	:	Common Burnt Clay Building Bricks.
12)	IS : 1127	:	Recommendations For Dimensions And Workmanship Of Natural Building Stones For Masonry Work.
13)	IS : 1528	:	Method Of Sampling And Physical Tests For Refractory Materials.
14)	IS : 1597	:	Code Of Practice For Construction Of Stone Masonry (All Parts).
15)	IS : 2116	:	Sand For Masonry Mortars.
16)	IS : 2185	:	Concrete Masonry Units (All Parts – Hollow And Solid Concrete Blocks).
17)	IS : 2572	:	Code Of Practice For Construction Of Hollow Concrete Block Masonry.
18)	IS : 2691	:	Burnt Clay Facing Bricks.
20)	IS : 3414	:	Code Of Practice For Design And Installation Of Joints In Buildings.
21)	IS : 3495	:	Methods Of Tests Of Burnt Clay Building Bricks.
22)	IS : 4441	:	Code Of Practice For Use Of Silicate Type Chemical Resistant Mortars.
23)	IS : 4860	:	Acid Resistant Bricks.

Woodwork :

1)	IS : 4021	:	Timber Door, Window and Ventilator Frames.
2)	IS : 1003	:	Timber Paneled and Glazed Shutters.
3)	IS : 2191	:	Wooden Flush Door Shutter (Cellular and Hollow Core Type).
4)	IS : 2202	:	Wooden Flush Door Shutter (Solid Core Type).
5)	IS : 848	:	Synthetic Resin Adhesives for Plywood.
6)	IS : 399	:	Classification Of Commercial Timbers And Their Zonal Distribution.
7)	IS : 883	:	Code Of Practice For Design Of Structural Timber In Building.

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Sheeting Work in Roof and Siding :

1) IS : 3007 : Code of Practice for Laying of Asbestos Cement Sheets.

2) IS : 2527 : Code of Practice for Fixing Rain Water Gutters and Down Pipes for Roof Drainage.

3) IS : 1626 : Specification for Asbestos Cement Building Pipes Gutters and Fittings.

4) IS : 277 : Specification for Galvanized Steel Sheets (Plain and Corrugated)

Miscellaneous Metals :

1) IS : 226 : Structural Steel (Standard Quality)

2) IS : 800 : Code of Practice for Use of Structural Steel in General Building Construction.

3) IS : 816 : Use of Metal Arc Welding for General Construction in Mild Steel.

4) IS : 2812 : Arc Welding of Aluminum and Alloys.

5) IS : 3150 : Hexagonal Wire Netting.

6) IS : 4948 : Welded Steel Wire Fabric for General Use.

Painting, Polishing and Whitewashing :

1) IS : 348 : Specification For French Polish.

2) IS : 428 : Specification For Distemper Oil Emulsion Color as Required.

3) IS : 1477 : Code of Practice For Painting (I & II) of Ferrous Metal in Buildings.

4) IS : 2338 : Code of Practice For Finishing (I & II) of Wood and Wood Based Materials.

5) IS : 2395 : Code of Practice For Painting Concrete, Masonry and Plaster Surface.

6) IS : 2932 : Specification For Enamel, Synthetic, Exterior, Type – I.

7) IS : 5410 : Specification For Cement Paint, Color as Required.

8) IS : 6278 : Code of Practice For White Washing and Color Washing.

9) IS : 2645 : Integral Cement Waterproofing Compounds.

10) IS : 427 : Specification For Distemper, Dry Color As Required.

11) IS : 2339 : Specification For Aluminum Paints For General Purposes In Dual Containers.

12) IS : 2933 : Specification For Enamel, Exterior a) Undercoating, b) Finishing.

Metal Doors, Windows, Ventilators and Louvers :

1) IS : 1038 : Steel Doors, Windows and Ventilators.

2) IS : 1361 : Steel Windows For Industrial Buildings.

3) IS : 1948 : Aluminum Doors, Windows and Ventilators

4) IS : 4351 : Steel Door.

5) IS : 1949 : Aluminum Windows For Industrial Building.

6) IS : 3103 : Code Of Practice For Industrial Ventilation.

7) IS : 3614 : Fire Check Doors.

Glass and Glazing :

1) IS : 1081 : Code of Practice For Fixing and Glazing of Metal (Steel and Aluminum)

2) IS : 3548 : Code of Practice for Glazing in Building.

3) IS : 1083 : Code of Practice For Fixing and Glazing Metal Doors, Windows and Ventilators.

4) IS : 2835 : Flat Transparent Sheet Glass.

Floor Finish and Allied Works :

1) IS : 777 : Glazed Earthenware Tiles.

2) IS : 1197 : Code of Practice For Laying of Rubber Floors.

3) IS : 1237 : Cement Concrete Flooring Tiles.

4) IS : 1443 : Code of Practice For Laying and Finishing of Cement Concrete Flooring Tiles.

5) IS : 4860 : Specification For Acid Resistant Bricks.

6) IS : 5518 : Code of Practice For Laying of Flexible PVC Sheet and Tile Flooring.

7) IS : 13712 : Ceramic Tiles-Definitions, Classifications Characteristics and Marking.

8) IS : 2114 : Code of Practice For Laying In-Situ Terrazzo Floor.

9) IS : 3461 : PVC Asbestos Floor Tiles.

10) IS : 809 : Rubber Flooring Materials For General Purposes.

11) IS : 1195 : Bitumen Mastic For Flooring.

12) IS : 1196 : Code Of Practice For Laying Bitumen Mastic Flooring.

13) IS : 1198 : Code Of Practice For Laying, Fixing and Maintenance Of Linoleum Floors.

14) IS : 2571 : Code Of Practice For Laying In-Situ Cement Concrete Flooring.

15) IS : 5491 : Code Of Practice For Laying In-Situ Granolithic concrete Floor Topping.

17) IS : 5766 : Code Of Practice For Laying Burnt Clay Brick Flooring.

Suspended Ceiling :

1) IS : 2441 : Code of Practice For Fixing Ceiling Coverings.

Rolling Shutters And Grills :

1) IS : 6248 : Metal Rolling Shutters and Rolling Grills.

Roof Water Proofing, Insulation And Allied Works :

1) IS : 73 : Paving Bitumen.

2) IS : 702 : Industrial Bitumen.

3) IS : 1203 : Method of Testing Tar And Bitumen.

4) IS : 1322 : Bitumen Felts For Water Proofing and Damp Proofing.

5) IS : 1346 : Code of Practice For Water Proofing of Roofs with Bitumen Felts.

6) IS : 1609 : Code of Practice For laying Damp Proof Treatment Using Bituminous Felts.

7) IS : 3036 : Code of Practice For Laying Lime Concrete For a Waterproofed Roof Finish.

8) IS : 3037 : Bitumen Mastic For Use In Waterproofing Of Roofs.

9) IS : 3067 : Code of Practice For General Design, Details And Preparatory Work For Damp Proofing And Waterproofing Of buildings.

10) IS : 3384 : Bitumen Primer For Use In Water Proofing And Damp Proofing.

11) IS : 4365 : Code of Practice For Application Of Bitumen Mastic For Waterproofing of Roofs.

Lifts, Elevators And Escalators :

1) IS : 14665 : Electric Traction Lifts.

2) IS : 14671 : Inspection Manual.

3) IS : 2147 : Degrees of Protection Provided By Enclosures For Low Voltage Switchgear And Control Gear.

4) IS : 2332 : Nomenclature of Floors And Stories.

5) IS : 4591 : Code of Practice For Installation And Maintenance of Escalators.

Water Supply, Drainage And Sewerage :

1) IS : 404 : Lead Pipes.

2) IS : 458 : Pre-cast Concrete Pipes (With and Without Reinforcement).

3) IS : 651 : Salt Glazed Stoneware Pipes And Fittings.

4) IS : 771 : Glazed Fire-clay Sanitary Appliances (All Parts).

5) IS : 774 : Flushing Cisterns For Water Closets And Urinals (Other Than Plastic Cisterns).

6) IS : 783 : Code of Practice For Laying Of Concrete Pipes.

7) IS : 1172 : Code of Basic Requirements For Water Supply, Drainage And Sanitation.

8) IS : 1626 : Asbestos Cement Building Pipes And Pipe Fittings, Gutters And Gutter Fittings And Roofing.

7) IS : 1742 : Code of Practice For Building Drainage.

8) IS : 2964 : Code of Practice For Selection, Installation And Maintenance

of Sanitary Appliances.

9)	IS : 2065	:	Code of Practice For Water Supply In Buildings.
10)	IS : 2470	:	Code of Practice For Installation Of Septic Tanks (All Parts).
11)	IS : 3114	:	Code of Practice For Laying of Cast iron Pipes.
12)	IS : 4127	:	Code of Practice For Laying Of Glazed Stoneware Pipes.
13)	IS :12251	:	Code of Practice For Drainage of Building Basement.
14)	IS : 1200 (Part XVI)	:	Method Of Measurement : Laying of Water And Sewer Lines Including Appurtenant items.
15)	IS : 1536	:	Centrifugally Cast (Spun) Iron Pressure Pipes For Water, Gas And Sewage.
16)	IS : 1537	:	Vertically Cast Iron Pressure Pipe For Water, Gas And Sewage.
17)	IS : 3486	:	Cast Iron Spigot And Socket Drain Pipes.
18)	IS : 5329	:	Code of Practice For Sanitary Pipe Work Above Ground For Buildings.
19)	IS : 3076	:	Low Density Polyethylene Pipes For Potable Water Supplies.
20)	IS : 1538	:	Cast Iron Fittings For Pressure Pipes For Water, Gas And Sewage.
21)	IS : 1230	:	Cast Iron Rainwater Pipes And Fittings.
22)	IS : 1729	:	Sand Cast Iron Spigot And Socket Soil, Waste And Ventilating Pipes, Fittings and Accessories.
23)	IS : 784	:	Pre-stressed Concrete Pipes.
24)	IS : 1726	:	Cast Iron Manhole Covers And Frames.
25)	IS : 5961	:	Cast Iron Grating For Drainage Purposes.
26)	IS : 5219 (Part-I)	:	Cast Copper Alloys Traps : "P" and 'S' Traps.
27)	IS : 772	:	General Requirements For enameled Cast Iron Sanitary Appliances.
28)	IS : 775	:	Cast Iron Brackets And Supports For Wash Basins And Sinks.
29)	IS : 777	:	Glazed Earthenware Wall Tiles.
30)	IS : 2548	:	Plastic Water Closet Seats And Covers (all parts).
31)	IS : 2527	:	Code of Practice For Fixing Rainwater Gutters And Down-pipes For Roof Drainage.
32)	IS : 1239	:	Specification For Mild Steel Tubes And Mild Steel Tubular And Other Wrought Steel Pipe Fittings. (10mm to 15 mm Nominal Diameter).
33)	IS : 3589	:	Specification for electrically welded steel pipes for water, gas and sewage (220mm to 2000mm nominal diameter).

2009.3.14

ANNEXURE – II

SAMPLING, TESTING AND QUALITY ASSURANCE FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

1.00.00 INTRODUCTION

1.01.00 This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all works and structures covered in this specification i.e. excavation and filling, cast in situ concrete and allied works, fabrication and erection of structural steel works, masonry / sheeting and allied works, finishing items, water supply and sanitation, modular aerated concrete panel, pre-engineered building, special items of works, and piling.

1.02.00 This part of the technical specification shall be read in conjunction with other Parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.03.00 All tests required for all materials (procured by Contractor) and workmanship shall be done/ got done by the Contractor at his own cost. The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part.

1.04.00 The Contractor shall organize weekly QA/QC meeting with its subcontractor's QA/QC representative. All the ongoing activities shall be discussed and recommendations shall be reviewed for effectiveness.

1.05.00 Regular audits for the works of all its Vendors and testing Laboratories shall be arranged. Engineer shall be informed in advance about the Audit programs. All the Audit Reports and the follow-up Reports shall be submitted to the OWNER. OWNER may also perform Audits on the functioning of the CONTRACTOR and its Vendors/ Laboratories.

1.06.00 The Contractor shall provide the facilities whatsoever required and also bear all cost for all sampling, testing and quality assurance in the field and in the laboratory. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian standards and / or international standards and this technical specification. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All sampling shall be done in the presence of the Engineer or his authorized representative. The Contractor shall establish the Field Quality Assurance (FQA) laboratory and field tests shall be done in the presence of the Engineer and / or his authorized representative. The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute as agreed by the Engineer, If the Engineer desires to witness such tests at laboratory, Contractor shall arrange to conduct the test in his presence.

Mar 19, 2009

1.07.00 The recommendations and suitability of material for concreting and other building materials like brick, cement, aggregates etc., shall be ascertained by Contractor prior to start of work.

Preliminary evaluation of aggregate and its evaluation for potential alkali-aggregate reactivity as per following scope of work shall be done:-

A. Evaluation of Aggregates

i) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and flakiness index, as per IS: 2386.

ii) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis soundness, deleterious material, silt content, clay content and organic impurities as per IS: 2386.

iii) To prepare evaluation report based on test results of I) and ii) above and to advise regarding suitability of fine and coarse aggregates.

B. Evaluation of Aggregates for Potential Alkali-Aggregate Reactivity:

Evaluation for Potential Alkali-Aggregate reactivity as per following scope of work:

i) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (1N NaOH at 80 deg. Centigrade for 14 days as per ASTM 1260, or the method established/ developed by CSMRS for 22days test.

ii) To prepare a report based on test results of I) above and to advise regarding suitability of aggregates and further testing required if any.

C. To carry out repeated temperature cycle test on aggregates for aggregates to be used in RCC of dynamic foundations from a reputed rock mechanics laboratory like National Institute of Rock Mechanics, Kolar etc. and to advise regarding suitability of fine and coarse aggregates.

Moreover Contractor prior to start of work shall ascertain the recommendations and suitability for fill material. A full-scale test shall be conducted including Grain Size Analysis, Specific Gravity, Moisture Content and Standard Proctor Density of fill material. The Contractor shall submit the test results to the Owner in triplicate, within three (03) days after completion of any test. All records shall be submitted, unless specified otherwise, as per the format developed by the Contractor and approved by the Engineer.

The Contractor shall identify the main purchase orders & that of sub-contracts as per owner's specification and shall forward the list of manufacturers/ vendors for each bought out items envisaged in the contract. The bought out item (BOI) list shall include all the materials brought out in technical specifications and finalized drawings. The BOI's shall conform to the relevant IS/technical referred specifications for the highest quality grade of material unless otherwise specified. All bought out items shall be procured from the manufacturer's approved by OWNER and tested as per relevant IS Codes/ Owner's Specification. To facilitate advance planning (well before the start of activity as per L-2 network) of material testing/ approval of bought out items, representative samples shall be procured by the Contractor (from approved vendors) and submitted to the Engineer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. Approval of material / sample by the Engineer shall not relieve the Contractor of his responsibility, for their conformance to the specification, as well as the requisite quality and performance of material.

Structural Steel and reinforcement steel shall be procured from main steel producers like SAIL, TISCO, IISCO, RINL, Jindal Steel only.

Use of re-rolled structural / reinforcement steel is not permitted.

1.08.00 Field Quality Plans shall detail out all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organization", during various stages of site activities starting from receipt of materials/equipment at site.
The Contractor shall furnish complete QA & QC programme for the work envisaged which may include the following:-

a) The organization structure for the management and implementation of the proposed Quality Assurance Programme.

b) Documentation Control System

c) The procedure for procurement of materials and source inspection.

d) System for site controls including process controls.

e) Control of non-conforming items and systems for corrective action

f) Inspection and test procedures for site activities

g) System for indication and appraisal of inspection status

h) System for maintenance of records

i) System for handling, storage and delivery.

j) Quality Plan detailing out quality practices and procedures, relevant standards and acceptance levels for all types of work under the scope of this contract.

The Contractor shall appoint a dedicated, experienced and competent quality management representative on site, preferably directly reporting to the Senior Management but shall not be to either Construction or Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the Approved quality assurance programme.

The onsite quality management representative shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints.

The QA setup of the Contractor shall consist of qualified and experienced Engineers, with their supporting staff for approval of the owner. Field Quality Assurance (FQA) organizational set up in addition to requisite mechanical & electrical engineers shall consist sufficient qualified and certified civil engineers & supervisors to take care of quality assurance activities of both site & laboratory. An indicative QA organization chart is attached as Exhibit-III. The deployment of man power for FQA set up shall be scheduled on the basis of L-2 network so that necessary manpower shall be available to take care of relevant areas of works in progress during currency of works or as and when directed by the Engineer to cope with the work demand. Based on the schedule of work and the approved FQP, the Contractor shall prepare a schedule of FQA tests and shall submit to the owner and shall organize the tests as scheduled.

Before using any equipment that are used in the quality laboratory and the other important equipment like Survey Instruments and vital tools including slings, D-hooks etc, Contractor should submit Third Party Calibration Certificates to the Owner from time to time for his review and records.
While submitting the running / progressive bills in line with approved billing break up, the contractor shall submit a quality compliance certificate duly endorsed by the Quality Head and the Project Manager of Owner with out which the bill wont be taken up for processing by the Owner.

Weekly Quality Meetings shall be organized by the Contractor's quality In-charge in co-ordination with Owner's quality in-charge which shall be also attended by the Construction Managers of either side and the minutes of such meetings shall be circulated to the entire key personnel as informed to the Contractor during the currency of Project.

1.09.00 The Field Quality Assurance (FQA) laboratory shall have all necessary equipment and instruments and shall be managed by a qualified / experienced person. An indicative list of test equipment is attached at Exhibit-I. All these testing equipment shall be provided by the Contractor at his own cost. The Contractor shall maintain the equipment in good working condition along with valid calibration certificates, for the duration of the contract. Any other equipment though required for testing but not listed in the equipment list shall be provided / arranged by the Contractor at his own cost.

FQA laboratory building shall be constructed by the Contractor at his own cost. The laboratory building shall be constructed and installed with the appropriate facilities. Temperature and humidity controls shall be available wherever necessary during testing of samples.

1.10.00 All the construction activities shall be taken up according to the approved work procedure / method statement. All the work procedure / method statement shall be prepared by the Contractor and submitted to the owner at least 30 days prior to the intended start of the actual work. Work procedure / method statement shall be submitted in the format approved by the Engineer. Contractor shall ensure that work procedure / method statement shall include, among the others, the following:

a) Purpose
b) Scope
c) Reference document/Standards
d) Methodology of work
e) Field quality plan
f) Job safety analysis

The Contractor shall obtain the approval of the Owner of the work procedure / method statement including Field Quality Plan (FQP) before the award of the work. These shall cover for all the items / activities covered in the schedule of items and required for the completion of the work.

However the Owner reserves the right to add, delete or modify the Field Quality Plan and Quality Assurance Programme at any time during the contract period and no negotiations there of from the Contractor shall be entertained by Owner.

1.11.00 All materials components and equipment covered under this specification which shall be manufactured at shop/ factory of the vendor / sub vendor shall be covered under a comprehensive quality assurance program. The detailed quality plan for manufacturing shall be drawn up by the Contractor and will be submitted for owner for approval in the prescribed format for manufacturing quality plan.

Manufacturing Quality Plan (MQP) will detail out for all the components and equipment, various test/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/Sub-Contractor's/ sub-supplier's quality Control Organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing / performance testing. The quality plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

1.12.00 The Contractor shall store and handle the materials as per the requirements of the relevant standards/ procedures at his own cost.

1.13.00 All T&P / equipment brought at site for the use shall be in a good working condition and shall preferably be not more than two years old. The Contractor shall submit to the engineer the weekly status of performance of tools & plants deployed at site for mechanized working. These shall include availability of batching plant with printer for recording batch wise details, transit mixers, concrete pumps, vibrators, winches, cranes, welding

machines, hoists etc. as per format enclosed at Exhibit-II. In case of outage of any T&P / equipment for more than 40% of requirement, the Contractor shall ensure the deployment of additional T&P / equipment to augment the mechanized work at no extra cost to owner.

1.14.00 All major bought out items shall be included in the quality plan. The Quality plan shall include following works/ Bought out items wherever relevant to the Technical specifications, BOQ & drawings.

a) Earthworks including selection of fill material, compaction, proctor density tests etc.

b) Preparation of sub grades & sub-base for paving/ road works

c) Roads & Pavements.

d) Bituminous paints for water proofing & Bituminous concrete's

e) Cement, reinforcement steel & structural steel procurements

f) Coarse/ Fine aggregates, ash, water for concrete

g) Cast-in-situ concrete & allied works

h) Masonry & allied works

i) Pre-cast concrete & handling.

j) Ready Mix concrete.

k) Sheeting & allied works

l) Water supply & sanitation

m) Piling works if required

n) Structural steel works including approved welding procedures

o) Floor finishes, tiling etc.

p) Doors including fire proof doors, windows, ventilators, partitions, louvers, rolling shutters etc

q) Pre-fabricated / Pre Engineered buildings

r) False ceiling & insulation systems

s) Roof metal decking/ Wall claddings

t) Painting system- Procurement & application

u) Acid-Alkali resistant linings

v) Electro forged gratings/ Pressure locked gratings

w) Concrete Admixtures, chemical injection grouting, waterproofing chemicals etc.

x) Anti-termite treatments

y) Preparation of Concrete joints & joint fill materials

z) Roof water proofing

aa) Pond/ Hydraulic tests of water retaining structures

bb) Drainage/ Cross drainage works/ Hume pipes

cc) Glazing & aluminum works as specified

dd) CW liners

1.15.00 List of Exhibit is as follows:

a) Exhibit I-Typical Field Quality Lab Equipment

b) Exhibit II- List of Bought out Items

c) Exhibit III- FQA Organization Set up

d) Exhibit IV- Weekly Reporting of utilization of equipment

e) Exhibit V-Indicative Quality Plan.

2.00.00 **GENERAL QA REQUIREMENTS**

2.01.00 **QA Requirements for Properties, Storage and Handling of Common Building Materials**

1. All the materials like Bricks, Stones, Concrete Blocks, Lime, Cement, Water, Aggregates, Sand Reinforcement Steel, Structural Steel shall conform to the relevant IS Codes/Owner's Technical Specification requirements.

2. All materials shall be stacked and stored by the Contractor as per IS-4082 and as per the requirements specified in Owner's Technical Specification.

3. All material shall be stacked separately.

4. Lime and cement shall be stored in Weather Proof, Dry & Leak Proof Conditions stores.

5. Different consignment of different types of cement shall be stored separately with clear identification mark. Not more than 10 layers of Cement bags shall be permitted.

6. Cement stored for more than 60 days in Contractor's godown shall be
retested for compliance.

7. Cement shall be consumed on first in first out basis. At every stage of storage and usage the week of production of Cement shall be displayed in a manner satisfactory to the owner.

8. Steel shall be stacked and stored consignment wise, size wise and grade wise with identification mark. Identification mark shall be traceable to the lot no of manufacturing.

9. For properties, storage and handling of all materials used shall comply with the requirements of Owner's Technical Specification.

2.02.00 **QA Requirements For Acid/Alkali Resistant Lining**

1. Acid Resistant Bricks/Tiles shall be tested for Water Absorption, Compressive Strength, Resistance to Acid, Flexural Strength, Dimensions and all other tests as per IS-4860 and IS-4457.

2. Acid and Alkali Resistant Bitumastic ready mixed paint shall be tested for all tests as per IS-158.

3. Bitumastic shall be tested as per IS-9510.
4. Potassium Silicate, Resin type and Sulphur type Mortars shall be tested as per IS-4832, Part I, II and III/ Technical Specifications.

5. Surface preparation shall be checked as per IS-2395.

6. Application of Primer, laying of Acid Proof Bitumastic layer, Acid/Alkali Resistant Tiles/Bricks, Chemical Resistant Epoxy Lining and Epoxy Paint shall be as per Owner's Technical Specification.

7. Thickness of Acid and Alkali Lining shall be checked.

8. Epoxy painting shall be carried for required coating thickness and dry film thickness.

2.03.00 **QA Requirements for Pre Cast Concrete Works**

1. All the materials used in Pre cast Concrete work shall be tested and conform to the requirements of IS codes and Owner's Tech. Specification.

2. Concrete mix for Pre cast members shall be M25 grade conforms to IS-456-2000.

3. All relevant QA requirements pertaining to cast in-situ concrete shall be applicable.

4. Load test on Pre cast members shall be carried out for the type of members as decided by Owner's Engineer as per IS-456-2000.

5. Pre Cast Concrete member shall be checked for dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances shall be as per Owner's Technical Specification.

2.04.00 **QA Requirements for RCC Piles (Part I) - Bored Cast-In-Situ Piles, if required**

1. Standard Penetration Test (SPT) as per IS-2131 and Owner's Technical Specification for determining the founding level of piles.

2. Uniaxial Compressive Strength (UCS) test shall also be performed on Rock Cores. In case it is not possible to test the cores so obtained for Uniaxial Compressive Strength, core shall be tested for point load strength Index and correlated to obtain Uniaxial Compressive Strength.

3. Founding level of the piles shall be decided based on the criteria given in Owner's Technical Specification.

4. Check for control of position and alignment of piles as per IS-2911 Part I/Sec-2

5. Boring & Drilling : Drilling mud shall be tested for the following

   a) Liquid limit of drilling mud (Bentonite Slurry) as per IS-2720 Part V. Acceptance criteria shall be as specified in Owner's Technical Specification.

   b) Sand content of Bentonite powder.

   c) Density of freshly prepared Bentonite suspension shall be checked in each pile bore before concreting.

   d) Marsh viscosity

   e) Differential free swell index

   f) pH value of Bentonite suspension

Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, min. once per week or as found necessary by Owner's engineer. One sample consisting of 3 specimens shall be tested for above.

6. Check cleaning of pile bore

7. Concreting: All the checks/tests on concrete and concrete materials shall be carried out as per FQP and IS-2911 Part I/Sec.2

   a) Before starting concreting the contaminated drilled mud at the (slurry collected in sampler tube) bottom of pile bore shall be tested for density and sand content. Density should not be more than 1.25T/CuM.

   b) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength

8. Reinforcement bars used for piles shall be of tested for quality and conform to the requirements of relevant IS codes.

a) Check distances between two adjacent main reinforcement bars and should be as specified in Owner's Technical Specification.

b) Check proper cover and central placement of reinforcement cage in the pile bore by suitable concrete spacers/rollers. Check minimum clear cover to reinforcement should be as specified in technical specification.

9. Check cut off level of piles as per drawing.

10. Check recording of all data during installation of piles in prescribed pile data sheet.

11. Check that vibrators are used for preparation of test cubes/ specimens.

12. Slumps of concrete shall be tested at every one-hour interval.

13. Checking position and Alignment: Each pile shall be checked for its position w.r.t. specified location. Each pile shall be checked for its alignment. Permissible limits for deviation shall be as specified elsewhere in the Owner's Technical Specification.

14. Check for Pile Bore: On completion of boring and cleaning, the bottom of each pile bore shall be checked from the samples collected from near the bottom of pile bore or any other method approved by Owner's Engineer, to ensure that it is free from pile bore spoil/debris and any other loose material before concreting.

15. Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Owner's Technical Specification. This test shall be used to identify the piles for routine tests.

2.05.00 **QA Requirements for RCC Piles (Part V) Load Test On Piles**

1. Pile load testing shall conform to IS-2911 (Part IV) and Owner's Technical Specification.

2. Check all the equipments and instruments used are properly calibrated.

3. Initial load test and routine load test shall be carried out.

4. Initial load test to assess the safe load carrying capacity of pile before start of work.

a) Cyclic vertical (compression) load test to assess safe vertical load capacity.

b) Lateral load test to assess safe horizontal load capacity.

c) Pull out (Tension) load test to assess safe pull out load capacity.

5. Routine Load Test on Working Piles

a) Direct Vertical (Compression) load test for vertical load capacity.

b) Lateral load test for horizontal load capacity

6. All other tests on piles shall be carried out as specified in Owner's Technical Specification.

7. Pile load-testing procedure to be got approved from Owner.

2.06.00 **QA Requirements for Plastering & Allied Works**

1. Materials like sand, lime for preparation of putty, coarse aggregate, gypsum etc. shall confirm to the relevant IS codes specified in Owner's Technical Specification.

2. Check proper mixing of mortar.

3. Plaster surface shall be checked for following defects and the remedial measures for the same shall be adopted as per IS-1661.

a) Blistering

b) Bond filer or loss of adhesion.

c) Cracking and crazing

d) Efflorescence

e) Grinning

f) Irregularity of Surface Texture

g) Popping or blowing

h) Recurrent surface dampers

i) Softness or chalkiness

4. Trueness of Plastering System:

Finished plaster surface shall not show any deviation more than 4mm when checked with straight edge of 2 m length.

5. Check thickness of plaster.

2.07.00 **QA Requirements for Concreting Including Concreting Of Major Equipments Foundations**

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to owner for their record and future reference. Cement consumption at batching plant shall also be obtained through computer output. Provision of an on line printer is mandatory. Calibration of batching plant shall be carried out at the starting and once in three months, and shall conform to IS: 4925.

a) Testing data of aggregates

b) Mix design details.

c) Testing records of admixture including dosage, workability and setting time.

d) Approved scheme for concreting.

e) Quantity of ice used if any for temperature control of concrete for top decks of machine foundations.

f) Hourly records of concreting including pour card.

g) Protocol indicating the dimensional tolerance and details of inserts.

h) Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used.

i) Bar bending schedule for ID,FD,PA Fans, BFP, TG and Chimney).

j) Location and details of mechanical anchoring used for reinforcement.

k) Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings.

l) Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification.

m) Report on petrographic examination & potential reactivity of aggregate and the repeated temperature cycle tests.

n) All tests/checks shall be carried out as per FQP.

o) Check temperature control of fresh concrete temperature of fresh concrete should not exceed 25 degree C at the time of placement.

p) Plasticiser / superplasticiser cum Retarder type mixture to be added in the concrete shall be tested as per IS-9103. Once any

concrete mix design is approved by the engineer, the IR spectro analysis test result of the admixture shall be submitted along with test results as per IS 9103 for reference.

q) REINFORCEMENT : Check conformity of material to relevant IS codes.

a) Check lapping/spacing of Reinforcement staggered, as under no circumstances more than 50% of bars at cross section shall be lapped.

b) Sample test for mechanical bars grips shall be carried out upto the yield strength of reinforcement of bars. The no. of tests to be carried out shall be 3% of the number of bar grips used subject to a minimum of three.

r) Batching shall be calibrated regularly at least once in a 3 months.

s) Ultrasonic Pulse Velocity Test as per IS-1331 Part I for Top Deck and column of T.G. Foundation to ascertain the homogeneity and integrity of concrete. In addition additional cubes (@ of 150/m^3 of concrete subject to minimum of 6 cubes) shall be taken to carrying out UPV test on cubes. UPV test shall be carried out by a specialized agency.

t) All precautions and control as specified in Owner's Technical Specification shall be taken care of during concreting. IS 456-2000 shall be applicable for acceptance of execution of concrete works & test results.

2.07.01 **Staging and Form Work**

Automatic climb form scaffolding systems shall be used. Slip form with proven record for similar towers may be used subject to conformance to relevant IS and specific approval of the owner. The design and detailed construction of the form work and the scaffolding system shall be based on the relevant IS code. In absence of the same DIN 4420/ACT 347 shall be followed. Concrete shall have sufficient strength to with stand the anchoring loads of scaffolding system. The concrete strength shall be continuously checked and documented during the climbing process of the scaffolding.

a) Design and execution of the form work, staging, shuttering and scaffolding shall conform to National Safety Council and all relevant IS Code provisions, i.e. IS: 2750, IS: 4014, IS: 4923, IS: 800 etc. In case the IS Codes do not cover the specific type of shuttering system, then any international Code of Practice, as approved by the engineer, may be followed.

b) Deployment of vertical laser ray equipment for measuring the dimensions and controlling the shape of the tower at all elevations and plan angles shall be carried out.

2.08.00 **QA Requirements for Structural Steel Work**

1. Physical and chemical properties of material as per relevant codes. Review of correlated Mill Test Certificates or check testing in absence of MTC.

2. Ultrasonic test on plates above 40mm as per ASTM A435.

3. Welding Procedure Specifications, Procedure Qualification Record & Welders Qualification Test shall be as per ASME Section IX/AWS D1.1

4. Fillet Welds:

   a) Check for size and visual examination.

   b) Macroetch examination on production test coupons for main fillet welds with minimum one joint per built up beams, columns and crane girder etc.

   c) 25% weld length of tension member of crane girder shall be subjected to Dye Penetration Test.

   d) On all other fillet welds, DPT on 5% of weld length with minimum 300mm at each location shall be carried out.

5. Butt Welds:

   a) 100% visual examination

   b) DPT on all butt welds after back gouging

   c) Mechanical testing of production test coupons with minimum one joint per built up beam, column and crane girder.

   d) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder. All other butt welds shall be subjected to Radiography test on 10% weld length of each welder. Wherever RT is not feasible, UT shall be carried out.

   e) Full penetration welds (other than butt welds) shall be subjected to Ultrasonic Testing in following quantum:

   f) 100% UT on web to flange joint of crane girder.

   g) 10% UT on other full penetration joints.

6. Every 1st and further every 10th set of identical structure shall be checked for control assembly in shop before erection.

7. All structure components/members shall be checked for dimensional tolerances during fabrication and erection as per IS-7215 and IS-12843 respectively.

8. Check for Surface Preparation and Paint thickness.

9. In case of failure of any welds in SPOT RT/UT, the %age for retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1.

10. Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specs. /approved WPS.

11. For CW liners Inspection of welds for shop and field erection shall be as follows:-

a) 100% DPT after back gauging /grinding of butt welds by DPT kit shall be carried out as per IS-3658. No line / round and no crack should be observed.

b) 100%DPT shall be carried out on fillet welds by DPT kit as per IS:3658.

c) 10% radiography shall be carried out on shop butt welds, the acceptance criteria shall be as per ASME Sec.V and ASME Sec. VIII Div.1.

d) 100% Radiography/Ultrasonic test on field Butt welds shall be carried out, the acceptance criteria shall be as per ASME Sec.V and ASME Sec. VIII Div.1.

e) Hydro testing shall be done as per the method detailed out in Technical specifications.

2.09.00 **QA Requirements for Sheeting Works.**

1. **Colour coated sheet**

a) Chemical & physical properties of raw material sheet as per relevant codes.

b) Base Metal Thickness

c) Thickness of coatings

d) Type of coating/paint

e) Hardness of painted surface (2H pencil Hardness) (ASTM-D-3363)

f) Flexibility Test

Bend test as per ASTMD-328 at 180 degree bends (twice the thickness of sheet). There should not be any crack.

Dimensional check after profiling of sheets

h) Weathering Resistance Test

Salt spray test as per ASTM B-117 for minimum 1000 hrs. one sample per batch at random.

2. **Bonded Mineral Wool Insulation**

a) Thickness

b) Density

c) Thermal Conductivity

d) All other tests as per IS-8183.

3. **Sheeting Installation**

a) Workmanship including alignment

b) Level, Slope

c) Side and End Laps

d) Proper Installation of Flashing

e) Fixing including opening,

f) Location, Installation of Lining & Installation.

4. All bought out items shall be procured from the manufacturer's approved by Owner's Engineer and tested as per relevant IS Codes/Owner's Specification.

2.10.00 **Architectural & Misc. Works**

1. Material used for floor finishes and allied work shall conform and tested as per the requirements of relevant IS Codes specified in Owner's Technical Specification.

2. Finish shall be checked for :

a) Level, Slope, Plumb

b) Pattern & Symmetry

c) Alignment of joints, dividing strips etc.

d) Colour, Texture

e) Surface Finish

f) Thickness of Paint

g) Details of edges, junction etc.

h) Performance

i) Precautions specified for durability.

3. For fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. Following checks shall be carried out.

a) Overall Dimensions

b) Mullions Transoms

c) Doors & Windows shall operate without jamming

d) Doors, windows & frames etc. shall be on a true plane, free from wrap or buckle.

e) All welds shall be dressed flush on exposed and contact surfaces.

f) Correctness of locations and smoothness of operation of all shop installed hardware and fixtures.

g) Provision of hardware & fixtures to be installed at site.

h) Glazing beads shall be cut with mitered corners.

i) Glazing clips, fixing devices etc. shall be supplied in adequate nos.

j) Shop coats shall be properly applied.

k) Exposed aluminium surface shall be free from scratches, stains and discoloration.

2.11.00 **Rolling Shutters/Grills**

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the engineer. The shutter shall be smoothly operable under all ambient conditions. All controls and locking devices shall give fault free performance.

2.12.00 **Fire Proof Doors**

1. Fire Proof doors shall be tested for the requirements mentioned in IS-3614 Part-II and Owner's Technical Specification. The doors shall be approved by TAC & shall have minimum 2 hours fuse rating.

2. DFT of paint of Fire Proof Doors shall be checked.

2.13.00 **Glass and Glazing**

1. Materials used in glass and glazing shall conform to the requirements of Owner's Technical Specification and IS Codes specified in Owner's Technical Specification.

2. All installation shall be free from cracked, broken or damaged glass, edges of large panes of thicker glass and heat insulating glass be inspected carefully for chipped, cracked or underground edges.

3. Glazing shall be carefully done to avoid direct contact with metal frames.

4. All glasses shall be embedded in mastic for steel works and fixed by neoprene gasket for aluminium works to give a leak proof installation.

5. On completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the engineer.

2.14.00 **Roof Water Proofing & Allied Works**

1. Material used shall be tested and conforms to the requirements of IS Codes/International Codes specified in Owner's Technical Specification.

2. All elastomeric membrane is fully dried to perform testing with water ponds created on minimum 5% of area of nominal size 6m x 6m for height of 25mm to 30mm at critical locations for a period of 48 Hrs. No dampness shall be visible on the underneath side of roof (i.e. ceiling, parapet and well junction etc.). The above testing shall be carried out prior to application of wearing course.

2.15.00 **Painting & Allied Works.**

1. Various materials used shall conform and tested for the requirements of Indian/International Codes specified in the Technical Specification.

2. Surface to receive paint shall be made smooth.

3. Painting shall be checked for thickness of different coats as specified in schedule of items and Owner's Technical Specification/Drawing.

2.16.00 **QA Requirements for Road Work**

Quality Assurance and testing requirements for roadwork shall be as per IRC Publication-Specification for Road & Bridges (Section 900, Quality Control for roadwork)

1. Check for control of alignment and surface regularity as per Clause 902.

2. Quality control tests during construction as per Clause 903.

   a) Tests on earth work for embankment and subgrades construction as per Clause 903.2

b) Tests on sub bases and bases (excluding bitumen bound base) as per Clause 903.3 (Table 900-3)

c) Tests on Concrete Road Constructions as per Clause 903.5 (Table 900-6)

3. Road work shall be carried out as per relevant IS provisions if IS provisions are provided in the specifications

2.17.00 **Vibration Isolation System**

1. Chemical and physical properties of raw material
2. NDT on welds
3. MQP and Review of Manufacturer Test Certificates(If supply of VIS is in the scope of Civil Contractor)
4. Dimensional Check
5. Check for level.
6. Spring Rate Test

2.18.00 **Chimney Liners**

a) Check for chemical and physical properties of material as per relevant codes.

b) Welding Procedure & Welders Qualification test as per ASME IX.

c) Dye Penetration test on welds shall be carried out as per ASTME 165.

d) 10% spot radiography test on all butt weld shall be carried out where radiography test is not possible. Ultrasonic test shall be carried out.

2.18.01 **Fabric Expansion Compensator**:

Each layer of fabric Compensator shall be checked for thickness, unit weight, tensile strength & elongation, composite layer of the expansion joint shall be tested for temperature withstand ability test.

Thermal Insulation shall be checked for thickness, density, thermal conductivity test and all other tests as per IS 8183.

Tests and checks on all other items shall be carried out as per relevant codes and Owner's Technical Specification.

2.18.02 **Chimney Electrical Works**

All the equipments, being supplied shall be of type tested quality and proven one. All the equipment and devices shall be subjected to routine tests and acceptance tests as per relevant standard. The type test report shall be submitted to Owner for review and acceptance.

2.18.03 **Chimney Structural Steel Works And Misc. Metal Items**

QA requirement for this shall be as per Clause No. 3.03 pertaining for Fabrication and Erection of Structural Steel Work.

2.19.00 **Ash Pond Lining**

a) Requirement of 750 Microns thick LDPE Material – The high density Polyethylene Liner shall be manufactured of polyethylene resin. The resin composition and production shall meet its intended purpose as detailed in the technical specifications.The test methods shall confirm to ASTM D 1505 or ASTM D792 or equivalent for density test and ASTM D1238, condition E or equivalent for Melt Index test.

b) Carbon Black shall be included in the resin to make it UV resistant and its content shall not be less than 2 % as per ASTM D 1603

c) The lining shall confirm to ASTM D1004, ASTM D4833 ASTM D1693, ASTM D 4437, ASTM D 3895 and as per criteria mentioned in the Tech specification. Thickness shall be as per ASTM D 5199, Tensile properties shall be as per ASTM D 6693, Tear resistance shall be as per ASTM D 1004.

d) Vacuum box Testing (VBT) and Air Pressure Testing (APT) shall be carried out as per the procedure in Technical Specifications

e) Installation and laying shall be as per the procedure laid down in the tech specifications

The Contractor shall submit a field quality plan for the Ash Pond lining in the Owner's format incorporating all the requirement and acceptance criteria as per the technical specification.

2.20.00 **Stop Logs and Trash Racks**

a) Structural design shall be as per IS 5620 and IS: 4622 and as per details given in tech specifications.

b) Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log

c) The trash rack to be provided shall Type-1 trash rack (removable section rack) , conforming to IS:11388(latest) .

d) Center to center spacing , clear opening and center to center spacing of trash bars to be provided in the rack shall be as per technical specifications

e) Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specifications. The leakage shall then be measured and it should not be more than 5 liters/ minute /meter of length of seal under maximum head or as specified.

f) All material used for trash rack and stop logs shall be of high grade and free from defects and conforming to all the relevant standards mentioned for the various component material in the technical specification. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Contractor if asked by the employer.

g) The Contractor shall submit a Field quality Plan in Owner's format incorporating all the quality aspects mentioned in the technical specifications .

h) The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS: 13591 shall be referred for measurement of the deflection and acceptance criteria.

2.21.00 **Geomembrane/ Geotextile Filter**

a) Geotextile filter shall be woven type and shall satisfy the following criteria:

b) Material for Geotextile filter shall be 100% polypropylene.

c) Equivalent opening size shall be as required

d) Specific gravity shall be 091, Weight in gms/ sqm shall be mln. 200. Thickness shall be atleast 0.55 mm and width to be supplied shall not be less than 1.75 meter.

e) Other physical properties like Breaking strength, percentage elongation at break, grab strength, percentage Elongation(Grab Test), tear strength (single rip) Water permeability shall be as per the details given in technical specification and as per ASTM-D-5035, ASTM-D-5034, ASTM-D-2261 and IS:169 (Latest edition).

f) Geotextile filter shall be with U-V (Ultraviolet) treatment suitable for a temperature range from 0 ^{0}C to 50 ^{0}C so that the strength and life of the same is not affected due to exposure to ultraviolet rays. In addition to the above, geotextile filter shall have good resistance to chemicals and to biological degradation.

3.00.00 **CONSTRUCTION TOLERANCE AND ACCEPTANCE CRITERIA**

3.01.00 **Excavation and Filling**

Tolerance

Finished surface level shall be within 20mm of the level shown in the drawing.

Acceptance Criteria

Following acceptance criteria shall be followed.

a) When only one set of sample is tested, then all individual samples collected and tested should pass without any deviation

b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test than 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

Tolerance on finished levels for important filling areas at approved interval shall be + 20mm. However, for an unimportant area, tolerance up to +75mm shall be acceptable at the discretion of the Engineer. However, these tolerances shall be applicable for localised areas only.

3.02.00 **Cast-In-Situ Concrete And Allied Works**

Tolerances

A) Cast-In-Situ Concrete

Unless otherwise specified, the tolerance in construction shall be as follows:

Description of Item / Structural element	Permissible Deviation in mm
The dimensions of concrete as cast when compared with those on the drawings shall be within the tolerance given below:	
a) Faces of concrete in foundations and structural members against which backfill is placed.	+ 25 - 10
b) Eccentricity of footing 2% of footing width in the direction of placement but limited to 50mm.	
c) Top surfaces of slabs and of concrete grouted to receive base plates	+ 5 - 5

d)	Alignment of beams, lintels, columns, walls, slabs and similar structural elements.	+ 5	- 5
e)	Cross sectional dimensions of walls, slabs and similar structural elements	+ 5	- 5
f)	Deviation from specified dimensions of cross-section of columns and beams.	+ 12	- 6
g)	Alignment of holding down *bolts without sleeves	+ 1.5	- 1.5
h)	Alignment of holding down *bolts with sleeves.	+ 5	- 5
i)	Level of holding down *bolt assemblies.	+ 10	- 10
j)	Embedded Parts (in any *direction).	+ 5	- 5
k)	Level of embedment for equipment support	+1.5	0
l)	Level of embedment for other embedded parts	+ 5	- 5
m)	Centers of pockets or holes * with greatest lateral dimension not exceeding 150mm.	+ 10	- 10
n)	Variation in steps:		
	Riser	+ 1.5	- 1.5
	Tread	+ 3.0	- 3.0

(b) Reinforcement

Tolerance on placing of reinforcement and for cover shall be as per clause 12.3 of IS: 456.

Reinforcement shall be placed within the following tolerances:

a) For effective depth 200 mm or less ± 10mm

b) For effective depth more than 200 mm ± 15mm

Tolerance for cover

Actual concrete cover should not deviate from the required nominal cover by + 10 mm

(c) Pre cast concrete

Tolerance on dimensions of pre-cast units shall be as follows:

1. Length: +/- 0.1 percent subject to minimum of +/- 5 mm and maximum of + 10 mm.

2. Cross-sectional dimensions: +/- 3 mm or +/- 0.1 percent whichever is greater.

3. Straightness or Bow: 1/750 of the length subject to minimum of +/- 5 mm and maximum of +/- 10 mm.

4. Squareness: When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.

5. Flatness: The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.

(d) Formwork and staging

(i) Staging shall be checked for its soundness as a whole and for adequacy of the joints and its foundations. Formwork joints shall be inspected for soundness of connections. All joints shall be either vertical or horizontal and shall be such as to avoid loss of liquid through the formwork.

(ii) Dimensional tolerance for formwork shall be as per Clause 9.6 of IS : 14687 and 11.1 of IS : 456, which is reproduced as given below:

Deviation from specified dimensions of cross section of columns and beams	+12mm
Deviation from dimensions of footings	- 6 mm

1)	Dimensions in plan	+ 5 -12 mm
2)	Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
3)	Thickness	± 0.05 times the specified thickness

The above tolerances apply to concrete dimensions only, and not to positioning of vertical reinforcing steel or dowels.

(iii) Checklist for formwork shall be as per Clause 9.9 of IS : 14687. Format as per Annexure-C of IS : 14687 shall necessarily be made for all important structures including all machine foundations.

Acceptance Criteria

(a) The acceptance criteria of concrete shall be in accordance with clause no.16 of IS : 456. However in exceptional circumstances, and that too in non-critical areas, the Engineer may accept concrete work which is marginally

unacceptable as per the criteria laid down in IS : 456. For such accepted work, payment shall be made at a reduced rate pro rate to the concrete cube strength obtained, against that stipulated.

(b) Unacceptable concrete work shall be dismantled by the Contractor and replaced by fresh work, meeting the specification requirements. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, by the Contractor, to the satisfaction of the Engineer, at no extra cost to the Owner.

(c) Test shall be conducted for the water tightness of the liquid retaining structures as per IS : 3370 and IS : 6494.

(e) Tolerances for Cooling Tower Construction (For IDCT relevant tolerances shall be applicable)

(i) Shell wall center line in horizontal plane measured radially at mid point on a 3m wide chord.

(ii) Shell wall center line in meridianal plane measured over a height of 1m.

(iii) Shell thickness

(iv) Horizontal radius of shell at any section other than shell base

(v) Horizontal radius at shell base.

+/- 15 mm +/- 10 mm

+ 10 mm or - 5 mm

+/- 50 mm

+/- 40 mm

Check for shell geometry shall be carried out as per the method detailed out in the technical specification.

3.03.00 **Fabrication and Erection of Structural Steel Work**

Tolerances

I. Fabrication tolerances

(a) Maximum permissible gap in built up members

(b) Maximum permissible deviation in depth and/or width of girder at the joints

(c) Maximum permissible out-of-square of flanges in built-up girders

(d) Tolerances on length of beams and girders and their components

(e) Permissible deviation in column heights

All tolerances for above shall be as per drg / IS: 7215

II. Erection tolerances

(a) Permissible tolerances in erected steel columns

(b) Permissible tolerances in erected steel trusses

(c) Permissible tolerances in crane girder and rails

All tolerances for above shall be as per approved drg / IS: 12843

The tolerances for structural steel used for structural purpose shall be as referred in IS: 2062, IS: 1730

III. Requirement of pre-heating

Thickness of thickest part at the area of welding / heat affected zone	Welding using other than low hydrogen welding electrodes IS : 2062	Welding using low hydrogen welding electrodes or submerged arc welding IS:2062
Up to 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	66^0 C	20^0 C
Over 40 mm to 63 mm (including)	Not allowed	66^0 C
Over 63 mm	Not allowed	110^0 C

Acceptance Criteria

(a) The acceptance criteria of Non Destructive Testing (NDTs) on welds shall be as per AWS D1.1 (Dynamically Loaded Structures - tension welds). In case of failure of any of the tests, the Contractor at his own cost shall also carry out rectification of such defective welds. Retesting of the rectified joint, shall also be carried out by the Contractor at his own cost.

(b) Every 1st and further every 10th set of identical structure shall be checked for control assembly in shop before erection.

Embedded part

Tolerances shall be as specified under concrete works.

3.04.00 **Masonry & allied works**

Tolerances

(a) All masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the perpends properly aligned. Unless specified otherwise the tolerances in construction of masonry shall be as below:

i) Deviation in verticality in total height of any wall of a building more than one storey in height shall not exceed ± 12.5mm.

ii) Deviation from vertical within a storey shall not exceed ± 6mm per 3m height.

iii) Deviation from the position shown on the plan of any brickwork more than one storey in height shall not exceed 12.5mm.

iv) Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment shall not exceed 6mm.

v) Deviation of bed joint from horizontal in any length upto 12m shall not exceed 6mm, and in any length over 1m it shall not exceed 12.5mm total.

vi) Deviation from the specified thickness of bed-joints, cross-joints or perpends shall not exceed ± 3mm.

(b) The plastered surface shall be checked for

i) Blistering, bond failure or loss of adhesion, cracking, crazing, efflorescence, grinning, irregularity of surface texture, popping or blowing, recurrent surface dampness, softness or chalkiness defects and the remedial measures for the same shall be adopted as per IS: 1661.

ii) The finished plastered surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 metre length placed against the surface.

iii) The thickness of the plaster shall be measured exclusive of the thickness of key i.e., grooves or open joints in brickwork. The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm for plaster thickness above 12mm and 1 mm for ceiling plaster. Extra thickness required in dubbing behind rounding of the corners at junctions of wall or in plastering of masonry cornices etc. shall be ignored.

Acceptance Criteria

Following acceptance criteria shall be followed:

a) General workmanship is being good and as recommended by the manufacturer and approved by the Engineer.

b) Tolerances are within the specified limit.

c) Material test certificate is in compliance with the applicable codes/standards.

d) Bought out material is from the approved manufacturer / vendor. Bought out material is matching with the approved sample.

3.05.00 **Finishing & allied works**

Tolerances

a) The floor finish shall be checked specially for the following:

i) Level, slope, plumb as the case may be

ii) Pattern and symmetry

iii) Alignment of joints, dividing strips etc.

iv) Colour, texture

v) Surface finish

vi) Thickness of joints

vii) Details of edges, junction etc.

viii) Performance

ix) Precautions specified for durability

Local depressions on account of faulty workmanship shall not be acceptable. Tiles / natural stones with cracked or broken/chipped edges shall not be acceptable.

b) **The door, window, ventilator, partition** during and after fitting and fixing etc shall be checked for the following: -

i) Installation shall be at correct locations, elevations and in general on a true vertical plane.

ii) Fixing details shall be strictly as shown on drawings.

iii) Assembly of composite units shall be strictly as per drawing, with mastic caulking at transoms and mullions, gaskets, weather strips etc. complete.

iv) All frames on external wall shall be mastic caulked to prevent leakage through joint between frames and masonry.

v) All openable sections shall operate smoothly without jamming. Lock, fasteners, etc, shall engage positively. Keys shall be non-interchangeable.

vi) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint or same quality as shop paint.

vii) Aluminium doors, windows, ventilators, partitions etc., shall be free from scratches, stains or discolouration.

viii) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 2.5 mm.

3.06.00 A) **For False ceiling system following shall be checked for**

i) As installed shall be true to shape, level.

ii) Correctness for the opening for the fixtures, colour and shade.

iii) All joints shall be in the same line and cross-joints shall be securely fixed to walls.

iv) There shall not be any sagging and/ or unevenness in the surface

Acceptance criteria

Ceiling panels shall be best quality material in thickness and properties called for in the schedule of items. Material Test Certificate to be submitted before bulk supply.
Finished ceiling shall be at the correct plane and prevent an aesthetically pleasing and uniform appearance, free from sags and warps. Joints and exposed grids shall be in true lines and symmetrically placed in manner as shown in drawings. Cut outs for light fixtures, diffusers and other relevant services shall be of exact dimensions and in exact locations.

B) **Water proofing**

Water proofing shall be tested for water tightness by creating a pond of water minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces. Minimum 5% area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel/ drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and well junctions etc. which have been subjected for testing. The above testing shall be carried out prior to application of wearing course.

3.07.00 **Water Supply, Drainage & Sanitation**

Tolerances

a) All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. all sewers and drain laid below ground shall be watertight.

b) Obstruction / straightness test

The obstructions shall be checked by inserting a smooth ball, of diameter 13 mm less than the pipe bore at the high end of the sewer or drain. If absence of any obstructions, such as yarn or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at the lower end. The straightness shall be checked by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

c) Service pipes testing with water

The service pipes shall be slowly and carefully charged with water, allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working condition of pressure and flow, when all draw off taps are closed. The service pipes shall be checked for satisfactorily support and protection from damage corrosion and frost.

d) Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping of water shall be acceptable.

Acceptance criteria

Following acceptance criteria shall be followed:

General workmanship is being good and is recommend by the manufacturer and approved by the engineer.

Tolerances are within the specified limit.

Material test certificate is in compliance with the applicable is codes.

Bought out material is from the approved manufacturer / vendor.

Bought out material is matching with the approved sample.

EXHIBIT - I : TYPICAL FIELD QUALITY LAB EQUIPMENT

S.No	Equipment	Nos.
1	Vicat Apparatus with deskpot	2
2	Le chatelier flask	2
3	Le chatelier Mould	2
4	Cube Moulds for cement testing	12
5	Vibration Machine	1
6	Laboratory cement autoclave	2
7	Length comparator	2
8	Shrinkage Bar mould	2
9	Sieve shaker	1
10	Sieves for sand, coarse & fine aggregate	1 set for each
11	Sieves for coarse aggregate for Road	2 sets
12	Proctor testing equipment	4 sets + 18 cores
13	Slump testing equipment	6 sets
14	Oven	2
15	Physical balance	1
16	Rapid moisture meter	2
17	Digital Thermometer (range 0-300 o C)	4
18	Burette	2
19	Measuring cylinders	9
20	Measuring flasks	3
21	Cube compressive Strength Testing Machine of capacity 2000 kN (Automatic pilot, Hydraulically operated with digital display)	2 sets of 2000 kN capacity each
22	Cube moulds of assorted sizes	150
23	Electronic/ digital Weigh balance	2 (30 kg capacity), 2 (200 mg capacity)
24	pH balance	As per requirement

S.No	Equipment	Nos.
25	Radiographic facilities	Party should deploy BARC approved agency for carrying out RT
26	Mechanical weighing machine	1 (100 kg capacity)
27	Ultrasonic testing machine	As per requirement
28	D.P. Test kit	10
29	Vernier 300 mm, 600 mm	2
30	Micrometer (0.25 mm) out side (25.00)	2
31	Radiography film viewer	1
32	Inside Micrometer 25-750 dia	2
33	Digital elcometer for paint thickness	2
34	Baking oven for electrode	3
35	Portable ovens	2
36	Hot plate	2
37	Vibrating table for Cube casting size 1.0 m X 1.0 m as per IS : 2514	1
38	Pressure type Air content meter	2
39	pH meter digital with Calibration liquid	2
40	Thermostatically controlled Oven of size 600mmX600mmX600mm of range 0-300oC	2
41	Compaction factor apparatus	2
42	Pocket Penetrometer	4

Note: The list of equipment and their corresponding numbers shown above is indicative only. Contractor has to mobilize /arrange further equipments which are not shown in the above list or mobilize /arrange more numbers than indicated above as per instructions of the Owner from time to time without any additional cost to the Owner. No negotiations from EPC Contractor regarding this will be entertained at any stage.

EXHIBIT - II : LIST OF BOUGHT OUT ITEMS*

1. Zinc silicate primer
2. Polly Amide cured painting system
3. Epoxy based titanium dioxide / micaceaus iron oxide pigmented paint
4. High solid content liquid applied urethane based elastomeric membrane as per ASTM C836 and C898
5. Epoxy based coloured pigmented finish , polyamide cured paint
6. Epoxy adhesive and structure sealant
7. Electro Forged gratings of M.S. conforming to IS: 2062
8. Glass Block for Glass block masonry work
9. Unitized Glazing system of approved glass and structural system
10. Heavy duty C.C tiles with abrasion resistant Corborundum / quartz chips
11. Glass Mosaic tiles
12. Vitrified ceramic tiles
13. PTFE type sliding bearings
14. Modular aerated concrete panels with U channels as per IS:277m galvanized steel expansion fasteners and fiberglass tape
15. Colour coated metal decking
16. Troughed permanently colour coated sheets
17. Pre-Engineered Buildings .
18. Fire Proof single leaf / double leaf metal doors with mineral wool insulation, conforming to IS:3614 with panic device and panic lock, horizontal full width lever, openable on pressing door stoppers
19. Automatic operation systems for doors size 2000x2100 mm with all electrical and mechanical accessories
20. False Ceiling System
21. False Ceiling suspension System
22. Anchor Fasteners
23. Plasticizers

24. Aluminium composite panel cladding comprising of 4 mm thick thermoplastic core of mid low density polyethylene sandwiched between two skins of minimum 0.5 mm thickness.

25. Granular textured coating finish

*Note: The above list is indicative additional items if any, required for successful completion of work may be added in the list

SCHEDULE II

TECHNICAL SPECIFICATION

VOLUME # 4

(ELECTRICAL SYSTEMS)

Project	6 x 600 MW THERMAL POWER PLANT PROJECT AT NARIYARA, CHATTISGARH, INDIA	
Owner	KSK Power from knowledge	**Wardha Power Company Private Limited, India**
Owner's Consultants		**DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI**
E P C Contractor	SEPCO	**SEPCO Electric Power Construction Corporation, China**

薛利 1/4/09
(XUE LI)

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1/4/09
(XUE LI)

ANNEXURE-E, SECTION 3-B

SCOPE OF OFFSHORE SUPPLY

ELECTRICAL SYSTEM

SECTION-XVIII
ELECTRICAL SYSTEM

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VOLUME-II
SECTION-XVIII
ELECTRICAL SYSTEM

1.00.00 **GENERAL**

1.01.00 This section provides basic technical parameters and details of the Electrical system to be provided by the EPC (BTG + BOP) CONTRACTOR for engineering, supply, installation and successful operation of electrical system required for the plant.

1.02.00 The CONTRACTOR shall fully describe the plant and equipment offered together with the operation of the electrical system under normal, emergency, planned maintenance and abnormal/fault conditions.

1.03.00 All electrical equipment and material as offered shall conform to latest applicable standards published by the Bureau of Indian standards (BIS), International Electro technical Commission (IEC) as per Annexure-VIII, Central Bureau of Irrigation and Power (CBIP) and Central Electricity Authority (CEA) whichever is most appropriate. Chinese standard equivalent or superior to above standards is acceptable.

1.04.00 All electrical installation work shall comply with the provisions of the CEIG, Indian Electricity Act, Indian Electricity Rules, Code of Practices by BIS, recommendation of the Tariff Advisory Committee (TAC) and all other rules and regulations applicable to the work. CONTRACTOR to provide that all electrical and instrument panel tags shall be in English only.

Approval from statutory authorities shall be obtained by the CONTRACTOR. Necessary drawings, data and documents as required shall be furnished. Necessary changes or addition in design and installation if desired by statutory authority shall be carried out for meeting the approval of the authority concerned within the quoted price. CONTRACTOR has to submit the complete data sheet for the following equipments during detail engineering or after ordering:-

a. 400kV Switchyard equipments.
b. Generator.
c. Transformers. (GT, UT, ST and LT Transformer)
d. IPBD & SPBD
e. HT & LT Switchboards.
f. HT and LT motor above 30kW.
g. HT & LT Cables
h. Emergency DG Set.
i. Battery, Battery Charger & UPS.

CONTRACTOR will submit the Start up power requirement schedule shall be submitted during detailing. CONTRACTOR shall furnish the sizing of equipment

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according to the design criteria of specification and establish sizing meeting approval of the OWNER in basic design stage.

1.05.00 The plant and equipment supplied shall be suitable for heavy industrial use and selected from standard ranges of equipment having a record of proven operation success in a similar environment.

1.06.00 While selecting various equipment, due consideration shall be given to interchangeability in order to reduce spare requirement, and to maintainability by local skill level. Equipment of a type or design, which requires limited/infrequent or no maintenance, is preferred.

1.07.00 The plant and equipment shall be suitable for operation in its installed environment under all operating conditions and all extremes in the environmental conditions. Measures to prevent entry of dust, vermin, and rodent shall be considered. Space heaters, silica gel breathers shall be provided wherever required to prevent internal condensation.

1.08.00 Non-metallic materials used in the plant shall preferably be fire resistant type.

1.09.00 All equipment and material offered shall have satisfactorily passed all applicable type tests, conducted by an independent authority in accordance with the relevant National/International standards. The cost of any additional type testing required to meet this specification shall be included in the quoted price. Copies of type test certificates and supporting documentation shall be supplied. The plant and equipment shall also satisfactorily pass all applicable works routine and sample test and site tests in accordance with the relevant standard and this specification. All tests as per Annexure-IX shall be carried out by CONTRACTOR. Detailed QAP and test plan of all electrical equipments and systems shall be submitted for owner approval. Type test report of generator, generator transformer, and IP bus duct shall be provided which are not more fifteen year older instead of Carrying out type test on one set for this project. In case type test report is more than fifteen years, it shall be brought to notice of OWNER for their approval. All statutory clearance in India shall be in CONTRACTOR scope regarding type test reports

1.10.00 Minimum testing instruments to be supplied for testing and commissioning of electrical equipments shall also be included which can be taken back.

1.11.00 Field Quality Plan (FQP) shall be developed and submitted by CONTRACTOR for approval of OWNER which shall cover protocol.

1.12.00 The CONTRACTOR shall prepare pre-commissioning test performa of each equipment/ work / system indicating the data of each equipment / work / system. Pre-commissioning check list shall be as per ANNEXURE-VII attached in this specification.

1.13.00 In case of equipment being sourced outside India, the CONTRACTOR shall provide catalogue of all equipments for our understanding, list of manufacture, their web site, place of manufacturing.

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1.14.00 Calibrations certificate of electrical equipments shall be provided for approval. All CTs, PTs, transducers, meters etc. shall be calibrated at site before installation.

1.15.00 All live parts and connections shall be enclosed and access to such live parts shall not be possible during operation and maintenance unless all safety rules are followed.

1.16.00 Equipment such as switchgear, control panels shall be provided with a main earth bar and the complete plant shall be provided with safety earthing network so as to limit the step and touch voltage within the permissible limit.

Tropical Protection - All electrical equipments, accessories and wiring shall have fungus protection involving special treatment of insulation of and metal against fungus, insects and corrosion.

Electrical equipments shall be design for ambient of 50 deg.C and shall be suitable for operation at ± 10% voltage and ± 5% frequency variation and combined variation of voltage & frequency of 10% (except for generator voltage & frequency variation).

1.17.00 Electrical systems shall be designed to minimize the generation of harmonics, radio interference with communication system and electrical interference between power and control/instrumentation circuits.

1.18.00 All relays for Generator, GT, ST, UT, 400kV, electronic devices, DCS, SCADA shall have settings. All relays in 11kV switchgear shall have manual self-time settings.

1.19.00 All equipment shall be capable of operating satisfactorily at ambient air temperature of 50 deg.C. and relative humidity of 90%. In air-conditioned area like control room equipment may be designed for 40 deg C provided adequate redundancy in the air conditioning is kept.

2.00.00 SYNCHRONOUS GENERATOR

2.01.00 Ratings and Salient Parameters of Generator.

i)	Rated Output (MW)	--	600 MW, 3 Phase; stator winding cooled by DM water, stator core and rotor winding cooled by Hydrogen, complying with IEC 60034-1 & IEC 60034-3
ii)	Rated Frequency (Hz)	--	50 Hz
iii)	Rated Power Factor	--	0.85
iv)	Rated terminal voltage	--	* kV

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v)	Rated Speed	--	3000 rpm
vi)	Rated Phase Current	--	* A
vii)	Excitation Current at rated output.	--	* A
viii)	Short Circuit ratio (without negative tolerance).	--	0.5
ix)	Direct axis synchronous reactance (unsaturated)	Xd	* Pu
x)	Direct axis transient reactance (unsaturated)	Xd'	* Pu
xi)	Direct axis sub-transient reactance (unsaturated)	Xd"	* Pu
xii)	Permissible voltage & frequency variation, with rated output.		
	a) Voltage	--	As per IEC - 60034
	b) Frequency	--	As per IEC - 60034
	c) Combined frequency & voltage	--	As per IEC - 60034
xiii)	Winding insulation/temp. rise		
	a) Stator		Class F temperature rise limited to Class B
	b) Rotor		Class F temperature rise limited to Class B
xiv)	Without exceeding temp. rise limits the de-rated capacity of generator with ±10% voltage variation, ±5% freq. Variation and ±10% Combined variation.		*

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xv)	Limit of Unbalanced loading continuous		As per IEC - 60034
xvi)	Overspeed withstand capability for 2 minutes		120%
xvii)	Capacity of generator in the event of outage of one cooler section.		67 % (with 10% tubes plugged in each cooler)
xviii)	Excitation System	--	Static
xix)	Automatic Voltage regulator	--	Microprocessor based digital type having two auto and one manual channel.
xx)	AVR response time		*

(* To be filled in by CONTRACTOR)

xxi) Rated output of the generator shall be 600MW at 100% TMCR and also be capable of generating additional power corresponding to VWO condition of turbine.

2.02.00 Parallel Operation

The turbine generator units shall be capable of synchronizing and running in parallel with power grid. Also the generator shall be capable of running in isolation with house load i.e. power plant auxiliary loads.

2.03.00 Specific requirement

The turbine generator units shall be statically and dynamically balanced. The CONTRACTOR shall indicate the maximum vibration level that can be tolerated on the bearings during operation of the machines.

The radiated sound level of the turbine generator units shall be as per IEC.

2.04.00 Scope

The generator shall have, but not limited to, the following items: -

i) One (1) set of static excitation system with field suppression/flashing equipment, excitation transformer, thyristoerized rectifier, interconnecting special cables etc. complete with all equipment & accessories. Generator reactive capability and short circuit withstand capability will be submitted by CONTRACTOR.

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ii) CONTRACTOR will also provide hardwired backup panel for metering, control and indication for generator transformer breaker.

iii) Microprocessor based digital Automatic Voltage Regulator.

The Hardwired backup panels for auto/manual with check synchronization complete with synchronizing relay, meter, indicating lamps and control switches.

ii) All local and remote monitoring/supervisory instruments complete with generator instrumentation as per ANNEXURE-I including sensing elements, connecting pipes/tubes/wirings.

iii) All equipment and accessories to facilitate erection, maintenance and removal of the equipment.

iv) Equipment for all generators required for generator drying out operation during commissioning.

CONTRACTOR will provide that the generator including its auxiliary and ancillary systems shall be designed for the same or higher MTBF as the turbine. The generator shall have the same life expectancy as the turbine, taking into account the operating cycles expected for the entire turbine-generator set (overhauls).

2.06.00 Operating Conditions

a) System Operation

The generator shall be connected to 400 kV Switchyard through Generated voltage / 420kV, Delta/Star generator Transformer. The generator shall be non-effectively earthed through a distribution transformer and secondary loading resistor. It shall be capable of operating alone or in parallel with other generators and/or utility power system.

b) Voltage & Frequency Variation

The generator shall be capable of delivering continuously the rated output at rated power factor without exceeding the specified temperature rise when the voltage variation is within ± 5% of the rated value and frequency variation is within ± 2% of rated value (with out undue heating and vibration).

c) Extended Voltage & Frequency Variation

Generator shall be capable of delivering continuously the rated power at rated Power Factor when the voltage variation is within ± 5% and the frequency variation is within +3% and –5% with temperature rises to increase by up to 10°K approximately. CONTRACTOR shall specify the

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safe cumulative time for under frequency operation for the unit. Generator shall be able to operate in synchronism with grid with ±10% Voltage or ± 5% frequency or 10% Composite variation of voltage and frequency at reduced output, so that the generator temperature does not exceed the temperature limit.

d) Combined Voltage and Frequency Variation

The generator shall be capable of delivering continuously the rated power at rated power factor when the absolute sum of combined voltage and frequency variation is as per IEC of the rated value without exceeding the specified temperature rise.

The CONTRACTOR shall also indicate compliance to IEC-60034 for voltage, frequency variation beyond this limit. The permissible loading of generator for such variation shall also be furnished.

e) 3 Phase Short Circuit Withstand Capability

The generator shall be capable of withstanding, without damage, a three phase short circuit at the terminals for three (3) seconds when operating at the rated output and power factor, at 5% over voltage with fixed excitation. Also the generator shall be capable of withstanding stresses developed during fast reclosing of EHV lines under fault condition.

f) Operation under Unbalanced Load

The generator shall be capable of operating continuously on an unbalanced system such that, with none of the phase currents exceeding the rated current, the ratio of the negative sequence component of the system of currents to the rated current shall be as per IEC-60034.

g) Operation under Unsymmetrical Short Circuit/Unbalance Load

The generator shall be capable of withstanding, without damage, any unsymmetrical short circuit at its terminals or unbalance loading on the system, provided the per unit negative phase sequence component (I_2) of the unsymmetrical currents and the duration of short circuit in seconds (t) are limited to values which give an integrated product I^2_2t as per IEC-60034

h) Capacity with one Cooler out of Service

The generator shall be capable of delivering the 67 % rated output continuously without the specified temperature rise exceeded with one cooler section out of service for maintenance and 10% tubes plugged in each cooler.

i) Overload Capability

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With balanced current, the short time thermal capability of the generator armature shall permit operation at 150% of the rated armature current for at least 30 seconds starting from stabilized temperature at rated load.

j) Generator Capability Diagram

The CONTRACTOR shall submit the capabilities of the generator at various hydrogen pressures in addition to rated and at different power factor leading and lagging, clearly indicating the operating limits. The constraints and limitations imposed for operating the unit shall be highlighted. CONTRACTOR will submit all the performance curves as indicated during detailing.

k) Line Charging Capacity

The line charging capability (MVAR) of the generator shall not be less than 35% of its rated MVA.

In addition, the generator shall be capable of stable operation at 0.95 (leading) power factor when delivering its rated MW at rated voltage.

l) Over Speed

The over speed requirement shall be 1.2 as per IEC 60034-1.

m) Limits of Maximum Temperature

The stator and rotor windings inclusive of main and neutral leads shall be provided with copper conductors with class F insulation. The maximum temperature rise shall be limited to that of Class B insulation adjusted for ambient temperature and the rated voltage when delivering the rated output of the steam turbine at 0.85-power factor and the Cooling water temperature of 33°C.

2.06.00 Generator Design and Construction

2.06.01 Stator Housing

a) The stator housing shall be of totally enclosed, gas tight construction, having sufficient mechanical strength and rigidity to withstand internal hydrogen explosion without any damage or permanent deformation.

b) The housing shall have suitable provisions for handling, lifting and/or jacking. Manholes with sealing arrangement shall be provided to facilitate inspection of terminals, internals etc.

c) All leads, including power, control and instrumentation shall be brought out of the generator housing through gas tight seals. Power leads shall be accessible for carrying out maintenance.

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d) The dimensions of the stator body shall be within the maximum permissible rail/road transportation dimensions within the country. The CONTRACTOR shall coordinate with the Railway/surface transportation Authorities and shall ensure that the clearance for transportation of the stator from the port of unloading to the project site has been duly obtained.

2.06.02 Stator Core

a) The stator core shall be fabricated out of best quality grain non-oriented silicon steel so that losses are minimum.

b) The core assembly and mounting arrangement shall be such that the transmission of the forced vibration of the core to the housing and foundation is effectively restricted.

c) The core assembly shall have adequate ventilation ducts for cooling by hydrogen. Magnetic screens shall be provided to reduce the end zone heating by leakage flux.

2.06.03 Stator Winding

a) The winding insulation shall be epoxy thermosetting or VPI type and rated for class `F' with temperature rise limited to class 'B'.

b) To prevent slot discharge in the gaps between the bar and the slots, necessary semi-conducting coatings, fillers etc. shall be provided.

c) Firm seating of the stator bar in the slot shall be ensured by proper wedging and fillers. Ripple springs shall be provided below the slot wedges to compensate for any future shrinkage and ensure permanent firm seating of the bars in the slot during operation. The overhangs shall be suitably braced and supported to withstand the forces during normal operation and sudden short circuit at generator terminals as per IEC 60034, when the machine is operated at rated MVA, at rated power factor and 5% over voltage. Teflon hoses with necessary dielectric strength shall provide the connection between cooling water manifolds and the stator bars. Cooling water pipes, manifolds and fittings shall be of stainless steel, further these shall be suitably insulated from the stator housing to facilitate checking of winding insulation resistance.

d) Impulse voltage strength of generator stator winding shall be 4U + 5, where U = Rated voltage.

e) Dielectric test voltage of generator winding shall be 2U + 1, where U = Rated voltage and the same for terminal bushings shall be 1.5 times the one minute test voltage of winding.

2.06.04 Winding Connections and Terminal Bushings

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a) The stator winding shall be star connected with three (3) phase and the three (3) neutral terminals brought out separately.

b) All phase and neutral terminals shall be brought out from the bottom of the generator (non-driving end) and located in a non-magnetic steel terminal box. Phase terminal bushings shall be spaced to permit connection to isolated phase bus duct to provide complete phase isolation directly up to the generator housing. Adequate spacing shall be provided between phase and neutral bushings to permit connections of the neutral enclosure.

c) The terminal bushings shall be tested for power frequency and impulse withstand characteristics as per relevant standard consistent with applicable voltage level.

d) Hydrogen cooled terminal bushings shall be provided and shall be complete with silver-plated terminal connectors.

2.06.05 Rotor Body

a) The rotor shall be forged in one piece from alloy steel to ensure required mechanical strength and magnetic properties.

b) The forging shall be subjected to elaborate ultrasonic and mechanical tests to ensure freedom from any internal defect

c) The rotor with all the details mounted shall have an adequate margin between critical speed and the running speed to ensure smooth running between 47.5 to 51.5 Hz.

d) After assembly, the rotor shall be dynamically balanced and subject to 120% of rated speed for 2 minutes.

2.06.06 Rotor Winding

a) Winding insulation shall correspond to Class-F, i.e. glass, mica, nomex etc. with temperature rise limited to Class-B.

b) Rotor winding shall be secured in the slots by suitable slot wedges and fillers. The overhung portion of rotor winding shall be held in position against centrifugal force by retaining rings.

c) The retaining ring shall be machined from high strength, non-magnetic alloy steel forging. The retaining rings shall be floating type, shrunk on rotor body and prevented from axial movement by snap rings/locknuts.

d) Suitable provision shall be made in the rotor particularly for the end zones to permit circulation of negative sequence current during any asymmetrical and asynchronous operation.

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2.06.07 Bearings

a) The generator shall be provided with end-shield-mounted bearings. The bearings shall be of split construction and forced lubricated from turbine oil system. Oil baffles shall be provided to prevent leakage of oil along the shaft.

b) Bearings shall be insulated from stator frame and foundation plate to prevent shaft current. Provision shall be made for bearing insulation measurement while the machine is in operation

2.06.08 Shaft Seals

a) Shaft seals, preferably of floating ring type, shall be fitted to the end shields to prevent hydrogen leakage from generator housing. To ensure effective sealing, seal oil pressure in the annular gap between the rotating shaft and seal ring shall be maintained at a higher level than the gas pressure in the generator casing.

b) The H2 side seal oil housing shall be provided with oil baffle rings to prevent intrusion of seal oil into the generator along the rotor shaft.

c) The shaft seals and oil piping shall be suitably insulated to prevent flow of shaft current.

2.06.09 Slip Rings

a) The slip rings, if required, shall be located in an accessible position. The slip ring enclosure shall be provided with latched door, internal illumination and safety glass observation windows on each side.

b) The enclosure shall be natural air ventilated with intake filters to clean the cooling air and discharge filters to prevent discharge of the dust from brushes to the turbine room.

c) The slip rings shall be helically grooved, alloy steel rings, shrunk fit into the shaft but insulated from it. Provision shall be made for easy change of slip ring connection for uniform wear of slip ring.

d) Brushes shall be removable, replaceable and pressure adjusted without use of special tools. The design shall be such that these works can be accomplished with the units is in operation.

e) For monitoring the rotor winding insulation and shaft voltage a separate brush suitably mounted shall be provided.

f) There should be adequate redundancy in carbon brushes so as to ensure smooth operation in the event of replacement of brushes in one assembly.

2.06.10 Grounding

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- Two (2) detectors for slip ring inlet and outlet air temperature (in case of static excitation system).
- Temperature detectors for seal oil, in case seal oil cooler is provided.

b) All temperature detector leads shall be brought out to a terminal box suitably located on the either side of the generator frame for easy access. The leads shall be suitably fastened to the frame to prevent movement and shielded against stray field.

c) The manufacturer shall indicate the details as offered clearly in their proposal.

d) In addition to the ETDs, temperature switches shall be provided as required for alarm and interlocks.

e) All the above temperature detectors shall be duplex type. However two (2) nos. simplex type detectors in place of each duplex type detector may also be provided.

2.06.12 Seal oil system

a) System

Seal oil system supplies pressurized oil at shaft seals to prevent leakage of Hydrogen from and ingress of air into generator housing.

Seal oil pressure shall be maintained automatically at higher level than the H_2 pressure in the generator housing over the entire operating range. The design shall be such as to reduce H_2 - diffusion loss through seal oil to a minimum and maintain high H_2 - purity level inside the generator casing.

b) Components

All components, tanks, instrumentation etc as required for safe & efficient operation of system shall be considered.

c) Main Features

The seal oil stream shall have 2 x 100% A.C. motor driven pump - one running and other standby for automatic cutting in on loss of seal oil pressure. Upon failure of both pumps, the seal oil supply shall be maintained by a 100% emergency seal oil pump (D.C. motor driven) without any interruption shall be provided on both air and hydrogen side. There shall be individual starting/control panels for each pump and one common signaling panel. The A.C. seal oil pump shall also be connected with D.G. set to cater emergency.

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a) Generator Housing

The generator shall be provided with four (4) nos. grounding pads complete with bolts, plain & spring washers for connection with Purchaser's ground grid. All other equipment shall be provided with at least two (2) no. grounding pads to comply with regulation.

b) Generator Shaft Grounding

Suitable provision with brushes and brush holders shall be made for generator shaft grounding and measurement of shaft current & voltage.

c) Generator Neutral Grounding

The Generator neutral shall be grounded through a distribution transformer, which shall be loaded with a resistor in secondary winding. The maximum design ground fault current through generator winding and core shall be considered as 10A amperes for one second to avoid any core damage.

Provision for generator neutral grounding voltage and current measurement shall be provided.

CONTRACTOR will provide Continuous and Intermittent duty of Neutral Grounding Transformers and Loading Resistor during basic design.

2.06.11 Temperature Measurement

a) Embedded temperature detectors, resistance or thermocouple type, shall be built into the machine for measurement of temperatures of various active parts, bearings and cooling medium etc. The minimum requirements are listed below:

- Twelve (12) detectors, four per phase and uniformly distributed around the stator, located between insulated coil sides in stator slots.
- Twelve (12) detectors for stator core of which six (6) shall be located in the end zones.
- One (1) detector in gas stream entering and one (1) in gas stream leaving each hydrogen cooler.
- One (1) detector in water inlet and one (1) in water outlet of each hydrogen cooler.
- One (1) detector in the primary water inlet and three (3) detectors at the primary water outlet of the stator winding.
- Two (2) detectors for each generator bearings, located in the lower bearing sleeve.

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Seal oil coolers (if required by the CONTRACTOR) and filters shall be of 2 x 100% capacity designed for 36 Deg.C cooling water (DM quality) temperature. The piping and valve arrangement shall permit taking out any cooler/filter without affecting operation of the system.

Seal oil system shall have connection to turbine main oil system for make-up and also for excess return. The turbine main lube oil system shall also serve as a back-up to seal oil system in the event of failure of both AC & DC Pumps. The H_2 side oil drain shall be suitably degassed before being returned to main oil system.

The Seal Oil system shall preferably be supplied through two separate and independent stream - one for air side and the other for H_2 - side the arrangement shall be such that even in case of failure of H_2 - side stream, sealing shall be maintained by the air-side stream.

2.06.13 Gas system

a) The gas system comprises a hydrogen gas circuit, for cooling the stator core and rotor windings, complete with a carbon-di-oxide scavenging system.

b) The system is required to fill the generator with hydrogen, maintain it under pressure, monitor and control gas purity, and to empty the generator of hydrogen.

c) The design is such as to ensure safe filling/emptying by preventing formation of explosive H_2 - air mixture. For filling, air is first displaced by CO_2, which in turn is replaced by H_2. While emptying, H_2 is first displaced by CO_2 before admission of air in the machine.

d) The major system components are H2 and CO2 gas manifolds, H2 and CO2 cylinders, H2 gas coolers, side stream H2 drying equipment, inter-connecting pipings, fittings, valves, gauges and other instruments, control monitoring panel complete with annunciation. Hydrogen shall be circulated in the generator in closed circuit by fans fitted on the rotor shaft at either end. H2 gas is cooled by ACW water heat exchangers located in the generator housing. The cooler shall be of sectionalized design such that with one cooler section out of service, the unit can carry at least two-thirds rated load continuously, without exceeding the permissible temperature limits. Hydrogen coolers shall be so designed that it is possible to meet the full load requirement of the machine with at least ten (10) percent of the tubes in each cooler plugged.

e) Two (2) full capacity refrigeration type H2 - drier with in - site reactivation facility shall be provided. The arrangement shall be such that one drier can be taken out of service for reactivation without affecting the system performance in any way.

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f) The valves in gas system shall be of special design to minimize gas leakage. Safety relief valves shall be furnished both on low and high-pressure sides of the gas system. A manually operated vent valve shall be provided for discharging casing hydrogen to atmosphere in case of emergency to a location outside the building top.

g) During the transportation, storage and also during long shut down the machine shall be kept under nitrogen atmosphere. CONTRACTOR shall bring out the requirement, if any, of Nitrogen gas. The complete nitrogen system along with the necessary nitrogen cylinders shall be furnished for each machine.

h) Hydrogen storage & handling unit shall be located following the rules of Indian Explosives.

2.06.14 Stator Cooling system

a) System

The stator cooling water shall be of DM closed cycle cooling system. The system comprises the closed loop, dematerialized (primary) water circuit for direct cooling of stator windings. Primary dematerialized water shall be cooled in the stator coolant heat exchanger by means of secondary cooling water, which is a part of the plant auxiliary cooling water system / DM Water System.

The design for secondary water circuit shall be such as to ensure a continuous flow of auxiliary water at constant winding inlet temperature, while maintaining the water quality to the desired level of purity The maximum water pressure in the stator conductors shall be automatically maintained below the minimum hydrogen pressure over the entire operating range. Provision to remove entrapped air/gas in the stator winding/stator water system and provision to check hydrogen leakage through winding and system shall be made. There shall be individual starting panels for each pump and one common signaling panel.

b) Components

The system essentially comprises primary water storage tank, cooling water one (1) running and one (1) standby pump, water/water heat exchangers and filter units, one polisher unit with redundancy, interconnecting piping, fittings, valves, gauges, conductivity cells and regulating equipment. A stator cooling water control cabinet shall be furnished complete with control devices for operating and monitoring the system, runback and protective circuitry and annunciators.

c) Main Features

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The storage tank shall have liquid level indication and shall be supervised by a float switch, which actuate alarm if the level varies above or below normal.

The pumps, heat exchangers and the filters shall have standby facility. The standby pump shall be switched on automatically.

The piping and valve arrangement shall be such that any pump/ cooler/ filter can be taken out of service for maintenance, without affecting the full generator output.

All metallic material used in the conductor cooling system that come in contact with the water shall be stainless steel, copper-nickel, brass or similar materials to provide a system resistance to corrosion and which shall have no effect on the cooling water resistivity.

The packing for joining the pipes flanges shall be Teflon/neoprene type. All the fittings of Teflon hoses and manifold should ensure leak proof joints.

2.07.00 Generator Excitation System

2.07.01 General Requirements

a) Generator Excitation System and Generator Protection shall meet the specification requirement. Details shall be furnished in basic engineering stage. A complete generator excitation and voltage regulating system shall be furnished with the generator. The dual channel excitation system shall be static type with all features including V/f limiter and protection. The excitation system offered shall be of proven design and have a satisfactory field service record on machines of similar size and construction of the system offered along with the appropriate evidence of the satisfactory performance record shall be submitted with proposal. Necessary junction boxes shall be provided, system wise, for wiring/looping the field devices in the vicinity of about 5 meters.

b) The excitation system shall be complete with excitation power requirements, voltage regulators, dry type excitation transformer, De-excitation equipment, thyristor rectifier, field flashing equipment and the equipment & devices required for protection of excitation systems (including ground fault). AVR shall ABB make.

c) The excitation system shall have matching characteristic suitable for satisfactory parallel operation in the plant. Automatic voltage regulators shall be of digital type.

d) The various changeover, relays and other equipments which are not controlled by the control supply required by AVR, electronic circuits of either mode, shall be such that the loss of their control supply shall not lead to the excitation system outage.

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e) The necessary inputs and interface equipment shall be provided with Generator Excitation System and Automatic Voltage Regulator for hooking up with Turbine Automatic Run up System and Electro-Hydraulic Governing System.

f) Remote indication (i.e. at DCS or SCADA system) of generator excitation to show it's healthy and faults shall be included. Hardwired backup panel for control indication and monitoring.

g) Generator excitation system shall meet the requirement of CEA norms & CSEB grid code operations.

2.07.02 Salient Data for Design and Sizing of Equipment

a) The excitation system shall be of high initial response type and shall be rated to continuously carry currents at least 10% (ten) above the rated generator field current requirement. The ceiling voltage shall be at least 200% of the voltage required at MCR condition. Response ratio of the excitation system shall not be less than 2 (two).

b) The excitation system shall control the field voltage of the generator in such a way that the transient changes in the regulated voltage are effectively suppressed and sustained oscillation in the regulated voltage are not produced by the excitation system during steady state load condition or following a change to a new steady state condition.

c) The system shall be capable of maintaining the generator terminal voltage to within ±0.5% of the preset value over the whole load range of the machine.

d) When the generator is subjected to a sudden loss of rated output at rated power factor, the system shall be capable of restoring the voltage to within 2% of the nominal preset value within negligible time.

e) It shall be possible to make remote variation of reference voltage setting from 90% to 110% of the rated nominal value under all load conditions to take care of the system voltage variation.

f) The excitation system shall be capable of supplying without damage to any of the components, the field forcing voltage and current of the system for a period of 10 seconds with the equipment initially at normal operating temperature.

g) For static excitation the converter bridge shall have N-2 redundancy

h) A method of control shall be incorporated to limit the per unit ratio of generator voltage/frequency to such a value that a maximum generator transformer core flux density does not exceed the permissible & safe value.

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Main field flashing, over voltage protection

Field breaker cubicle

Interconnecting cables

b) Features of Major Equipment

1. Field Suppression System

This comprises of essentially a one-pole field breaker and non-linear field discharge resistor. The field breaker shall have two (2) trip coils. A crow bar comprising of two anti-parallel thyristor groups shall be included as additional over voltage protection. The CONTRACTOR shall indicate detail of cooling system envisaged

2. Excitation Transformer

Transformer shall be epoxy moulded dry type, 3 phase step down with F class of insulation complete with flanges and terminal lugs for connection to the generator terminals through isolated phase bus duct. Temperature rise of winding shall be limited to 70 deg C over ambient temperature. The transformer shall be housed inside sheet steel cubicle. Rollers for transformer movement shall be provided. CTs as required shall be provided for transformer protection

The primary and secondary winding of transformer shall be shielded with grounding. The excitation transformer capacity shall satisfy with the requirements of field forcing and all generator operation conditions including maximum continuous generator operating condition.

Signal and protection

Winding temperature

Stage I Over-temperature alarm
Stage II Over-temperature trip and de-excitation (as external trip)

3. Thyristor Rectifier

Three phase full control with inverse operation possibility. Thyristor bridges design has (N - 2) redundancy. If two bridge is out of operation, the other can satisfy with the requirement of all operation conditions including 1.1 times rated excitation current except field forcing. Ultra-speed fuses shall be equipped against short circuit in time. Cooling method shall be forced open air, and adopts reliable fans with low noise.

4. Field Flashing

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i) The AVR measurement circuit shall be suitable for 5 Amperes current transformer secondary and 110 Volt potential transformer secondary (phase to phase).

j) Normal control of excitation system shall be by automatic voltage regulator but manual control shall also be provided.

k) Provision shall be kept for power system slip stabilizer (PSS) to provide positive damping in case of static excitation system.

2.07.03 Performance Requirement

a) The excitation system shall have sufficient reserve and redundancy to permit effective utilization of generator capability over the entire operating range and under all service conditions without any restriction.

b) The system shall function without hunting and shall be capable of preventing any abnormal change or oscillation in the generator voltage.

c) The system shall have high initial response to improve steady state and dynamic stability of the generator.

d) The excitation system shall be capable of maintaining generator voltage within± 0.5% of the preset value over the entire load range of the machine.

e) The reference voltage set point shall be adjustable over a range of 85 to 110% of the nominal rated voltage under all load conditions.

f) The rated current and voltage of the excitation system shall be 110% of the machine excitation requirements at rated output. The ceiling voltage shall not be less than 200% of the machine excitation voltage.

g) The system shall be capable of supplying the field forcing requirement for at least 10 seconds.

2.07.04 Static Excitation System

a) System components

The system shall comprise of the following major components, but not limited to:

Excitation Transformer

Automatic voltage regulator

Thyristor converter cubicles with regulating cubicle

Dc excitation cubicle housing field breaker

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Field flashing power source shall be from auxiliary supply. Short time operation allowed to be initiated every 5 minutes. The field flashing time is not more than 10 sec. The flashing circuit shall be switched off automatically in the case of failure of field flashing.
Field flashing equipment shall ensure that AVR could put into operation reliably, when generator voltage is less than 10%.

2.07.05 Static Excitation System

Contractor shall submit brief write up on static excitation system during detail engineering.

2.08.00 Automatic Voltage Regulator (AVR)

2.08.01 The automatic voltage regulator assembly shall be installed in an indoor cubicle. This shall include all the equipment necessary to receive power from excitation transformer. The AVR consists of microprocessor based Digital Voltage regulator with two independent modes of operation

a) Dual Auto mode
b) Manual mode

2.08.02 The AVR shall consist of but not limited to the following.

a) Voltage detector assembly
b) Voltage rectifying, filtering and comparing circuitry
c) Reactive current compensator assembly
d) Digital Automatic Voltage Regulator.
e) Signal mixer assembly
f) Limiting modules such as maximum excitation limiter, rotor angle limiter, stator current limiter, rotor current limiter.
g) Firing circuit module with silicon controlled rectifiers in the power amplifier assembly.
h) To provide maximum operational reliability of the voltage regulator, dual power amplifiers and pulse generators shall be furnished.
i) Arrangement shall be made for both automatic and manual control of the voltage regulator from plant DCS including raiser/lower.
j) Follow-Up Circuits
CONTRACTOR will provide two auto and one manual channel. In order to avoid a sudden change from 'Auto' to 'Manual' operation, a automatic changeover device (include in AVR) will be provided to follow-up changes in 'Auto' mode. An alarm and visual indication will be provided by means of a relay to indicate changeover from 'Auto' to 'Manual'. Automatic changeover will be possible from 'Auto' to 'Manual' in case of loss of main feed back by any of voltage transformer fuses blowing up. The comparison of output from the error amplifier with that from the hand controller will be indicated on local display screen..
k) Power factor control circuitry
l) Power system stabilizer

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2.08.03 The parameters for AVR shall be as follows :

a)	Range of voltage level of generator	:	±10% of the rated voltage in all modes of operation adjustments
b)	Frequency range of operation	:	47.5 to 51.5 Hz
c)	Range of transformer droop compensation	:	0 to 15%
d)	Accuracy with which generator terminal voltage is to be held at the set valve.	:	Not less than ± 0.5% of the rated voltage.
e)	Max. change in generator voltage when AVR is transferred from 'Auto to manual' under all conditions of excitation	:	Less than 0.5% of the rated voltage.
f)	Manual control range	:	70% of no load to 110% full load excitation.
g)	Excitation system response time (time required for the increase in generator field voltage upto 95% of the difference between ceiling voltage and the rated voltage.	:	0.05 Sec.

The AVR shall have negligible dead band and high speed of response. The system shall consist of an automatic and a separate manual voltage regulator suitable for remote operation and shall employ an accurate automatic follower device and changeover switch for changing from automatic to manual control and vice-versa under all operating conditions. Auto channel shall have all redundant hot stand-by modules changeover from service modules to hot stand-by modules should be bump less.

The regulator equipments shall be free from voltage drift and temperature errors.

2.08.04 The AVR shall have the following facilities built into it through software programme.

a) Regulating the generator terminal voltage to the set valve.

b) Maximum and minimum excitation limiter in auto-excitation control.

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c) Manual control complete with follow up device.

d) Automatic change over form 'Auto' to 'Manual' after field forcing and over excitation condition with a predetermined time delay.

e) VT fuse failure circuit with trip to manual

f) Volt/frequency limiter circuit.

g) Stator current limiter.

h) Power factor regulator

i) Power system stabilizer.

j) Transformer droop compensation.

k) Local panel indication for thyristor converter condition and isolator position.

2.08.05 The features incorporated in the AVR shall be as follows:

a) Transformer Droop Compensation

Suitable feed back proportional to generator transformer droop shall be provided for transformer droop compensation.

b) Slip Stabilizer

The system shall be provided with a slip stabilizer in which a supplementary control signal proportional to the rotor speed provide positive damping of the electro-mechanical oscillations at all frequency in the range of 0-3HZ that occurs as a result of system disturbances. Facility for remote switch ON-OFF, automatic blocking and supervision facility shall also be provided.

c) Rotor angle limiter

A rotor angle limiter shall be incorporated in the system. This shall enable to keep the angle between the direct axis of the machine and network axis of the machine, and network vector within the set reference value as determined by stability by adjusting the excitation.

d) Stator Current Limiter

The stator current limiter shall influence the voltage regulator depending on the nature of operation i.e. under excited or over-excited operations. The stator current limiter shall act immediately in under-excited range. The time delay in over excited range shall enable a temporary overloading of the machine.

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e) Rotor Current Limiter

A rotor current limiter shall be provided for protecting the field winding against overheating. The regulator shall act with time delay, so that the regulation dynamic are not impaired in case of a fault.

f) In order to avoid a sudden change in generator voltage when voltage regulation is transferred from `Auto' to `Manual' a automatic changeover device shall be provided to follow-up changes in `Auto' mode.

g) An alarm and visual indication shall be provided by means of a relay to indicate change-over from `Auto' to `Manual' Automatic change over shall be possible from `Auto' to `Manual' in case of loss of main feed back by any of voltage transformer fuses blowing up, loss of reference voltage and also during over excitation. A centre zero balance meter shall be provided for comparison of output from the controller shall be indicated on local display screen.

h) Automatic changeover from `Auto' to `Manual' mode shall give annunciation in local panel with facility to duplicate the same in the remote, control room. List of troubles for which such changeover is envisaged shall be listed in the proposal.

2.08.06 Other Requirements

The CONTRACTOR shall furnish in his offer, the VA burden accuracy class, type of connection etc. of CT's and VT's required to feed the AVR from the generator terminals.

The CONTRACTOR shall also furnish in his offer the details regarding technique and time period for rapid defluxing of the machine in case of any internal or external fault.

In addition the excitation system shall include the following control and protective features:

a) Generator and exciter field ground detectors with a time delay to prevent false ground indication during transients. Necessary slip ring/shaft brush shall be provided for this purpose.

b) Generator field over voltage protection to trip the generator.

c) Alarm for inoperative condition of each diode/thyristor cells.

d) The power system stabilizer is conjunction with the excitation system shall be adjustable to provide damping torque to the machine system and tie line oscillation in the range of 0.1 to 3 Hz. Equipment required for the generation of the control signal to the stabilizer shall be furnished as part of stabilizer.

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e) The power system stabilizer parameters shall be coordinated with the parameters of the turbine-generator and the excitation system such that the loading capability of the generator can be fully utilized.

f) There shall be provision for changing polarity of rotor magnetic field

g) Remote indication (i.e. at DCS or SCADA system) of AVR to show it's healthy and faults shall be included.

h) AVR shall meet the requirement of CEA norms and CSEB grid code operations.

2.09.00 **TESTING AND INSPECTION**

The following tests shall be conducted on turbine generator:

2.09.01 **Generator Tests**

General

The tests listed below shall be carried out on generator to be supplied. If possible, running trials shall be conducted for the generator, exciter and automatic voltage regulator equipment combined as a unit, on the test bed and the contractor had indicated to meet these test requirements.

The readings taken during the electrical tests, the results noted, and the calculations made are to be included in a test report which shall include, inter-alia description of test method, equipment used and any limitations of the test plant.

Shop Tests

Shop test conducted on various parts/components of generator and auxiliaries during manufacture, by the CONTRACTOR shall be specifically carried out and shall be submitted to OWNER for review.

2.09.02 **Inspection & Testing of Generator**

a) Routine electrical tests on generator

i) Measurement of insulation resistance of the following before high voltage test:

- Terminal Bushings.
- Stator windings, including tan delta measurement.

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- Rotor windings.
- Embedded resistance thermometers.
- Exciter side bearings and oil pipe connections.

ii) Measurement of the DC resistance of the following:

- Stator Winding.
- Rotor Winding.
- Embedded Resistance thermometers.

iii) Determination of generator open circuit characteristics.

iv) Stator Phase Sequence Checking.

v) Measurement of mechanical losses.

vi) Determination of short circuit characteristics.

vii) Measurement of core losses at the rated voltage and frequency.

viii) Determination of direct axis synchronous reactance.

ix) Determination of potier reactance.

x) Equivalent heat runs to determine temperature rises comprising of an open circuit run at 110% of the rated stator voltage followed by a short circuit run at the rated stator current. A zero excitation heat run may be conducted at the Contractor's option but in the absence of such a test no correction for the inclusion of zero excitation losses in both the open circuit and short circuit heat runs shall be allowed in the calculation of temperature rises of the stator and rotor windings.

xi) Determination of generator efficiency by the separation of losses at 100%, 80%, 60% and 50% load.

xii) AC high voltage test of stator winding and stator terminal bushings after heat run test.

xiii) Measurement of rotor winding impedance.

xiv) AC high voltage testing of the field windings after the heat run test, with the rotor revolving at 3000 rpm and also with the stationary rotor.

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xv) High voltage testing of resistance temperature detectors after the heat run test.

xvi) Measurement of the insulation resistance of the items listed under (i) above after the high voltage test.

xvii) Calculation of the temperature rise of the stator and the rotor.

xviii) Retardation test.

xix) Measurement of phase to neutral and phase to phase capacitance of all the three phases of the stator and the rotor and calculation of the equivalent generator capacitance as viewed from the generator terminals; also the measurement of the capacitance between the complete winding and the body and the dissipation factor.

xx) Hydrogen leakage test.

xxi) Partial discharge test followed by P.I test

b) **Type test on generator**

i) Sudden 3-phase short circuit withstand test at 50% of the rated voltage and measurement of all reactances and time constants, SCR and synchronous reactance.

ii) A single-phase short circuit test at reduced excitation to determine the zero and negative phase sequence reactances.

iii) Telephone influence factor and harmonic analysis of the voltage waveform.

iv) Impulse withstand voltage test on the terminal bushings.

c) **Mechanical Tests on Generator**

i) Mechanical inspection.

ii) Measurement of bearing vibrations.

iii) Over speed test.

iv) Hydraulic test on coolers.

v) Hydraulic tests on machine housings.

vi) Rotor balance.

d) Air leakage test on hydrogen cooled stator frame followed by P.I test.

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e) Resistance temperature detector test.

f) Flow continuity for armature winding.

g) Additional Tests:

- Gas tightness after test bed assembly.
- Mechanical loss and core loss test.
- Measurement of cold resistance of the stator, rotor winding and RTD.
- Measurement of insulation resistance of the stator including bushings and rotor windings, embedded resistance thermometer, bearings, shaft seals.
- Measurement of polarization index of stator winding.
- Measurement of vibration level during running with and without excitation and also during short circuit test.

h) Excitation System, Regulator Equipment etc.

- Inspection at intermediate assembly stage.
- Wiring and bus bar check, including checks on printed circuits.
- Examinations of thyristor characteristics for forward voltage drop, firing characteristic, reverse voltage withstand capacity etc.
- Characteristic checks on amplifiers and associated circuitry.
- Simulated tests on excitation and AVR circuits to demonstrate control, response, discrimination and excitation limit features.
- Function and HV test on field breakers.
- High voltage and insulation tests.
- Visual, dimensional and appearance check on various panels and equipments.

2.09.03 **Field Test on Each Generator**

The field tests to be conducted at site shall include but not be limited to those listed below. Any other test considered necessary by the CONTRACTOR shall also be carried out by him.

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a) **Electrical**

i) Measurement of the insulation resistance of the stator and rotor windings to the frame and between phases, after drying out the machine, and measurement of the polarisation index.

ii) Measurement of the DC resistance of all windings and embedded temperature detectors.

iii) Measurement of the insulation resistance of bearings.

iv) Capacitance measurement and dissipation factor between the winding and body.

v) Open circuit and short circuit tests.

vi) Measurement of temperature rise at the rated load.

vii) Performance capability of the machine.

viii) Line charging capacity.

ix) Short circuit tests on the generator HV end and the generator transformer HV end to check the stability and operation of the generator and the overall (i.e. generator and generator transformer) differential protections and negative phase sequence protection.

b) **Mechanical**

i) Hydrogen leakage test.

ii) Vibration test.

iii) Over speed test.

iv) Hydraulic tests on coolers.

v) Bearing and shaft current test.

c) Load throw-off tests.

2.09.04 **Electrical Tests on AVR**

The tests to be conducted, at works, on the Digital AVR shall include, but not be limited, to those listed herein. Any other tests recommended by the CONTRACTOR shall be specifically brought out in the tender.

a) Accuracy test.

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b) Sensitivity test.

c) Response ratio test.

d) High voltage test.

e) Performance test at reduced supply voltage.

f) Performance test of all limiters.

g) Impulse input response test.

h) Manual channel following auto channel test.

i) Range of voltage adjustment test for both auto and manual channels.

j) Output test.

k) IR test.

Site tests on Digital AVR.

1. Logic sequence check.

2. Functional test -
   Signal flow test -

   i) Actual value setting

   ii) Checking and setting of gate control circuit

   iii) Regulator and limiter setting

   iv) Light load characteristic

   v) Current sharing

   vi) Heat run test

3. Alarm circuit check.

The Tests indicated above are minimum requirements, however during QAP finalization the detailed Inspection and Test plans shall be submitted by successful CONTRACTOR for approval of purchaser.

3.00.00 POWER SUPPLY SYSTEMS

3.01.00 Voltage Levels

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3.01.01 The CONTRACTOR shall restrict his selection of system voltage levels to the following nominal values:

Power evacuation	:	400 kV
Generation voltage	:	To be decided by Manufacturer
Voltage for AC auxiliaries	:	11 kV, 415/240 V
Voltage for D.C. auxiliaries	:	220 V
D.C control voltage	:	220 V, 24 V and 48V
C.T. Secondary current	:	5A or 1A
V.T. Secondary voltage	:	110V

3.01.02 The system shall be so designed that the voltage and where applicable frequency, at the input terminals to plant and equipment shall be well within the manufacturer's guaranteed limit during normal operation. All circuits shall be adequately rated for the normal, overload and fault currents. The plant and equipment shall be designed to achieve and maintain satisfactory operation under sudden variations of load, voltage and frequency during normal running as well as transients, surges, short circuits and other fault conditions. The design shall ensure that damages and malfunction does not occur.

3.01.03 Rating of all electrical equipments shall be worked out and detailed calculation in support shall be submitted for approval of OWNER in Design Basis Report.

3.01.04 Insulation co-ordination above 1 kV shall be in accordance with IEC-71 selecting the higher of the standard insulation level. Below 1 kV insulation co-ordination shall be in accordance with IEC-664.

3.01.05 An insulation co-ordination study associated with transmission connection shall be considered as part of contract to demonstrate the adequacy of the over voltage protection measures applied. The extent of supply shall include any surge protection necessary to protect the generator transformer and the station transformer

3.02.00 **System Studies**

3.02.01 A.C and D.C system analysis studies shall be made during design stage in order to substantiate the satisfactory operation of the electrical systems and the studies shall be subject to Owner's approval. The studies shall include load flow, fault levels, voltage regulation (steady state and motor starting) and stability studies both during start-up and normal running.

3.02.02 The CONTRACTOR shall be required to carry out the detailed computer studies considering single machine with infinite bus so as to confirm the suitability of the

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Turbine Generator and its excitation system in the grid for maintaining the power system stability under dynamic and transient conditions and tune the PSS parameters at site for the machines. The data and worst possible conditions pertaining to Purchaser's system shall be discussed and finalized between Purchaser and the CONTRACTOR in accordance with the system modeling techniques and depth of modeling . The CONTRACTOR shall furnish the details of simulation technique and method, which he proposes to use for this purpose.

CONTRACTOR will furnish the study details during detailed engg.

3.03.00 Single line diagram of the proposed electrical distribution system with a comprehensive write-up substantiating the adequacy and redundancy of system/ equipment offered shall be furnished by the CONTRACTOR. Quantity of material shall be provided as per layout.

3.03.00 **Electrical Auxiliaries System**

3.03.01 The tentative electrical power distribution shall be provided in Key Single Line Diagram.

3.03.02 The unit auxiliary loads associated directly with running of a unit like, BF Pump, ID Fan, FD Fan, CW Pump etc shall be fed from the 11 kV unit switchboards. Boiler Feed Pump (BFP) motor shall be fed from 11kV switchboard and all other motors rated and above 200kW shall be fed from 11kV switchboard.

3.03.03 Station auxiliary load like Ash Handling Plant, Coal Handling Plant, Water Treatment etc shall be fed from 11 kV station switchboards.

3.03.04 Unit Auxiliary Power Supply shall be fed by tapping of power as generated by respective unit along with associated two (2) number unit transformers of generated voltage / 11.5 kV level of adequate rating.

Station power supply shall be made available from 400 kV switchyard Station Transformer bay and further stepping down by means of 3 Nos adequately rated three winding station transformers of ratio 400kV/11.5kV/11.5kV.

11 kV station switchboards shall have two connections, one from secondary windings of station transformer and other from tie connection to other 11 kV station switchgear. All 11 kV station switchgears are connected to each other by 11 kV phase segregated bus ducts.

3.03.05 Each 11 kV unit switchboards shall be tied up with 11 kV station switchboards by means of 11kV phase segregated bus duct.

3.03.06 For downstream load distribution at 11 kV, duplicate transformer feeder of adequate rated transformer from 11 kV switchboards shall be utilized. 415 V load shall be catered by a number of 11kV /0.433 kV auxiliary transformer as required.

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3.03.07 Both 11 kV and 415 V switchboards shall be provided with permanent alternative supply for flexibility of operation and to cater for planned or forced outages.

3.03.08 11kV system shall be used only for HT motors (i.e. motors rated 200kW and above).

3.04.00 **Essential Supply System**

Essential supply systems shall be provided to maintain unit output and to protect plant from damage following a loss of supply. These shall be sized to enable the station to be shutdown in a safe manner following the loss of the transmission supplies and allow supplies to be restored following re-connection.

i) **D.C Supplies**

220 V DC supplies shall be provided for essential functions such as protection, switchgear closing/tripping, alarms, control, emergency drives, emergency lighting, communication equipments etc. the batteries shall be complete with float and boost chargers.

Each unit and station system shall have its own full capacity 2 x 100% Lead Acid Plante type battery of Indian make with 2 x 100% float cum boost chargers. Separate 2x100% battery for switchyard shall be provided.

220 V, 2x100% for switchyard with 2x100% float and float cum boost charger.

220 V Separate battery for FO handling & pump house, WTP & CW pump house if required shall be finalized during detail design.

The ampere hour capacity of batteries shall be based on one (1) hour supply to essential auxiliaries. Nominal cell voltage of 2V per cell shall be considered.

CONTRACTOR informed DC jacking oil pump & DC scanner air fan motor if provided then battery shall be sized for that also. And SEPCO has included DC motors for DC lube oil motor & Seal oil motor only.

24V DC supplies shall be provided if required for control and instrumentation of the entire plant items. The system shall be of full capacity on unit basis having 2 x 100 % lead acid plante type battery with 2 x 100 % float and float cum boost chargers. The supplies shall be maintained for a minimum period of not less than 30 minutes.

Unitized DC distribution board of 220 V & 24 V having two incomers and one bus coupler concept with as required outgoing feeders shall be considered for DC power distribution.

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Dedicated DC system for 220V station loads and switchyard loads on above philosophy shall be provided.

All other offsite plant like AHP, CHP shall have independent DC system on above philosophy.

Separate 48V DC system for switchyard PLCC and separate DC system for plant communication system shall be provided.

Separate battery for DG sets, fire systems.

ii) AC Uninterruptible Power Supplies

AC uninterruptible power supplies (UPS) shall be provided for essential loads such as instrument, control and computer and shall include loads which are required for post-incident monitoring and recording following a unit trip and loss of station AC supplies. The supplies shall be maintained for a minimum period of 30 minutes. Each unit UPS system shall be supplied with 2 x 100% systems of on line type capable of supplying the total system load and complete with static transfer switch and maintenance bypass switch.

The type of battery will be maintenance free lead acid battery.

The following UPS has been considered and shall be supplied:

1) Unitwise UPS
2) Station loads one UPS
3) UPS for CCW/ACW controls (If remote I/O are provided)
4) UPS for FOPH if required.
5) For off site plant separate UPS shall be provided for each PLC if necessary.
6) For 400 KV switchyard system
7) One no. 25kVA UPS with ACDB will be provided for administrative building.

Each UPS shall have dedicated maintenance free lead acid type battery.

UPS output voltage shall be 240V and shall be sized as per criteria mentioned above. The Lead Acid Plante type battery sized as per specification; one for each UPS system is acceptable. Two feeders from UPS system to one bus in UPSDB shall be provided.

c) Emergency AC Supplies

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The plant shall be provided with an emergency AC supply facility comprising one (1) no. Diesel generators for each unit. The CONTRACTOR shall state and justify the basis of selection of the DG set considering loss of normal supply due to any contingency. The DG sets shall have AMF (Auto Mains Failure) feature capable of starting picking up load within 30 seconds. The minimum load to be considered shall be safe shut down, essential lighting lift and charging of storage batteries. The minimum capacity of emergency DG shall be 1500KVA, 415V. However, actual rating shall be as per approved design calculation to be decided during detailed engineering.

The degree of protection of DG control panel shall be IP 42.

3.05.00 **Power Evacuation System & Start up Power**

3.05.01 The generated power shall be evacuated at 400 kV level. Generator transformer of each unit shall deliver power to the plant 400 kV switchyard, by means of overhead conductors at the incoming 400 kV gantry of respective generator bay.

Three Nos single-phase transformer of 250MVA rating shall be used to step up the generated voltage of each unit to 420 kV.

3.05.02 For startup power and station auxiliary load three separate feeders from 400 kV switchyard shall be used to feed power at 11 kV by means of 400kV/11.5 kV/11.5kV three phase three winding transformer of adequate rating.

Start up power shall be drawn from CSEB (Chatthisgarh State Electricity Board) at power factor above 0.92 at all the times.

3.05.03 Total nine (9) diameters for 400 kV switchyard with one and half breaker scheme shall be provided. Accordingly eight outgoing line feeder, six incoming lines from generator, three stations supply feeder and one future bays unequipped but inclusive of bus bar shall be provided. One bus sectionalizer on each bus comprising breaker & isolator shall be provided to evacuate the power at two different grids. Space for second bus sectionalizer with flexible bus (conductor) connection shall be provided. CONTRACTOR shall provide in SLD & layout drawing in basic design for OWNER approval.

3.06.00 **A.C. and D.C. System Grounding**

The grounding of various electrical systems shall be as follows:

a) Neutral of HV side of generator transformer & station transformer - solidly earthed.

b) Main generator neutrals - high resistance grounding through distribution transformer and secondary loading resister.

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c) Unit transformer LV winding (11 kV) and 11 kV side of transformer neutral - low resistance grounding.

d) Station transformer LV winding neutral - low resistance grounding.

e) LT auxiliary transformer LV winding shall be star-connected and the neutral point shall be solidly grounded.

f) Diesel generator neutral shall be grounded through single phase VT. Shall be discussed during detail engineering.

g) The DC system shall be ungrounded.

3.07.00 **Control**

3.07.01 All equipment shall be provided with the facility for local control. Local stop facility shall be provided meeting the requirement of relevant Electricity Rules.

Accordingly, Local Push button stations shall be provided near all motors for starting & stopping. For selective drives like exhaust fan etc. both local start & stop is envisaged.

3.07.02 Remote control of electrical distribution system along with all necessary isolation points, interlocks, alarms, indications, instrumentation, data logging, condition monitoring/recording equipment, test and diagnostic facilities etc. shall be provided for the secure, reliable and safe operation of the electrical systems.

3.07.03 CONTRACTOR shall provide RTU (Remote Terminal Unit), PLCC, etc to transmit data to LDC (Load Dispatch Centre). Data to be transferred are the status of all 400KV breakers, isolator (ON/OFF), MW of each outgoing line & generator, voltage, MVAR, frequency. CONTRACTOR shall provide the interface terminal upto and including RTU. From RTU to LDC is in OWNER scope.

3.08.00 **Protection**

3.08.01 The protection system shall be designed so that in the event of faults occurring, the faulty plant is safely disconnected, whilst continuity of supply consistent with system stability is maintained. The selection and setting of protection devices for the auxiliary system shall be based upon the following major requirement.

Faults on plant items shall be disconnected as quickly as possible to minimize damage.

Faults external to major power sources, e.g. unit transformers, shall only open the circuit breaker controlling these power sources after all other protections nearer the fault have failed.

Faults internal to major power sources shall cause their circuit breakers to open as fast as possible to ensure that the transmission system can restore itself within the limits of stability.

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The protection shall be designed to be stable in transient conditions such as motor starting and shall not operate for current surges caused by faults external to the auxiliary system, for which the main generator would recover and the item of plant protected would not be damaged.

Protection of plant is designed to match the plant operating characteristics and provide discrimination with other plant.

The accuracy of CT's & PT's will be 0.2S & 0.2 for metering for generator, generator transformer and for UT. For generator differential protection depending upon relay manufacturer's requirement, suitable CT of 5P 30/ 5P 20 checks shall be supplied.

3.08.02 Relay setting calculations and coordination curves shall be worked out for the complete electrical system for adoption.

3.08.03 Multifunction numerical relays (microprocessor based digital relays) with communication facility shall be utilized for this project for generators, transformers, HV & LV system. DC power systems and UPS power distribution systems are not required to adopt multifunction numerical relays.

Generator, Generator Transformer, Unit Transformer & Station transformer and 400 kV switchyard bay protections shall be considered having twin channel (2X100%) feature. Each channel shall be fed from separate CT and PT cores as well as separate (AC if required) and DC source.

3.08.04 Computer with all relevant hardware and software including those required during installation, commissioning and operation of all numerical relays (microprocessor based digital relays) shall be supplied and installed.

3.09.00 **Metering**

3.09.01 The CONTRACTOR shall provide export/import metering which shall include all the equipment necessary to provide a complete metering system. Current, Voltage, kW, kVAR, Power factor, kWH, Frequency measurements for each Generating unit and Station Transformer shall be made at 400 kV. The metering data shall be made available at DCS.

3.09.02 Separate sets of CT's s and EMVT's shall be provided for main & check tariff metering.

3.09.03 General Metering

Plant electrical parameters shall be metered to the extent required for proper operation and monitoring of plant conditions. As a minimum, the following metering shall be provided for the equipment indicated:-

a) <u>Generators</u>

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Current, voltage, vars, watts, watt-hours, varhours, frequency, and power factor measured at the generator terminals, exciter/field current and voltage.

b) Unit and Station Transformers

Current, voltage, watts, vars, watt-hours and varhours measured on the high voltage side of unit transformer and also at low voltage side at the switchgear incomers.

c) Medium and low Voltage Switchgears

Current, voltage, and watt-hours measured on each incomer and all feeders for 11kV switchboard and incomer feeder of 415V switchgear.

Current measured on each feeder above 30 kW.

Voltage measured on each bus.

d) Motor Control Centers

Voltage measured on each bus. Current measured on each feeder.

Communicable meters with DCS interface requirement to be met. All meters shall have RS 485 / 232 mod bus connectivity.

3.09 04 The metering shall be done through Load Manager at all 11kV & LV Switchgear (PCC) incomer panels. The Load Manager shall cover current, voltage, kW, kVAR, Power factor, kWH, frequency.

Aux. Consumption at different voltage levels and utility shall be metered.

3.09.05 Revenue Metering/Tariff Metering

Revenue meter/Tariff meter shall be ABT (Availability Based Tariff) type only. Main revenue meters of 0.2S class accuracy shall be installed and provisions for check meters at the same points shall be provided. Main and check meters shall utilize separate sets of CTs & PTs. The revenue metering units shall be in accordance with Indian standards and requirements. Gross generation metering shall be provided at the outlet of generator.

CTs and PTs used for revenue metering shall have the accuracy class of 0.2S and 0.2 respectively.

For revenue metering the PT lead burden shall be restricted to 0.2 ohm/ phase. Also integration of the data's generated on communicable meters shall be considered by the CONTRACTOR.

The revenue metering shall be tested and calibrated in the presence of the Owner's representatives.

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3.09.06 Energy accounting and audit meter shall be installed as per CEA Regulation - 2006 on installation and operation of meters.

4.00.00 **DESIGN CRITERIA**

4.01.00 **Isolated Phase Bus ducts**

4.01.01 Isolated phase bus ducts of rated current as per calculation shall be used for the primary connection between the main generator and single-phase generator transformers including delta run and for the associated tee-off connections.

4.01.02 Isolated phase bus duct shall be provided with flexible expansion joints, bellows, terminal enclosure, flanges, disconnecting links for isolation of transformer/auxiliary equipment, adopter box, shorting link for CT core, CT, LA_rVT, neutral grounding equipment and all other equipments & accessories.

4.01.03 The design and construction of the bus duct shall be such as to limit the temperature rise within the following values considering the maximum continuous base and peak output of the unit at rated power factor and allowable generator voltage variation.

a) Hot-spot temperature of bus conductor : 105°C for silver plated joints, and 90°C for other joints

b) Hot-spot temperature of bus enclosure : 70°C

4.01.04 Equipment mounted outdoors shall be completely weatherproof (IP-55) designed to withstand weather conditions, UV radiation and solar heating. Internal equipment shall be splash proof, dustproof and vermin proof (IP-54).

4.01.05 The performance of the connections and associated equipment shall be substantiated by all type testing certification by a recognized Testing Authority.

4.01.06 The Generator IP Bus duct from Generator terminal to Generator Transformer shall run and tap off duct shall connect Unit Transformer.

4.01.07 The bus duct shall be pressurized type complete with pressurization equipment, monitoring system etc to keep the insulation high during shut down period.

To avoid condensation of moisture inside busduct during shut-down of the generator, suitable facility for blowing hot air inside the bus enclosure shall be provided.

4.01.08 Lighting arresters and surge absorbers as recommended by generator manufacturer of proper rating shall be provided at locations as close as practicable to generator terminals.

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4.01.09 Wall frame assembly with seal off bushing shall be provided wherever bus duct crosses building wall for connection equipment located outside.

4.01.10 The sizing criterion of bus duct shall be as under.

a) The main isolated phase bus shall be designed for maximum generator output at any voltage from 95 to 105 percent of rated generator voltage. The bus tap for the unit auxiliary transformer shall be designed for the maximum auxiliary electrical load at any voltage from 95 to 105 percent of rated generator voltage.

b) Main isolated phase bus from Generator to GT shall be braced for the peak value of the fault current contribution from the Generator or from the EHV system through Generator transformer, whichever is higher. The DC component of the fault current and contribution of connected large induction motors shall also be included. While computing the fault current, negative tolerance on generator sub-transient reactance and transformer reactance shall be considered.

c) The isolated phase bus for tee-off to unit transformer shall be braced for the peak value of the maximum available fault current at the unit auxiliary transformer terminals. This shall include fault current contributions from generator as well as from EHV system through generator transformer, including the DC component and contribution of connected large induction motors.

d) The thermal withstand of the bus duct shall be designed for sustained fault current.

e) The current transformers mounted within the bus duct enclosure shall be designed for an ambient temperature equal to the maximum temperature attained within the bus duct enclosure when carrying the maximum rated current. Positive pressure shall be considered for Isolated Phase Bus duct.

f) The bus duct current rating shall consider VWO output condition of Turbine and Generator and that rating shall also be considered while sizing bus duct.

g) IPBD shall be established by calculation during detail engineering and short time rating shall be 3 sec.

h) CONTRACTOR to provide that rated voltage of seal off bushing, insulator and other equipments mounted on IPBD shall be of 24 KV class for 20 or 22kv generation voltage.

4.01.11 Supporting Structures

a) All supporting structures required for hanging and/or supporting the complete bus duct shall be provided. These include all members,

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indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.

b) All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces and all specified design loads

c) Support shall be designed to provide a tolerance.

d) The indoor supports shall be in general of hanger supports while outdoor shall be generally supported from the ground.

e) All steel members shall be hot-dip galvanized after fabrication. All hardware shall be of high strength steel with weather resistant finish.

f) Arrangement of support steel work shall be such as to prevent heating of structure caused by circulating currents.

4.02.00 **Transformers**

4.02.01 Transformers shall comply with IEC-76/equivalent Indian Standards and CBIP manual of transformer.

4.02.02 Three (3) Nos. Single Phase 250MVA OFAF Generator Transformers (GT) for each unit and three (3) nos. adequately rated ONAF Station Transformer (ST) shall be provided. Additionally one number spare single-phase generator transformer for entire 6 units shall be provided. The same shall be installed over rail on foundation.

Two (2) Nos. adequately rated ONAF Unit Transformers (UT) shall be provided for each unit. Generator Transformer shall have vector group Y_Nd11. Station transformer shall have vector group $Y_N/y_n0/y_n0$ where as unit transformer shall have vector group Dy_n1.

The ONAN rating shall be at least 80% of the ONAF rating for UT & ST. The ONAN and ONAF rating of GT shall be at least 60% and 80% of OFAF rating respectively.

4.02.03 For GTs, 2x60% capacity separately mounted radiator banks shall be provided. For UTs, STs 2x50% capacity separately mounted/tank mounted radiator banks shall be provided.

Insulation level of transformer windings as per IEC and the same will be indicated during detail engineering. Transformer impedance on base MVA and guaranteed losses at principal tap shall be indicated for ONAN/ONAF and OFAF.

CONTRACTOR will provide winding material of transformers shall be copper only. CONTRACTOR confirmed bolted connection with intermediary sealing, hinges, pins and the like are not considered to be conductive connections. Cooling system of generator transformer shall be provided during basic design.

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Radiators and coolers shall be designed to withstand the vacuum and pressure conditions specified for the tank.

Tank mounted radiators/coolers shall be of the detachable type with bolted and gasketted flanged connections.

Separately mounted radiator banks shall have bolted flanged connections and pipe extensions to permit withdrawal of transformer tank without disturbing the radiators. Flexible joints shall be provided in the interconnecting pipes (unless otherwise approved) to facilitate erection and dismantling and reduce transfer of vibrations from tank to radiator. The interconnecting pipes shall be provided with drain plug and air release vents.

The protective lightning arresters shall be provided on 11 kV switchgear (for Unit & Station transformers), if required.

4.02.04 All power transformers shall be oil immersed except 11kV/415V transformer, with conservator of air cell type.

CONTRACTOR to provide that even at the minimum tap of transformers the rise of oil and winding temperature will be within the specified limits for the rated output of generator.

Temperature rise over ambient temperature of 50°C shall be as under:

For GT

a) Top oil by thermometer - 40°C
b) Winding by resistance - 50°C

ST, UT

a) Top oil by thermometer - 45°C
b) Winding by resistance - 55°C

All 11/0.433kV LT auxiliary transformers shall be naturally air cooled (AN) dry type. The winding of dry type transformers shall be class 'F' insulated, either encapsulated with fiberglass reinforced epoxy resin under vacuum or impregnated by vacuum process and resin enriched by pressurization. Dry type transformers shall be installed in naturally air-ventilated enclosures.

The maximum capacity of LT transformers shall be 2500kVA. The size of LT transformers shall be established by supporting calculation considering voltage drop during running of all connected loads and starting of largest motor.

4.02.05 GT and ST shall be provided with OLTC with ± 10% range or taps in steps of 1.25%. UT shall have off-circuit tap-changer for 2x ±2.5% ranges of taps

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respectively. All other auxiliary transformers shall have off-circuit taps to suit operational requirements.

The OLTC gear shall be suitable for local and remote electrical control and local manual control. Further, there shall be provision of automatic operation through voltage sensing relay.

OLTC gear shall be provided with RTCC panel and all other accessories and interlocks. Provision shall be kept in for link with the plant DCS.

4.02.06 The 400/11.5/11.5kV station transformers shall be provided with surge arrestor of suitable rating at 11 kV system to arrest the transferred voltage surge impressed on the secondary winding. Insulation level of the secondary winding also shall be suitably upgraded to avoid any damage to the transformer due to the transferred surge from EHV system.

4.02.07 The GT, ST, UT shall be capable of being operated continuously on any tap at the rated MVA with voltage variation of ±10%. The transformers shall also withstand combined voltage and frequency variation, which produce the following over-fluxing conditions.

a) 110% - continuous for all transformers

b) 125% - for one minute (for GT, UT & ST)

c) 140% - for five seconds (for GT, UT & ST)

Transformers shall operate below the knee of the saturation curve at 110 percent voltage to preclude ferro resonance and non-linear oscillations.

4.02.08 The transformer shall be capable of withstanding without damage the stresses caused by tripping of a fully loaded turbine generator. The transformer shall also be capable of withstanding without damage during the time, the turbine generator is coasting to standstill or for a duration of at least two seconds for generator transformer and 3-5 seconds for unit transformer the stresses caused by short circuit limited only by the transformer impedance with 110% rated voltage maintained at source end.

4.02.09 The noise level shall be in accordance with NEMA Standard TR-1- 1993 when measured in accordance with conditions outlined in ANSI/IEEE C 57.12.90-1999/IS 13964/CBIP publication.

The maximum flux density of transformer at 110% rated voltage shall not be more than 1.9 Tesla.

The maximum current density of transformer shall not be more than 2.5 A/ mm2.

GT, ST and UT shall be provided with suitable no. of bushing mounted CT's on all phases & neutral bushing for protection & metering.

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LT transformer winding shall be of copper. Insulation class of winding shall be F with temperature rise limited to Class-B. The degree of protection of dry type transformer shall be IP 23 and marshalling box shall be IP42. Winding insulation level of LT transformers shall be as per IEC values indicated during basic engineering.

4.02.10 Each UT shall be sized to cater for 50% of total unit auxiliary load corresponding to 100% BMCR at 80% transformer loading.

The Generator and Unit transformers shall be designed for maximum generator output at any voltage from 95 % to 105% of rated generated voltage.

Each station transformer shall relate to duty conditions as detailed below. Further, outage of one station transformer is to be considered at a time. Sizing of station transformer capacity shall be based on higher of the two values obtained under condition 'a' and 'b' stipulated below.

a) Under outage of UT

i) Power requirements of the auxiliaries being fed by UT under outage.

ii) Half of the station loads.

b) Under outage of a Station Transformer

i) Load of a unit under HP-LP by pass mode of protection.

ii) Full stations load.

Station transformer so chosen shall be of three winding type with two secondary windings and MVA and voltage ratings of both the secondary shall preferably be equal.

Rating of LT transformers shall be established by the calculation as per design criteria during basic design.

LT auxiliary transformers shall be sized for full load with 100% standby concept. 10% design margin shall be considered for sizing of LT auxiliary transformers.

4.02.11 The MVA rating of Unit transformers, Generator Transformer and Station transformers shall be substantiated by calculation/system study. The MVA rating of each LT-auxiliary transformer shall correspond to the incomer rating of associated L.V switchgear/power control centre.

4.02.12 The transformers along with all accessories and fittings shall be subjected to routine tests as per relevant IEC. In addition, oil leakage test on each oil filled transformer shall be carried out as a routine test for a period of 24 hrs and with pressure of 35 KN.m^2 plus the normal oil head pressure. The transformer tank of

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each size shall be subjected to vacuum test with pressure 1.33 KN.m^2. Each rating of transformer shall be subjected to temperature rise test as type test. Partial discharge measurement shall be done on all dry and oil type transformers as per relevant standard.

4.02.13 For finalization of minimum creepage consideration of 25mm/kV shall be adopted.

4.02.14 Transformer oil soak pit and burnt oil pit shall be sized as per Indian regulation and codes.

4.02.15 Rails shall be provided for all the GT, ST, UT to main road and from main road to one STG maintenance bay for transportation & maintenance purpose as marked in Plot Plan Layout.

4.03.00 **11 kV & 415 V Bus duct for Switchgear Connection**

4.03.01 11 kV Bus duct shall be metal enclosed, phase segregated and natural air-cooled type in construction. 415V Bus duct shall be similar to the above except that it shall be of non-phase segregated type.

CONTRACTOR will supply busbar of HT Switchgear shall be of aluminium / aluminium alloy. Copper busbar shall be used for bus bar current rating above 2000A.

4.03.02 The design and construction of the bus ducts shall be such as to limit the temperature rise within the following values when operating continuously at the current corresponding to the rated MVA of transformer and 90% rated voltage.

a)	Hot-spot temperature of bus conductor	:	105°C for silver Plated joints, and 90°C for other joints
b)	Hot-spot temperature of bus enclosure	:	70°C

4.03.03 Inspection facility for bus duct enclosure in straight run of bus duct along with the places where vertical and horizontal bends are encountered shall be provided. Necessary flexible and metal bellows shall be considered in design for thermal expansion and operational considerations. Terminal adopter boxes, interconnection hardware etc. as required shall also be provided.

Detailed calculation for bus bar sizing, supports, flexible & metal bellows along with detail drawing/document shall be submitted for approval.

4.03.04 Wall frame assembly and seal off bushings shall be provided where for the bus duct passes through walls.

4.03.05 The busduct shall have the same short circuit current, insulation and temperature rise rating as the switchgear to which it connects.

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The busduct shall be sized for the full capacity of the associated auxiliary transformer.

4.03.06 Provision shall be made to allow for bus contraction and expansion through a full ambient temperature range from 0°C to 50°C

4.03.07 Outdoor section shall be weatherproof and drip proof.

4.03.08 Space heaters in both indoor and outdoor section shall be considered.

4.03.09 Supporting Structures

a) The busduct shall be provided with all supporting structures required for hanging and/or supporting it. These include all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.

b) All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces and all specified design loads.

c) Supports shall be designed to provide tolerance in the horizontal and vertical directions.

d) All steel members shall be hot-dip galvanized after fabrication. All hardware shall be of high strength steel with weather resistant finish.

4.04.00 **11 kV Switchgear**

4.04.01 The switchgear shall be indoor, metal clad, floor mounted, draw out type and suitable for located in a clean but hot, humid and tropical atmosphere. Degree of protection shall be IP4X. Sheet steel used for construction shall be minimum 2mm thick for structural load bearing members, doors, covers, partitions. Additional stiffeners shall be provided to increase rigidity wherever cutouts are made.

11kV Switchgear shall be rated for 40 kA for three (3) seconds.

4.04.02 Each unit switchboard shall have two 100% incomers-one from the UT and the other from the ST. There shall be fast bus transfer feature in auto mode to restore power supply to the 11 kV unit board from 11 kV standby sources in case of failure of unit supply.

4.04.03 Circuit breakers, voltage transformers, bus bars, current transformers with cable termination, relay/meter/controls etc. shall be housed in separate compartments within the cubicle so that failure of one equipment shall not affect the adjacent unit.

4.04.04 The continuous current rating for incomers, bus section and bus bar shall be based on total running load plus highest load during change over of

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equipment/Stream (One at a time) as applicable plus 20% overall margin. A 20% spare feeder (at least one in each bus section) shall be kept for future use and shall be considered in rating selection.

CONTRACTOR shall provide 2 nos of 11kv feeders for RWPH (each feeder 5.5MW loads of Raw Water Intake P/H and Intermittent P/H) and 2 nos of 11kv feeder for colony supply(**each feeder shall be 630A**).The loads of these feeders shall be considered for sizing calculation also.

4.04.05 The short circuit withstand, making breaking duty of switchgear shall be decided based on system study and subject to Owner's approval.

4.04.06 The main buses and connections shall be sleeved and joints shall be shrouded. Sleeves & shrouds shall withstand full working voltage. No reduction in phase-to-phase or ground clearance shall be allowed due to sleeving. High conductivity copper/aluminium alloy, as per relevant IS/BS/IEC, shall be used for bus bar. The temperature rise shall be limited as per relevant standard. The bus bar chamber shall be provided with inter-panel barrier.

4.04.07 All switchgear feeders above 1000 KW will be a vacuum circuit breaker type .For other rating it will be Fuse and contactors, triple pole ganged, draw out type, trip free, physically and electrically interchangeable with identical rating and will have motor wound stored energy spring charged closing mechanism, shunt trip facility. CONTRACTOR shall provide adequate auxiliary contacts for circuit breaker.

4.04.08 Circuit breaker shall have SERVICE-TEST-DISCONNECTED positions with positive indication for each position. Mechanical safety interlock shall be provided to prevent circuit breaker from:

a) Racking in or out of the service position when the breaker is closed. Racking in or out shall be possible only when the front door is closed.

b) Racking in unless self-aligning control contacts/control plug is fully engaged.

c) Closing in any intermediate position between test and service position.

Automatic safety shutters shall fully cover the female primary disconnects when the breakers is withdrawn to test position._

The frame of each circuit breaker & draw out P.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by safe distance.

4.04.09 Circuit earthing facilities shall be provided for all incoming and outgoing circuits. In addition, provision shall be made to earth each bus section at two separate points.

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4.04.10 Circuit breaker shall have emergency manual trip, mechanical ON-OFF indication, an operation counter, closing spring charged/released indicator, auxiliary switches, position/cell switches in required quantity and rating, other control, indication devices.

The key interlock shall be provided for selector switch.

The class of CT used for differential protection shall be 5P20.

The class of CT used for metering of incomer feeder shall be 0.5.

The class of VT for metering shall be 0.5 class.

4.04.11 Over voltage produced by the circuit breaker during switching off induction motor or switching on-off dry type distribution transformer shall be limited to 2.5 times the peak value of rated phase to neutral voltage. Surge absorbers of either Zno or CR type with nonflammable nontoxic liquid filled capacitors shall be used and located in switchgear cubicle if the over voltage limit exceeds.

4.04.12 VTs and CTs shall be cast resin type. VTs shall be draw out type with HV primary fuse and secondary control fuses on all ungrounded leads. Accuracy class shall be suitable for metering, protection and acceptance test. Secondary voltage of V.T. shall be 110V.

4.04.13 The minimum protections to be provided for different kind of circuits are:

a) **Incomer Feeder**

Each incoming (source) breaker shall be provided with numerical feeder management type devices. These devices shall be multi-element type or multi-function devices comprising of the following protective elements:-

- Inverse time over current relays for phase fault (51)
- Inverse time over current relay for earth fault (51N)
- Under voltage with time delay (27/2)
- VT fuse failure

b) **Tie Feeder**

Each tie-breaker shall be provided with -

1. One multifunctional relay comprising of following protective elements
   - Inverse time over current relays for phase fault (51)
   - Inverse time over current relay for earth fault (51N)
   - Under voltage with time delay (27/2)
   - VT fuse failure

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2. One numerical check synchronizing relay (25), if applicable, complete with guard relay and hardwires.

c) **Motors**

Each motor feeder shall be provided with -

1. One numerical Motor Protection Relays to detect and take appropriate action against the following:
   - Short circuit (50)
   - Thermal over load (49)
   - Current unbalance / single phasing (46)
   - Locked rotor (50LR)
2. Definite time over current relay (50G) for earth fault (through CBCT)
3. Differential protection (87M) for motor rated above 1000kW
4. U/V tripping (27)

d) **Auxiliary Transformers**

Each transformer breaker shall be provided with

1. One numerical multifunctional Transformer Protection Relay having following protective functions:
   - Instantaneous over current relays (50)
   - Inverse time over current relay for phase fault (51)
   - Definite time over current relay for earth fault (50G)
   - Differential protection (87T) for transformer rated 5 MVA and above
   - Restricted earth fault relay (64R) for transformer 2 MVA and above
2. One electro-magnetic / static auxiliary relay having set of flag relays for transformer gas and temperature protection (alarm & trip stage), oil level alarm (for oil filled transformer feeders only).

e) **Bus Coupler Feeder & Outgoing Power Feeder**

Each bus coupler/outgoing breaker shall be provided with -

1. One multifunctional relay comprising of following protective elements

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- Inverse time over current relays for phase fault (51)
- Inverse time over current relay for earth fault (51N)

2. One numerical check synchronizing relay (25) complete with guard relay and hardwires for auto change over and momentary paralleling operation shall be provided for Bus Coupler feeder.

f) Bus VT

Each Bus VT panel shall be provided with numerical voltage relay having following functions:

- Under voltage relay with delay unit (27/2)
- VT fuse failure relay

In case any trip function is not available in a single relay, separate numerical relays shall be provided to achieve the requirement.

Apart from protection relays, each breaker shall be provided with anti-pumping (94), trip annunciation (30), trip supervision (74), electrically reset type breaker contact multiplication (52X) relay and lockout (86) relay. Lockout relay shall be hand reset type.

IDMTL relay version shall be decided as per system requirement and the same shall be finalized during detail engineering.

Zero-sequence CT and associated relay combination shall be such as to ensure a pick-up sensitivity of 10A primary ground fault current.

Separate locked rotor protection relay (50 L.R) with auxiliary relay (50 LRX) shall be furnished, if required.

Computer with all relevant hardware and software including those required during installation, commissioning and operation of numerical relays shall be supplied and installed. CONTRACTOR shall provide one PC for numerical relays per unit and this shall be online.

4.04.14 Each motor, transformer feeder and incomer shall be provided with switchgear mounted ammeter with phase selector and remote metering/monitoring facilities, as applicable with current transducers. Incomer shall have watt & energy measurement and voltmeter with phase selector.

4.04.15 All control, interlocks and synchronizing facilities shall be provided for operation of the switchgear from control room. All fault indicators shall be available on DCS/SCADA as all numerical relays are connected to DCS/SCADA.

4.04.16 The 11 kV Unit switchgears shall have an automatic microprocessor based fast backed-up by slow bus transfer scheme when transferring to alternate sources from a protective trip. For transfer of auxiliaries during normal operator actions, the

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control and protective relay scheme shall be based on manual parallel bus transfer with automatic tripping of the previous source. Synchronism check relays shall be used as required to prevent paralleling alternate sources that are out-of-phase with each other. In case of prolonged paralleling of the two sources, the one that has been closed later shall be automatically tripped.

For complete details of interlocking and changeover schemes envisaged for the project please refer the notes on the tender single line diagram and write up on bus transfer scheme attached on ANNEXURE-II attached with this specification.

4.04.17 The performance of the switchgear and associated equipment shall be substantiated by routine testing as per relevant IS/IEC and shall include impulse test, temperature rise and short circuit test performed on a typical section of the bus assembly with the breaker in cubicle.

4.05.00 **415 V Switchgear (SWGR), Power Control Centre (PCC), Motor Control Centre (MCC), A.C. Distribution Board (ACDB), D.C. Distribution Board (DCDB) & D.C. Starter Panel (DCSP)**

4.05.01 L.V switchgears, PCCs, MCCs, DBs, shall be indoor, metal clad, floor mounted suitable for location in a clean but hot, humid and tropical atmosphere. Degree of protection shall be IP-42 or better. Switchgear/PCC/MCC/DB in ESP/Coal/Ash area shall be IP-52. Sheet steel used for construction shall be minimum 2 mm thick for structural load bearing members, doors, covers and partitions.

415V Switchgear, PCC, MCC shall be rated for 50 kA for one (1) second.

LT switchgear in TG building will be IP42 & LT panels at off site areas like CHP, AHP, ESP, WTP & CW shall be IP52.

All equipments of LT switchgear shall be rated 1.1kV.

4.05.02 Each 415 V Switchgear, PCC and MCC shall have sectionalized bus with two incomers and one bus section. For redundant loads or load consisting a number of drives shall be equally distributed to the extent possible on both the bus section.

4.05.03 Auto-changeover scheme with fast bus transfer feature shall be adopted if supply failure to any bus section may lead to unit trip under abnormal conditions.

Manual change over or live bus transfer shall also be done by momentary paralleling I/C-I & I/C-II through synchro check relay & trip selector switch. Breaker selected to trip shall trip out immediately after a preset time delay.

In case momentary paralleling is sustained for more than a preset time, the last breaker closed shall trip through a time delay relay (2) & lockout relay (86).

Also please refer ANNEXURE-III attached with this specification for Operation Philosophy of 415V Switchgear.

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4.05.04 Switchgear cubicles shall be component wise compartmentalized so that failure of one equipment shall not affect the equipment in adjacent compartment or adjacent cubicle. Circuit breakers in switchgear cubicle shall be draw out type and not more than two circuit breakers shall be located in a vertical panel with metallic partitions in between the breakers.

4.05.05 Incomers, bus couplers and all outgoing feeders including motor starter modules shall be draw out type and of modular design. All components of incomers, feeders shall be placed within a metal-sided compartment. DBs shall be of fixed type compartmentalized modular design. MCCB shall not be used unless specifically approved by OWNER. Complete feeder shall be draw out type.

4.05.06 SWGRs/PCCs/MCCs/DBs assembly shall comprise a continuous lineup of dead front freestanding vertical sections, housing the control modules in multitier formation. Each vertical section shall have a full height vertical cable chamber with cable supports, removable back cover and module wise front access door independent of draw out chassis. Switchgears shall be extendable on both sides.

4.05.07 The continuous current rating for incomers, bus section and bus bar shall be based on total continuous running load plus highest load during changeover of equipment/stream (One at a time) as applicable plus 25% of total connected intermittent loads like valves, dampers where ever applicable) plus 20% overall margin. 20% spare feeders and/or one for each rating and type shall be provided and considered in rating selection. All SWGRs, PCCs, MCCs, DBs shall have 2 x 100% incomers at two extreme end of line up.

All incomers, bus couplers, breakers/isolators for 415V Switchgear/MCC/DB shall be four (4) Pole type. Only Motor feeders shall utilize Three (3) pole type breakers.

4.05.08 The short circuit within stand, making-breaking duty, etc. shall be designed based on system study and subject to Owner's approval. Selection and sizing of starter module shall comply with the requirement of IEC in respect of co-ordination of characteristics of switch, contactor, overload relay and fuse. Type of co-ordination shall be Type-2 as per IS-13947/IEC-947-4.

4.05.09 High conductivity aluminium alloy, as per relevant IS/BS/IEC shall be used for bus bar with maximum temperature limited to 90°C. Main bus bar size shall be same for the entire length of SWGR/PCC/MCC & DBs and shall be adequately supported to withstand stresses during fault.

4.05.10 Circuit breaker used in SWGR/PCC/MCC shall be air break type and shall have, control, operating and other safety features generally similar to 11kV circuit breakers. Rated making current of circuit breaker shall be 105kA.

4.05.11 All draw out type starter modules shall have SERVICE-TEST position to enable circuit testing without actual power feed to load. Door interlock with defeating feature shall be provided for switches of all modules. Switches shall be pad-lockable in both ON & OFF position.

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4.05.12 Motor feeders rated above 30KW shall be provided with ammeters in module door unless remote ammeters are provided. Each incomer shall be provided with a voltmeter and ammeter with selector switches and energy meter. ESP PCC incomer shall be provided with energy meters.

4.05.13 All control, interlock facilities including remote operation from control room shall be provided for SWGRs/PCCs. Further auto closing provision shall be kept where ever required so that in case a normal incomer trips due to upstream fault, standby incomer/bus-section shall auto close. All indication on panels and to DCS/ SCADA shall be provided.

4.05.14 The minimum protections to be provided for different type of circuits:

a) **ACB operated incomer feeder**

- Extremely Inverse time over current relays for phase fault (51)
- Extremely inverse time over current relay for earth fault (51N)
- Under voltage relay (27) with timer (2)

b) **Bus coupler/outgoing breaker feeder**

- Definite time delayed short circuit protection (51)
- Inverse time over current relay for earth fault (51N)

c) **ACB operated motor feeder**

- Composite motor protection relay consisting of protection against Thermal Overload (49), Phase fault (50), Unbalance current (46), Locked rotor (50LR) and Earth fault (50G).

d) **Contactor operated unidirectional motor feeders**

- Short circuit protection by HRC fuses
- Thermal over load relay (hand reset type) with built in single phasing preventer.
- Adjustable time delay earth fault relay operated from zero sequence CTs for motors rated 75 KW and above only.

e) **Contactor Operated valves/Damper feeders – (Refer to C & I Specification.)**

- Short circuits by HRC fuse.
- Thermal over load (relay hand reset type).

f) **Switch fuse feeders protected by HRC fuses.**

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Apart from protection relays, each electrically operated breaker shall be provided with antipumping (94), trip annunciation (30), lockout (86), lockout supervision (95) and trip supervision (74) relays. Lockout relay shall be hand reset type.

Fuse monitoring relay (98) shall be provided on the secondary side of voltage transformer to monitor fuses.

Relays shall be microprocessor based numerical type only and computer for downloading shall be provided.

4.05.15 V.Ts and CTs shall be cast resin type. V.Ts shall be protected by primary HRC fuses and shall be draw out type. Accuracy class shall be suitable for metering, protection and acceptance test. Secondary voltage of V.T. shall be 110 Volt.

4.05.16 Sizing of UPS shall be done accordingly to cater control supply loads.

4.05.17 The performance of the SWGRs, PCCs, MCCs, DBs and associated equipment shall be substantiated by routine testing as per relevant IS/IEC and shall include temperature rise, short circuit test performed on a typical section of the bus assembly with the breaker in cubicle.

4.05.18 DC Starter Panels for DC Motors shall be of fixed resistance type, designed to provide fast acceleration during starting. The starter shall be completed with switch fuse units, contactors, resistors, relays, meters, push buttons, lamps etc. The starter shall be in totally enclosed, floor mounting, sheet steel cubicle completed with a hinged front access door. The Cubicle enclosure shall provide dust & damp protection; the degree of protection shall be not less than IP-52. The Cubicle space heater shall be provided to maintain internal temperature above dew point. The other features shall be similar to 415V MCC.

4.05.19 Different type of control schematic for motor starter and DC starter panel shall be as per DWG. NO. - K7V12-000-DWG-E-1201. This control schematic shall be considered as reference only and CONTRACTOR shall develop the control schematic as per the requirement of this project as described on Drive Control Philosophy in Section-XIX-A, Annexure-2 (C&I portion).

4.06.00 **Local Control Stations**

4.06.01 This shall be sheet steel with 2mm thickness construction, dust & vermin proof and suitable for mounting on wall/structure/column. The enclosure shall conform to the degree of protection IP55 for indoor services and IPW55 for outdoor services. Two numbers earthing terminals as per IE Rules shall be provided. The door shall be hinged at one side and bolted on the other side

4.06.02 Push button shall be oil tight, heavy duty, push to actuate type with coloured button and inscription plate marked with its function.

Each push button shall have of 2NO+2NC contacts, rated for 5A AC and 2A DC at operating voltage.

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GT, UT & ST shall be provided Emergency tripping device (with glass break).

Push button shall be shrouded type except for emergency stop button which shall be mushroom type for easy identification. Emergency stop button shall be pressed to lock & release by key type.

As per statutory requirement, lockable push button should be provided for all the local control stations including emergency stop buttons.

Emergency tripping device (with glass break) shall be provided near the transformers.

4.06.03 In local control stations, START / STOP push buttons shall be provided for unidirectional motors and FORWARD / REVERSE / STOP push buttons shall be provided for bi-directional motors.

4.07.00 **Local Junction Boxes**

4.07.01 All power and control cables emanating from CT, PT and other equipment under Contractor's scope of supply shall be terminated to Local Junction Boxes. Junction Boxes shall be located at strategic points to be decided by the CONTRACTOR in consultation with Purchaser.

4.07.02 Junction boxes shall be made of minimum 2mm thickness sheet steel, dust and vermin proof, generally conforming to IP55 and suitable for wall/column/equipment mounting.

4.07.03 Junction boxes shall be complete with gasketed cover, conduit knock out/threaded hub and terminal blocks.

4.07.04 Junction boxes shall be of two types viz. one suitable for control wiring and the other with terminals for power cable terminations. Junction boxes shall have two (2) nos. earthing terminals with nut, bolt and washers for connection with earthing network.

4.07.05 The junction boxes shall have the following indelible markings:

a) Circuit nos. with ferrules (inside) as per approved drawing.

b) Danger sign in case of 415V circuit

4.08.00 **D.C. System**

4.08.01 The batteries for the DC system will be stationary storage type, consisting of high performance lead acid plante cells along with accessories with the cells assembled in polypropylene/hard rubber container. Freestanding type wooden/steel or as per the recommendation of manufacturer racks with acid resistance type paint shall be provided. The batteries shall be installed in single/double tier and single/double row arrangement.

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Maintenance free type lead acid battery will be supplied for UPS. The batteries will be installed in single/double tier and single/double row arrangement.

CONTRACTOR shall provide Lead Acid Plante type battery for unit, station and switchyard DC battery only. Except these above all other batteries shall be maintenance free battery and this shall be placed in Air Condition room.

4.08.02 The battery capacity shall be decided based on load cycle so that minimum permissible voltage at load terminal is maintained with adequate margin for the total duty cycle. Emergency period shall be considered as one (1) hour. To arrive at required capacity, necessary calculation, as per relevant standard IEEE method, shall be furnished for OWNER's approval. Adequate design margin (20%), aging factor, temperature effects and manufacturer's guaranteed capacity factor shall be considered.

4.08.03 Float and float cum boost charger shall be static type, comprising SCRs connected in three-phase full wave full/half controlled bridge circuit. The chargers shall be provided with auto manual voltage regulation. The float mode shall be provided with current limiting device.

During normal operation float charger shall supply continuous load requirement plus trickle charging of battery. For any fault on float charger, float cum boost charger shall be automatically switched on in float mode. Boost charge mode shall be selected manually and shall be capable of charging the battery in 10-12 hours. During boost charging battery shall remain connected with load through suitable dropper diode/tapped cell connection to match permissible voltage at load end.

4.08.04 The float charge rating shall be selected based on the continuous load plus test run load of emergency oil pump plus trickle charging of battery. Boost charge rating shall be based on the requirement of battery.

The charger sizing shall provide a 25% margin over the estimated DC system load.

4.08.05 Battery & charger system shall be provided with earth fault detector and remote alarms required for supervision.

4.08.06 Battery shall be tested as per relevant BIS standard including capacity test, AH & WH efficiency test, endurance test on one cell.

Chargers shall be tested for voltage regulation, ripple content, functional operation and heat run test on current limiting value.

4.08.07 Separate PLCC and Plant Communication system DC system (48V) and 24V DC system for C & I loads shall be considered.

4.09.00 **Plant Communication System**

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4.09.01 The inter-communication system shall provide quick and reliable communication between plant personnel located in different areas. The system provides two independent and simultaneous channels of communication viz. page and party channel. The selection of channel is through a "press to page switch" at the handset. Page channel is for making announcement over the system loud speakers. A call attention gong tone shall automatically precede each paging announcements. Party channel is for holding conversation between two or more stations without being heard over the loud speakers.

4.09.02 Each location of handsets shall be provided with loud speakers, power and preamplifiers. The location shall be near all-important system/equipment and various other strategic points and buildings. The location shall be finalized in consultation with OWNER.

4.09.03 The telephone system shall provide quick and reliable communication between different personnel located at various plants, offices, departments etc. as well as with outside parties.

4.09.04 The telephone system shall be Micro-processor based Digital Electronic Private Automatic Branch Exchange (EPABX), complete in all respects and suitable for industrial telephone communication system.

4.09.05 Plant communication shall include PA system, telephone system shall be supplied by Contractor. Contractor shall supply fifteen pairs of transceiver without base unit for owner. Statutory approval from Indian govt. shall be applied and obtained by OWNER for Transceiver (Walkie-Talkie).

4.09.06 Telephone system shall have facility of video conferencing, exchange for administrative building, security, stores, railway siding, quarters etc. for complete plant.

4.09.07 UPS for communication system shall be separate from plant UPS.
For further details regarding Plant Communication System please refer C&I section.

4.10.00 **Illumination system**

4.10.01 The lighting fixture/lamp shall be of energy efficient type. Quantity shall be selected to achieve the following illumination levels at different locations of the plant:

Sl. No.	Location	Average Illumination Level (Lux)	Type of Fixture
(a)	Turbine Hall operating floor	200	HPSV high/medium bay
(b)	Switchgear rooms	200	Industrial trough type fluorescent

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(c)	Control room, computer room, control equipment room	400	Mirror optics with anti-glare features
(d)	Offices, conference rooms, etc.	300	Decorative mirror optics type
(e)	Battery rooms	100	Totally enclosed corrosion proof
(f)	Transformer yard	10 (general) 50(on equipment)	HPSV flood light
(g)	Boiler platforms	100	HPSV well glass fixtures
(h)	Diesel generating room, Compressor room, pump house etc.	150	HPSV medium bay/Industrial trough type fluorescent
(i)	Fuel oil pump house	150	Flame proof fluorescent fixtures suitable for division-2 hazardous area
(j)	Cable galleries	50	Industrial trough type fluorescent
(k)	Street lighting- - Primary roads - Secondary roads - Approach road to site	 20 10 10	 HPSV street lights Degree of Protection IP54
(l)	Outdoor storage handling, ash disposal area and unloading area and all around outside the buildings	20	HPSV flood light,
(m)	DM plant, water treatment plant	150	Industrial trough type/corrosion proof fluorescent
(n)	Cement stores	100	Industrial trough type fluorescent dust proof
(o)	Chemical stores	150	Corrosion proof fluorescent
(p)	Permanent stores	150	Industrial trough type/HPSV
(q)	Workshop, general work bench	150	Industrial trough type fluorescent
(r)	Laboratory - General - Analysis area	 150 300	Mirror optics fluorescent Corrosion resistant, fluorescent

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(s)	Garage/Car Parking	50	Industrial trough type fluorescent
(t)	Switchyard and all outdoor areas	20(general) 50(on strategic equipment)	HPSV flood light
(u)	CW pump house, Chlorination plant building, Raw water and fire water pump house	150	Industrial trough type fluorescent/ Well glass HPSV fitting or HPSV high/medium bay fitting
(v)	Facility building, canteen	150	Industrial trough type Fluorescent
(w)	Gate lighting	50	Post Top Lantern Type HPSV Degree of Protection IP43
(x)	Compound wall lighting	10	HPSV street lights Degree of Protection IP54

4.10.02 The supply shall be from normal PCC for normal lighting and from EMCC for emergency (DG backed up) lighting. Emergency AC lights shall be provided at important locations all over the plant with special emphasis on lighting of staircases, Diesel generator room, operating floor of turbine hall, switchgear room. Ratio of normal & emergency lighting fixtures shall be 80:20.

DC emergency lighting shall be provided in control rooms & DG room. chargeable, portable DC emergency lights - 100 Nos. for complete plant shall be provided.

4.10.03 The main lighting distribution board (MLDB) shall be supplied from PCC through 2x100% rated 415/433V lighting transformer. Separate lighting transformer shall be provided for main plant & offsite area. Similarly, for AC emergency lighting, 2x100% rated lighting transformer and emergency lighting distribution board (ELDB) shall be considered. A number of switch fuse outgoing feeders shall be provided to supply power to various lighting panel located in different floors of power house and other buildings. Both the MLDB/ELDB and lighting panels shall be provided with at least 20% spare outlets. In lighting panel, 3 phase & 1 phase circuit shall not be mixed and segregation between 3 phase and 1 phase circuit shall be maintained by insulation / metal partition.

4.10.04 Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 3 pin sockets shall be fed from the lighting panel through separate circuits. Earth leakage circuit breaker (ELCB) shall be provided for all lighting distribution board.

4.10.05 To cater to welding and other low voltage power requirement of the plant 63A, TPN welding socket fed from AC distribution boards of respective area shall be

provided. For other services 15A, 3-pin socket outlet and 24V maintenance plug/socket shall be provided.

4.10.06 Power sockets at all places including near chimney for placing environment monitoring system, near four corners of compound wall for installing environment monitoring system, welding sockets at important places, administrative building.

4.10.07 30M height lighting tower /mast shall be provided for outdoor area lighting and switchyard lighting.

4.10.08 Lighting circuit wiring shall be carried out by wires in galvanized conduit as per BIS code of practice of wiring and installation. The insulation lighting wires shall be minimum PVC for places where ambient temperature is prevalent and heat resistant cables for high temperature areas like boiler etc.

4.10.09 All indoor/outdoor lighting (street, fence and area lighting) within EPC plant boundary shall be provided by CONTRACTOR.

4.11.00 **400kV Switchyard**

4.11.01 Switchyard shall have high security against loss of power supply to feeders as well as minimum outage for maintenance. Accordingly one and half breaker scheme shall be adopted for the design of 400kV switchyard. 'D' type configuration shall be envisaged for the switchyard The substation shall comprise nine (9) diameters having the following feeders and one bus sectionalizer on each bus comprising breaker & isolator. Space for second bus sectionalizer with flexible bus (conductor) connection shall be provided.

a.	Generator Transformer	:	6 Nos.
b.	Station Transformer Bay	:	3 Nos.
c.	Feeder Line	:	8 Nos.
d.	Unequipped line Bay	:	1 No.

4.11.02 Switchyard control room will be supplied, but nobody will be on duty normally in switchyard control room, 400kV circuit breakers and isolators will be controlled by DCS and/or NCS (network control system) in central control room.

SCADA for switchyard control which will be located in switchyard control room for monitoring & control. CONTRACTOR shall provide 1 terminal of SCADA in central control room for monitoring & control.

CONTRACTOR shall provide the monitoring of switchyard parameters at DCS in central control room.

SLD of 400kV switchyard with detailed bus configuration, metering and protection scheme with relays for Main-1 & Main-2 protections housed in separate cabinets with separate redundant DC power supplies will be furnish by

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contractor during basic design. Routing of the control & DC power cables will be laid separately to the extent possible.

Hardwired back up control panel, relay panel of associated bays shall be provided.

All 400 kV circuit breakers will be of synchronizing duty class only
The number of poles of 400kV circuit breaker and isolators shall be discussed and finalized during detailing.

The number of trip coils of 400kV circuit breakers shall be two.

4.11.03 Switchyard shall have its dedicated control room along with associated control panel, electrical relay panel, PLCC panel, SCADA, battery and battery charger for 220 V and 48 V, billing and metering panel etc.

The control and monitoring of the feeders of 400 kV shall be provided through SCADA in addition to the hardware back up panel.

420 kV circuit breaker offered would be of sulpher hexa fluoride (SF_6) type only. Breaker shall be rated for 40 kA r.m.s short time current rating and of continuous rating 2000A/3150A/4000 A as required with auto reclosing feature.

CONTRACTOR to supply ABB / SIEMENS/ AREVA make for circuit breaker, Current transformer, voltage transformer, control & relays.

PLCC shall be of ABB make – Type ETL 41/42.

4.11.04 Switchyard shall be designed with following parameters:

a) NOMINAL SYSTEM VOLTAGE---------- 400 KV
b) MAXIMUM SYSTEM VOLTAGE---------- 420 KV
c) LIGHTNING IMPULSE WITHSTAND VOLTAGE-------- 1425 KV (peak)
d) SWITCHING IMPULSE WITHSTAND VOLTAGE------- 1050 KV (peak)
e) BASIC IMPULSE LEVEL FOR TRANSFORMER WINDING---------- 1300 KV (peak)
f) POWER FREQUENCY WITHSTAND VOLTAGE------- 630KV (rms)
g) CREEPAGE DISTANCE---------- 25MM/KV
h) SHORT CIRCUIT WITHSTAND CAPACITY---------- 40 KA FOR 1SEC.
i) PHASE TO PHASE CLEARANCE (MIN)---------- 4200MM
j) PHASE TO EARTH CLEARANCE (MIN)---------- 3400MM
k) SAFETY WORKING CLEARANCE (MIN)---------- 6400MM
l) GROUND CLEARANCE (MIN)---------- 8000MM
m) MIN ELEVATION FOR MAIN BUS-I & II FROM GROUND LEVEL ---------- 15000MM

4.11.05 27 meter bay width shall be adopted for 400kV switchyard. All structure inside switchyard shall be made of hot dipped galvanized steel. Phase location of web

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trap shall be finalized after consultation with PGCIL/Power Evacuation Authorities consultation shall be done by OWNER

4.11.06 Size of the bus bar /conductor shall be minimum 4 inch IPS nominal aluminium tube of heavy-duty class for bus and equipment connection. Triple ACSR MOOSE conductor shall be used for overhead bay and dropper connection. Poly cone/solid core type post insulators with sliding type and expansion type plants shall be provided alternatively. Suitable AL tube shall be considered for equipment connection.

The size of tubular bus and stranded bundled conductors shall be based on the maximum load current, suitability under short circuit conditions, corona / voltage gradient and effect of solar radiation. Calculations shall be submitted to the OWNER for approval.

The final temperature of the conductor when carrying full load current shall not exceed 85^0C with a maximum ambient temperature of 50^0C.

4.11.07 The lightning protection shall be provided by lightning masts and/or shield wires.

4.11.08 The CONTRACTOR shall adopt bolted type connectors for tubular bus conductors, fixed type of terminal connectors for isolator terminals, flexible type of terminal connectors for circuit breakers, current transformers and reactors and flexible jumper connectors for connecting lightning arresters and voltage transformers. Every bus shall have a flexible connector at one end of the bus and at suitable intervals of the bus to allow thermal expansion.

4.11.09 Earth mat of suitable size with closely spaced earth conductor shall be provided below the operating handle of individual switchyard equipment.

4.11.10 Brief description/specification for equipment and philosophy of metering and control shall be as follows:

a) Circuit Breaker

Rated continues current.	2000/3150 A (as required)
Type	SF_6
Rated short circuit current (breaking)	40KA with percentage dc component.
Rated short circuit making current	100 KA peak
Rated line charging interrupting current at 90^0 leading power factor angle	600 A rms
Rated break time as per IEC (rms)	40 ms
Total closing time	Not more than 150 ms
Rated operating duty cycle	O-0.3s-CO-3min-CO
Reclosing	Single phase & three phase auto reclosing type.
Operating mechanism	Pneumatic/spring/hydraulic/or a combination of these
Closing coil voltage	220 V DC+10%,-15%

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Trip coil voltage	220 V DC+10%,-30%
Auxiliary contacts	10 NO+10 NC in addition to actual requirements.

b) Isolator

Type	Outdoors horizontal central Break / double break / Pantograph type
Rated short time withstand current of isolator and earth switch	40 KA for 3 sec
Rated dynamic short time withstand current of isolator and earth switch	100 KA p
Operating time	12 sec or less
Operating mechanism	AC motor operated
Operating mechanism for earth switch	Manual
Numbers of auxiliary contacts	10 NO+ 10 NC in addition to actual requirement

c) Current Transformer

Type	Ring type or hairpin type
Rated short time thermal current	40 KA for 1 sec
Rated dynamic current	100 KA peak
ISF	Less than 5 for metering core
No of cores (protection/metering)	5 or more
Ratio	As per requirement/1 amp

d) Potential Transformer

Type	Capacitor voltage divider with electromagnetic units.
System fault level	40 KA for 1 sec

e) Surge Arrester

Type	Heavy-duty station class, Zn0
Rated voltage	390 KV
Nominal discharge current	10 KA of 8/20 micro sec wave
Continues operating voltage at 50^0 C	303 KV (rms)

f) Billing and metering system

i) Line metering

Line metering is provided for recording export and import of energy through the 400 kV lines.

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Following transducers of 4-20 mA DC shall be provided for remote indication (Control panels / SCADA) in control room & to Load Dispatch Centre.

Amp Transducer.
Watt Transducer.
VAR Transducer.
Voltage Transducer
Frequency Transducer.

ii) **Station Metering**

Station metering is required for indication, record and statistical purpose. This shall include energy metering (kWh) for gross generation and consumption by station auxiliaries. Also following transducers of 4-20 mA DC shall be provided for remote indication (Control panels / SCADA) in control room.

Amp Transducer.
Watt Transducer,
VAR Transducer.
Voltage Transducer
Frequency Transducer
Power factor Transducer.

iii) **Energy Billing**

Energy metering scheme for tariff purpose shall be with redundant Main and Check metering (for active and reactive energy measurement) in 400 kV Line feeders for Export and Import respectively. Tariff meter shall be of ABT type. The impulses from energy meters need to be fed to a common tariff metering equipment to process, evaluate, display and provide for the purpose of switching over to healthy voltage transformer supply to energy meters in the event of PT fuse failure.

CONTRACTOR shall supply ABT meter and its required panel with sealing requirement as required by CSEB and PGCIL, and CMRI and software required for downloading.

iv) **Disturbance Recorder**

The Disturbance Recorder shall be provided to continuously monitor and record the analog inputs such as Voltage, Frequency, Current Wave forms of Main Power Output System and Station Auxiliary System along with recording of digital (contract) inputs from protection relays and Circuit Breakers, in case of occurrence of any system disturbances. The data made available by the Disturbance Recorder shall be used for detailed analysis and study of cause and effect of such disturbances and also to verify the performance of switchgear under disturbance condition.

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The disturbance recorder shall be triggered when –

- Analog input or its rate of change exceeds preset value.
- Digital channel contact changeover condition takes place in specified manner ("NO" to "NC' or vice versa).
- The disturbance recorder shall also have provision for manual external triggering facility for testing the functioning of the system.
- Triggering shall cause all digital and analog inputs to be recorded.
- Electrical disturbance Recorder panels are located in switchyard controls building.

v) **Control Panel and SCADA**

Switchyard control is envisaged through the SCADA system and hardwired control panels.

Following are the control and metering devices proposed to be provided in 400 kV switchyard control panels.

The parameters of the GT/UT/ST can be monitored from SCADA.

For each 400 kV Line feeders

- Ammeters in all phases and Voltmeter in R-Y phase.
- Wattmeter and VAR meter
- Discrepancy type control switches for Circuit breakers, Isolators and remotely controlled earth switches.
- Semaphore indicators for locally operated earth switches.
- Window annunciation for alarms including necessary push buttons for alarm management.
- Synchronizing select push buttons (Key operated type)
- Indicating lamps for feeder charged indication.

For Generator transformer

- Semaphore indicators for breakers, isolators and earth switches

Common equipment

- Synchroscope and Voltmeters and Frequency meters for running and incoming supplies for synchronising of feeder breakers.
- Push buttons and selector switches for synchronising.
- SCADA/PANEL selector switch
- Position control selector switches for center breakers.
- Mimic to represent complete switchyard including GT bays.
- Bus voltage and frequency meters for each Bus

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- Bus voltage and frequency recorders for each Bus.
- Bus charged indicating lamps
- Indicating lamps for synchronizing incoming and running and dc supply status indication.

For ST feeders

- Semaphore indicators for breakers, Isolators and earth switches
- Mimic to represent complete SUT.

4.11.11 Power Line Carrier Communication system shall be as per grid authority requirement and the scheme of PLCC shall be approved by Grid Authority and OWNER. Both end equipments of PLCC shall be of identical make CONTRACTOR shall provide the equipment of PLCC on the power plant's side , the grid side is not in CONTRACTOR's scope. The consultation and interface with the grid for the PLCC shall be done by OWNER

4.11.12 Necessary fire protection system comprising of fire hydrant system and automatic sprinkler system shall be used for various purposes i.e. for transformer or equipment containing oil, cable vault, cable tunnel etc. Fire hydrant shall be provided near switchyard and switchyard control room.

4.11.13 Ventilation system shall be provided to ensure proper working condition in the different areas of the switchyard control room building.

4.11.14 The switchyard and control room provided with adequate illumination. Access road shall be provided to facilitate transport of equipment and personnel for erection operation and maintenance.

4.11.15 Switchyard shall be complete in all respects including all civil works, drainage, fencing etc. Grounding, lighting protection and all allied electro-mechanical activities shall be included in the scope even is not mentioned specifically.

4.12.00 **Power & Control Cables, Cabling & Cable Raceway system**

4.12.01 Power cable conductor sizes shall be determined having consideration of maximum conductor temperatures under sustained and three phase short circuit/earth fault conditions, voltage regulation under steady state and motor starting conditions and automatic disconnection time for protection. The design values being used for standard current ratings, maximum conductor/armour temperatures, ambient and ground temperatures, soil thermal resistivity, depth of burial, cable spacing and grouping etc. shall be subjected to OWNER's approval. When a fault is cleared by backup protection on a non-fuse protected circuit, the cable insulation shall remain intact, safe and functional although some damage may occur necessitating detailed inspection and possible subsequent replacement. Cables shall be sized for 0.2 second for motor feeders and breaker feeders with instantaneous relay where as incomer breakers with IDMT relays shall be sized for 1.0 second.

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4.12.02 For fuse protected circuits the conductor size shall depend upon full load current subject to voltage drop limited to 3% during running of all feeders and 15 % during starting for motor feeders with rigid coupling. For motors with fluid coupling the starting voltage drop can be considered as 20%. In addition, transformer regulation shall also be considered for loads fed from 415V PCC.

For loads fed from local panels, the total running voltage drop in cable from 415V PCC to local panel and from local panel to individual motor shall be limited to 3% at full load motor current while the same during starting shall be limited to 15%.

For welding receptacle, 3% running drop shall only be considered.

4.12.03 The minimum sizes of L.T cable to be chosen are as below:

AL -10 mm^2
Cu - 2.5 mm^2

4.12.04 Following types of cables shall be used for different services of the plant:

a) **11 kV System Power Cable**

MV grade, 90°C rating, heavy duty XLPE power cable suitable for use in non-effectively earthed MV system, with stranded & compacted aluminium conductor, extruded semi-con compound screen, extruded XLPE insulated, extruded semi-con compounded with a layer of non-magnetic metallic tape for insulation screen, extruded PVC (type ST-2) inner sheath, galvanized steel strips/wire armored (for twin & multicore cables), non-magnetic hard drawn aluminium wire armour (for single core cables), extruded PVC (Type ST-2) FRLS outer sheathed, conforming to IS 7098 (Part-II) for construction and tests.

b) **LV Power Cable**

1100 V grade, 90°C rating, heavy duty XLPE power cable with stranded plain aluminium conductor, extruded XLPE insulated polypropylene filler extruded PVC (type ST-2) inner sheathed, galvanized steel strip/wire armoured (for twin & multicore cables only), non-magnetic hard drawn aluminium wire armoured (single core cables only), extruded PVC (Type ST-2), FRLS outer sheath, conforming to IS 7098 (Part-I).

c) **LV Control Cable**

1100 V grade, multicore stranded cupper conductor, PVC insulation extruded PVC inner sheath, steel wire armored, extruded FRLS PVC outer sheath as per IS 1554. Conductor size shall be 1.5 mm^2 and 2.5 mm^2 depending on application.

d) **LV Fire Survival Power Cables**

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1100 volt grade, 90 deg. C rating power cables with stranded copper conductor, heat resisting elastomeric insulation generally conforming to Type IE-2 of IS:6380-1984, extruded halogen free or very low halogen elastomeric inner sheath generally conforming to Type SE –3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE –3 of IS-6380-1984.

e) **LV Fire Survival Control Cables**

1100 volt grade, 90 deg. C rating power cables with stranded copper conductor, heat resisting elastomeric insulation generally conforming to Type IE-2 of IS:6380-1984, extruded halogen free or very low halogen elastomeric inner sheath generally conforming to Type SE –3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE –3 of IS-6380-1984.

4.12.05 All cables shall be subjected to tests as per relevant standard of BIS/IEC.

SEPCO agreed to provide FRLS type cables.

CONTRACTOR to provide armoured power cables for 11 kV system and other cables in the following areas like Fuel oil handling, hydrogen generation plant, chemical handling areas, and in power house for phosphate hydrazine ammonia dosing areas and all buried cables shall be armored.

All cable within the building (both the end of the cable within the same building) terminated shall be unarmoured. All the cable laid from the building to outside for field equipments shall be armoured cable.

Fire Survival type LV power and control cables shall be provided for the services listed.

4.12.06 The fire survival power and control cables shall be used for important auxiliaries / areas like-

a) DC emergency lube oil pump
b) DC hydrogen seal pump
c) Turbine lube oil pump/ barring gear
d) DC emergency lighting for main building
e) DC cables for battery to charger & DC distribution boards
f) Jacking oil pump
g) Emergency turbine trip in control room
h) Boiler: Turbine: Generator inter trip which include the interconnection between-

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- Boiler master fuel trip and turbine trip relays
- Generator trip relays & turbine trip relays
- Generator trip relays & generator breaker
- Generator trip relays & field breaker
- Generator trip relays & unit auxiliary transformer breaker
- Incomer cables for DG board, emergency board, DC lighting board etc.

4.12.07 Power Cable sizes shall be standardized so that inventory and spares can be minimized. Spare cores shall be kept in control cables for future use. Up to five core one spare core, and above five core at least two spare cores shall be provided.

4.12.08 A.C & D.C wires shall not run in same cable. Separate cables shall be used for power, control & interlock, metering and measurements, C.T, V.T cables. All cables shall be tagged with unique numbers at both ends.

4.12.09 All cable runs shall be continuous, straight-through joints not being permissible without the prior approval of OWNER. Control & instrumentation cables may be interconnected for marshalling purpose in suitable enclosures where point to point cabling would be uneconomic. Marshalling boxes in the field shall be located at 1 m above the Finished Ground Level.

4.12.10 Cables shall be generally laid on hot dip galvanized, prefabricated ladder type trays either in concrete trenches or overhead supported from building steel/structures.

4.12.11 All cable trays shall be of ladder type construction. There shall be a maximum spacing of 1500 mm between cable tray supports, except fittings (elbows, tees, etc.) which shall be supported at each splice.

Cable tray fittings shall have a radius equal to and greater than the minimum bending radius of the largest cables they contain.

Solid bottom trays shall be provided for all special noise-sensitive circuits and analog instrumentation circuits. For instrumentation and control cables perforated cable trays shall be used.

Individual tray systems from top to bottom shall be established for the following services: -

i) 11kV power cables.
ii) 415 Volt power cables.
iii) Control cables.
iv) Special noise-sensitive circuits or instrumentation cables.

The minimum design vertical spacing for trays shall be 300 mm measured from the bottom of the upper tray to the top of the lower tray. At least a 250 mm clearance

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shall be maintained between the top of a tray and beams, piping, or other obstacles to facilitate installation of cables in the tray. A working space of not less than 600 mm shall be maintained on at least one side of each tray.

Cable trays in boiler, ESP, Coal & Ash handling and outdoor areas shall be mounted vertically or mounted horizontally with tray cover.

4.12.12 Conduit shall be used to protect unarmoured conductors routed to individual devices and where the quantity of cable does not economically justify the use of cable tray. Rigid conduit shall be used for hazardous and outdoor areas.

Galvanized rigid steel conduit shall be used for all conduit encased in concrete and all exposed conduit except at cooling towers.

All conduits cast in concrete shall be routed in exposed runs parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings. Conduit shall be routed at least 150 mm from the insulated surfaces of hot water, steam pipes, and other hot surfaces. Where conduit must be routed parallel to hot surfaces, special high temperature cables shall be used.

4.12.13 Underground Cables or cables in trench below the ground shall not be acceptable. All cables shall be laid above ground except in transformer yard and switchyard where cable shall be laid in trench below the ground.

4.12.14 HT Power cables shall be laid in single layer. LT power cables of size 150Sq.mm and above shall also be laid in two layers only. LT power cables of less than 150Sq.mm laying of cable in trays in four layers or as permitted by tray height. Control cables may be laid in multi layer as permitted by tray height.

4.12.15 In hazardous area, outdoor area, gas filled area, buried application armoured cable shall be used. Unarmoured cable shall be used if both ends within the same building generally.

4.12.16 Termination

a) The termination and connection of cables shall be done strictly in accordance with manufacturer's instruction and approved drawings.

b) The work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job.

c) Responsibility of proper termination shall lie on the CONTRACTOR. Guarantee for termination shall also have to be given by the CONTRACTOR

d) The equipment shall generally be provided with blank bottom plates for cable/conduit entry and cable end box for power cables.

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e) All cables upto 1.1KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

f) All cable entries shall be through bottom only and top entry termination are made only after getting approval of OWNER.

g) Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

h) In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. CONTRACTORs shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block. All power and control cables shall be tagged with unique numbers at both ends for identification.

i) Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided. All switchgear and control panels shall have undrilled gland plate.

CONTRACTOR shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the CONTRACTOR at the discretion of the Engineer- in-Charge of OWNER.

k) The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

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l) Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.

Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

m) All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

n) Cable accessories for H.V. Systems

i) The H.T. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Engineer-in-Charge of OWNER.

ii) The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the CONTRACTOR or the type of cables issued by OWNER for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kit.

iii) The termination kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a. 'PUSH ON' type for LT cables.

b. Heat-shrinkable sleeve type for LT & HT cables

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

iv) The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

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a. 'TAPEX' of M-seal make or equivalent for LT cables

b. Heat-shrinkable sleeve type for LT & HT cables.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

4.12.17 All cables shall be installed in a neat and orderly manner conforming to good engineering practice.

HT, LT & Control cable terminations at both ends of the equipment shall be carried out utilizing double compression cable glands. For installation of single core cables aluminium gland plates shall be used.

4.12.18 After installation, all power cables shall be subjected to H.V test and insulation resistance shall be recorded.

4.12.19 In order to limit economic loss in the event of a fire or similar incident, segregation by a fire barrier shall be provided between main and emergency supplies, alternative-tripping supplies. Segregation shall be achieved by isolation of one from the other by adequate distance. In all other cases fire barriers and penetration seals shall be provided wherever the cables pass through wall, floors and ceilings and shall have a minimum fire rating of at least one hour to BS 476 part 20 or equivalent.

In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. The Fire Stop Mortar Seal/Fire Retardant Cable coating compound shall generally confirm to the specification enclosed in ANNEXURE-IV and II to this section. Also the cable runs both before and after the fire scale shall be suitably sprayed with antifire propagation liquid at least for 1M length.

4.13.00 **Grounding and Lightning Protection**

4.13.01 The station grounding system shall be so designed that the actual step and touch voltages are well within the maximum safe values for the site. The grounding system design and installation shall generally comply with the following standards and shall be subject to approval.

IS: 3043 : Code of practice for safety Earthing
IEEE-80 : Guide for safety in Alternating Current Substation grounding
IEEE-665 : Guide for generating station grounding
Indian Electricity Rules
National Electrical Code

4.13.02 Grounding system shall consist of a ground grid formed by a number of M.S rods placed in a mesh formation by all welded joints, riser connections from ground grid and aboveground G.S flat for grounding of equipment. Ground electrodes shall also be provided at intervals and driven to solid earth.

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4.13.03 Sizes of belowground conductor shall be selected based on unrestricted ground fault current of 50 kA and maximum duration of fault clearing time shall be 1 sec. Connections to individual equipment shall be sized based on the fault clearing time.

4.13.04 Metal body of all electrical items eg. motors, transformers, switchgears shall have duplicate ground connections. All exposed conductive parts of plant and equipment; control cubicles, valve actuators, cable glands & armour etc. shall be effectively earthed.

4.13.05 Following minimum earthing conductor sizes shall be used for equipment earthing:

Sl. No.	Equipment	Earthing conductor size
1	Generator, GT, UT & STs, generator bus duct	75x10mm GI flat
2	11kV equipment	50x6mm GI flat
3	415V Switchgear, MCC, DB	50x6mm GI flat
4	415V motors Above 90KW Above 30 KW upto 90 KW Above 5.0KW upto 30 KW Upto 5.0 KW	 50x6mm GI flat 35x6mm GI flat 25x3mm GI flat 8 SWG GI wire
5	Control panels & control desks etc	50 x 6 mm GI flat
6	Push Button stations	8 SWG GI wire
7	System neutrals	75x10mm GI flat
8	Cable trays	50 x 6 mm GI flat
9	Steel columns	75x10mm GI flat
10	Rails, fence & gates	50 x 6 mm GI flat

4.13.06 All extraneous conductive parts such as structural steelwork, cable support steelwork, steel tanks and pipe work, compound and station perimeter, fences, gates etc. shall be effectively bonded to the earthing system.

All non-current carrying structural shall be grounded at one point and all the electrical devices/equipment shall be grounded at two distinct points.

4.13.07 A separate instrument earth network shall be provided, single point connected to the main earth system, to which all alarm, control, computer, instrument etc, earth connection shall be made. Instrumentation cable screens shall be single point bonded to the instrument earth network to minimise the effects of electrical interference.

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4.13.08 Dedicated treated earth pit shall be provided for system earthing at locations where generator and transformer neutrals are grounded. Two pits shall be provided for each neutral.

4.13.09 The lightning protection of the complete power station, other buildings, structures, chimney and all the area within the plant boundary shall be done as per CBIP guidelines and codes of practice for lightning protection (IS-2039) and connected directly to the main ground grid. The lightning protection shall consist of horizontal conductors, down comers, test links, and earth electrodes connected to the building,/structure earth grid. Galvanized steel flats of 25x6 mm would be used for horizontal roof conductors and the down comers shall be of 50 x 6 mm GS flat.

4.13.10 Dedicated treated earth pit shall be provided for lightning protection system.

4.13.11 As the building / structure constructed lightning protection shall be provided / arranged by the CONTRACTOR.

4.14.00 **Motors**

4.14.01 AC Motors shall be suitable for 3 phase, 50 Hz supply and shall be of the squirrel-cage induction type suitable for direct-on-line starting. The rating of each motor shall be with at least 15% extra margin over the input power requirement and shall be continuously rated.

The temperature rise over 50 deg.C ambient of all motors shall be limited to Class B.

For differential protection depending upon relay manufacturer's requirement suitable CT of 5P 30/5P 20 as per application checks shall be supplied.

CONTRACTOR shall provide control & relay panel with degree of protection IP32.

4.14.02 All motors shall be squirrel cage type except for cranes. The motor winding shall be of copper. Motor shall be suitable for voltage variation of ±10%, frequency variation of ± 5% and combined voltage and frequency variation of 10%.

4.14.03 Motor frame size shall be so chosen such that maximum interchangeability is achieved over the entire plant.

4.14.04 Motors up to 200 kW will be 415 V ,rated and above 200 KW will be of 11 kV . Motors of rating up to 110 kW will be MCCB operated. Higher ratings will be ACB operated.

MCCB for motor control can be controlled from DCS. Incase if it is not possible to control from DCS, CONTRACTOR shall provide SFU with contactor operated. Motors of rating up to 110 kW shall be contactor operated. Higher ratings shall

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be ACB operated. All motors above 30 kW shall have space heater for avoiding condensation during idle hours.

4.14.05 Starting current, starting time, starting voltage etc shall be compatible with the supply voltage and its parameters, protection system. All motors (except DC motors) shall be started Direct On Line (DOL).

4.14.06 The motors shall be designed to be energy-efficient and have high power factor and low starting currents. All HT motors shall have efficiency and power factor higher than 0.9 and 0.88 respectively. The starting current with DOL starting inclusive of all tolerances shall not be higher than 5.4 p.u. for BFP motor, 6.0 p.u. for other HT motors and 7.2 p.u. for LT Motors.

Motors shall be capable of starting and accelerating to full speed at 80% of the nominal voltage and shall not stall at 70% of nominal voltage for one (1) minute. With voltage and frequency within permissible variation band, the motors shall be capable of 3 equally spaced starts in 1 hour with motor initially at temperature not exceeding rated operating temperature. 2 start in succession with motor initially at a temperature not exceeding rated operating temperature.

However, BFP Motor shall be capable for starting and accelerating to full speed at 75% of nominal voltage. All other requirements specified above shall be applicable.

The motors shall also be capable of restarting under full load after a momentary loss of voltage with the possibility of application of a total of 150% nominal voltage during bus transfer.

Variable frequency drive shall be used for ID fan, FD fan, PA fan (if axial fans is provided for ID, FD, PA, VFD is not applicable), HCSD, Coal feeder motors to ensure high power factor and efficiency during part load operation.

4.14.07 The torque characteristics of all induction motors shall be as required to accelerate the inertia loads of the motor and driven equipment to full speed without damage to the motor or the equipment at any voltage from 80 percent to 110 percent of motor nameplate voltage except those to be individually considered. A voltage drop greater than 10 percent from the specified motor nameplate rating shall be individually considered for proper motor starting and operating.

4.14.08 Motors shall be self ventilated type; total enclosed fan cooled or closed air circuit air-cooled type. Motors of rating 3000 KW and above may be water-cooled type with machine-mounted heat exchanger. Motors located outdoors shall be of weatherproof construction. The degree of protection of motor enclosure shall not be less than IP-54 (indoor)/IP-55 (outdoor). Motors to be operated with VFD shall be designed accordingly to take acre of additional cooling required while working at lowest speed as required by application.

All outdoor motors shall be provided with rain hood.

4.14.09 All 11 kV, 415 V motors shall have class-F but with temperature rise limited to that of class-B.

All insulated windings shall have Class F non-hygroscopic insulation systems rated for Class B temperature rise above ambient temperature of 50°C in accordance with the standards.

4.14.10 Special enclosure requirements such as flameproof and explosion-proof enclosures shall be provided for motors of hazardous areas.

4.14.11 Cable box and terminal box for 11 kV motors shall be phase segregated type where ELASTIMOLD termination with protective cover is not provided. 415V motors shall have non-phase segregated cable box. Cable box shall withstand maximum fault current for duration of 0.25 sec.

4.14.12 All 11 kV motors shall have six (6) winding temperature detectors, bearing temperature detectors, hot and cold air temperature indication (for CACA, CACW type). In addition, flow switches shall be provided for water-cooled motors and forced lubrication bearing, if used.

4.14.13 All motors shall be subjected to works routine tests. In addition, 11 kV motors winding shall conform to the requirement and impulse voltage withstand levels as per IEC 60034-15. Type test certificate on identical rated motors shall be furnished as a proof of design.

4.14.14 D.C motors shall be shunt/compound wound type; other features like enclosure type, cooling and class of insulation shall be generally similar to A.C motors. Starters shall be furnished along with the motors.

4.15.00 **Motor Operated Valve Actuators**

4.15.01 The actuator shall be electrically operated electronically controlled type. It shall be sized to achieve valve/damper closure at the specified differential pressure.

4.15.02 The actuator motor shall be time rated for at least 15 minutes or twice the valve stroking time, whichever is higher at an average load of atleast 33% of the maximum valve torque. For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour. It shall be capable of starting at 85% of rated voltage. Torque switch must trip at maximum driven equipment torque at 90% rated voltage.

4.15.03 Motor shall have minimum class 'F' insulation with temperature rise restricted to class 'B'.

4.15.04 Motor shall be suitable for operation under voltage variation of + 10%, frequency variation of + 5% and combined voltage & frequency variation of 10% absolute.

4.15.05 Motor shall be suitable for direct on-line (DOL) starting and starter shall be integral to the motor.

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4.15.06 The enclosure shall be of the totally enclosed weatherproof type, degree of protection being not less than IP-65.

4.15.07 The actuator shall be complete with all accessories viz. torque limit switch, end-of-travel switch, adjustable position limit switch, hand-wheel etc.

4.15.08 Complete actuator shall be tested at factory as per IEC before despatch.

4.16.00 **Variable Frequency Drive**

4.16.01 Variable frequency drive system shall be of minimum 12-pulse design, having two channels (each channel with six pulse design) for each motor. Coal feeders and HCSD drive shall be VFD control.

4.16.02 Performance Requirements

a) The system shall be energy efficient and shall provide very high reliability, high power factor, low harmonic distortion and low vibration/ wear/ noise.

b) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the motor and/or such selected auxiliary by CONTRACTOR with input supply variation of ±10% and frequency variation of ±5%. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit.

c) The drive system shall be designed to operate in one or more of the following
operating modes as to suit characteristics of the driven equipment

i) Variable torque changing as a function of speed i.e. speed squared
ii) Constant torque over a specific speed range
iii) Constant power over a specific speed range where the torque decreases when speed increases

d) The Total Harmonic Distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800-4 and it shall be considered in the design of the motor.

e) Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519.

f) Each channel and motor rating shall be rated to meet fan requirements. The system shall be designed for linear continuous speed control from 10% to 100% of fan rated speed and shall be of a modern proven design and fully compatible with excitation system offered.

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g) The drive controller shall be equipped with microprocessor based digital regulator with programmable functions.

h) Maximum noise level from the drive at 1meter distance, under rated load with all normal cooling fans operating shall not exceed 85dBA.

i) Variable frequency drive shall be arranged so that it can be operated in a circuit mode, disconnected from the motor for start up adjustment and troubleshooting/ maintenance.

j) Voltage at motor neutral terminal shall be maintained at ground potential for the total operating condition.

k) The drive system shall ensure following

- Harmful VFD induced harmonics which can create motor heating are eliminated.
- VFD induced torque pulsation are limited to maximum 1% (even at low speed) so there is minimal stress to the equipment.
- Motor is protected from dv/dt stresses.
- No appreciable increase in motor audible noise.

l) VFD and the dry type transformer shall be located in controlled environment.

m) Electrical performance of the system shall comply with IEEE, IEC and equivalent international standard.

4.16.03 Control Requirement

a) The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.

b) Short time voltage dip up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system. The drive shall not trip for an external short circuit fault till 200 millisecond

c) It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/manual selection shall be from VFD panel unless otherwise specified.

- With the selector switch in "manual" mode, the operator shall be able to set the speed through keypad, mounted on front of the drive panel or from speed increase/decrease push buttons from the field. Motor operated potentiometer shall be provided as a speed set point device.

- With selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20mA signal, from PLC/DCS system. Necessary equipment like protocol converter as required for interfacing with PLC/DCS shall also be provided in the drive panel. Contractor will

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consider IEC-103 protocol for communication and automation of switchyard.

4.16.04 Equipment/Component Specification

i) Motor

a) The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
b) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
c) The Motor shall be designed to operate continuously at any speed over the range 10-100 % of rated speed.
d) The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
e) Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value specified for in motor.
f) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
g) The motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800-4.

ii) Power Transformer

Indoor dry type and shall be suitable for rating complying with system details.

iii) Power Converter

a) The static power shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
b) Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
c) All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
d) The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range.
e) All power diodes shall be of silicon type with minimum V_{bo} rating as 2.5 times the rated operating voltage.
f) The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.

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g) The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
h) The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
i) Offered system shall also take in account the distance between drive panel and motor and system shall include all material and accessories to make system suitable for a distance suiting layout.

iv) DC Link Reactor

a) Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
b) The reactor shall be dry type, air cored, air-cooled or fan cooled type located within the panel.
c) Reactor shall be suitable for withstanding earth fault continuously and for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.
d) Noise level shall not exceed value specified in NEMA TR-1.

v) Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds. Output filter shall be provided if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance free and self-healing type.
The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

vi) CT/PT/Meters

As required for the system offered and shall be suitable for variable frequency operation.

4.16.05 Bypass Feature

a) Bypass breaker / contactor-HRC fuse complete with protection, annunciation and metering shall be provided.
b) All Variable frequency drives (VFD) having bypass feature shall have motor protection relay along with necessary control and metering etc. Switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended by opening its isolation devices.

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c) Safety interlock between inverter and bypass breaker/contactor shall be provided such that closing of healthy device is inhibited in case of external fault.

4.17.00 **Surge Arrestor**

4.17.01 The surge arrestors shall be utilized to protect Power Transformers. Surge arrestor of suitable voltage class and discharge current as per IEC 60099-4 shall be provided. The surge arrestors shall be heavy duty, station class, gapless type complete with insulating base, surge counter, leakage current meter, pressure relief device and grading/corona rings as required.

4.17.02 The surge arrestor (SA) Shall be hermitically sealed single-phase unit, self-supporting construction, suitable for mounting on lattice/tubular type support structures.

4.17.03 The non-linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties and Shall be capable of withstanding metrological and short circuit forces under site conditions.

4.17.04 SA shall protect power transformers with insulation levels specified and shall be capable of discharging over voltages occurring due to switching of unloaded transformers and long lines.

4.18.00 **Electrical Relay Panel & Control, Local Panels**

4.18.01 Relay panels provided for Generators, Generator Transformers, Unit Transformers and Station Transformers shall be simplex type complete with supply, mounting & wiring of all equipment, devices and accessories. The accessories like timers, auxiliary relays, interposing CTs & VTs, tripping relay etc. as required to fulfill the functional requirement of control, indication, interlock & protection shall be considered. However, initiating contacts in hardwired circuits performing essential functions such as main protection and safety interlocking shall operate directly into their associated control circuits and not via secondary devices such as interposing relays.

4.18.02 Duel channel protection for all 400kV feeders as well as for all Generators, Generator Transformers, Unit Transformers & Station Transformers shall be provided. Each channel shall be fed from separate CT and PT cores as well as separate AC and DC source. The trip relays in each group shall be tripping the respective circuit breakers through both trip coils I & II. The trip relays in each group shall be tripping the respective circuit breakers through both trip coils I & II.

4.18.03 **Unit Protection (Combine protection of Generator, GT & UT):**

The Generator, GT and UT protections shall be classified to initiate the following three classes of tripping:

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a) Class-A trip mode for critical electrical faults in the Generator system.
b) Class-B trip mode for non-critical electrical faults in the Generator system.
c) Class-C trip mode for abnormal operating conditions and system disturbances

The successful CONTRACTOR shall establish and submit the logic diagram of class A, B & C trips for review and approval of OWNER. For house load operation the grid condition or abnormalities in addition to machine requirements shall be considered.

The protections envisaged in GRP are listed below. The CONTRACTOR shall examine the adequacy of the protection indicated with respect to the equipment offered by him and submit his recommendation with justification for providing each protection considered by him for his equipment. CONTRACTOR shall include any additional protections deemed needed by him for the equipment offered even if not indicated in the list. The detailed proposal of CONTRACTOR highlighting the requirement of each protection shall be reviewed by OWNER. Numerical relays shall be provided for main protections of Generator, GT and UT. However, static relays have to be provided for Dead machine protection and for any other protection not adequately afforded by the multifunction numerical relay.

List of Relays/Protection

a) **For Generator:**

i) Differential,
ii) Overall differential including generator, generator transformer & unit transformers.
iii) Inter-turn fault,
iv) 100% Stator earth fault,
v) Stand by stator earth fault
vi) Rotor earth fault,
vii) Negative sequence current,
viii) Reverse power,
ix) Loss of field,
x) Back-up impedance,
xi) Over-load,
xii) Low forward power,
xiii) Over and Under voltage,
xiv) Over and Under frequency,
xv) Generator pole slipping,
xvi) Voltage Balance
xvii) Generator over fluxing
xviii) Local breaker backs up
xix) Dead machine protection
xx) Synchro-check – with Synchronization panel
xxi) Lock-out

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xxii) Accidental energisation relay

b) For Generator-Transformer:

i) Differential
ii) Over fluxing
iii) Over current relay for H.V side
iv) Restricted earth fault
v) Back-up by Earth fault
vi) Lock-out relay
vii) Buchholz relay
viii) Winding Temperature
ix) Oil Temperature
x) Pressure Relief Device

c) Unit Transformer:

The following protections are considered in UT Relay & Protection panel:-

i) Differential
ii) Back-up Over current, for HV side
iii) Restricted earth fault for LV side
iv) Back-up earth fault for LV side
v) Buchholz
vi) Over current on LV side.
vii) OLTC surge protection
viii) Winding Temperature
ix) Oil Temperature
x) Pressure Relief Device

4.18.04 **Station Transformer Protection:**

The following protections are considered in ST Relay & Protection panel:-

Numerical multifunctional relay shall be provided for protection of Station Transformer. The relay shall have minimum following functions.

i) Differential
ii) Over current on both LV separately
iii) Restricted earth fault on HT & both side of LV separately
iv) Back-up Earth fault on HT & both LV.
v) Local breaker backs up
vi) Over fluxing
vii) Lock-out relay
viii) OLTC surge protection
ix) Buchholz relay
x) Winding Temperature
xi) Oil Temperature
xii) Pressure Relief Device

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4.18.05 **HT Auxiliary Transformer Protection:**

N/A

4.18.06 **400kV Switchyard Protection:**

a) 400 kV outgoing line

Protection system envisaged for 400 kV outgoing line feeders are:

i) Distance protection (21-Main-1 & 21-Main-II)
ii) Open jumper protection (46L)
iii) Local breaker back up protection (50Z)
iv) Pole discrepancy protection (47)

Single & three phase Auto reclosure shall be provided as standard feature for line protection.

b) 400 kV Bus bar protection

i) Main bus differential protection for Bus-I and Bus-II (87B-I, 87B-II)
ii) Check Bus differential protection for Bus-I and Bus-II (87CH-I, 87CH-II)

c) Stub protection for all the feeders. (87TT-I, 87TT-II).

4.18.07 CONTRACTOR shall provide computer with software, hardware for downloading relays during construction, installation and operations.

4.18.08 Apart from above, trip circuit supervision relays, D.C. supply supervision relay, auxiliary relays, and timers etc. shall also be provided.

4.18.09 The CONTRACTOR shall furnish a write up on the tripping logic of the system along with the characteristics of relays to be supplied.

4.18.10 Control panel shall be provided for synchronizing, generator and generator transformer breaker control, OLTC control, generator field control along with annunciation, metering, indication etc.

The degree of protection of control & relay panel shall be IP32.

4.18.11 Any other panels required for local control of equipments including those located offsite shall be provided on as required basis.

4.18.12 Site testing and functional checks shall be carried out on all relays and their associated CTs & VTs and protection circuits to confirm the correctness of operation of the protection.

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4.18.13 The CONTRACTOR shall furnish single line diagram for metering and protection of generator, generator transformer, station transformer, 400kV switchyard and detail write up on control philosophy of electrical power distribution system in during basic design.

4.19.00 **Electrical Control and Synchronization**

4.19.01 All distribution feeders (power as well as motor feeders) of 11kV, 415V & 240V system shall be controlled & monitored from DCS located in Central Control Room.

4.19.02 A separate control room at 400 kV switchyard shall be provided to house the control and relay panels, digital and analog processing and recording equipment, AC and DC distribution boards, battery etc. however, generator relay panel and relay panels for Station Transformer, Unit Transformer & Generator Transformer shall be located in CCR.

The switchyard equipment like isolators, earth switches and circuit breaker shall be provided with proper interlock to avoid any wrong operation of isolators and earth switches due to human error. Earth switches can be operated only from locals whereas isolators and circuit breakers can be operated from remote control panels located in control room and also from locals, both with suitable selector switch control.

4.19.02 **Synchronization**

Synchronization panel shall be provided in Central Control Room and shall have synchronization facilities for following 400 kV breakers shall be provided as under: -

i) Generator breakers - Auto / Manual

ii) Line breakers - Auto / Manual

iii) Station transformer breakers - Auto / Manual

For this auto synchronizer shall be provided which shall monitor the voltage and frequency of both the incoming generators as well as the bus voltage and shall provide control signals for correcting the reference of the governor, the frequency matching and automatic voltage regulator reference value for voltage matching. It shall give the breaker closing command at a suitable time when the voltage and frequency differences are with the time limits taking into the circuit breaker closing time. The auto synchronizer shall inhibit operation in case the voltage is less than 80% of nominal.

Two nos single phase CVT shall be provided on 400 kV side of each Generator Transformer bay for generator synchronization.

4.19.03 **Communication and interface with DCS**

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All numerical relays and load managers shall have serial communication (multi drop allowed) with DCS and SCADA for relay operation status and for all analogue parameters (V, I, KW, kVAR, PF, KWH, HZ) respectively. SCADA shall be connected to DCS through communication bus.

Status of all auxiliary feeder breakers shall be made available at DCS. For motor feeder breakers, start/ stop shall be possible from DCS, Switchgear/MCC and local push button station. Remote/local switch shall be provided at switchgear/MCC. Status (ON/OFF/TRIP/RTS) shall be available at DCS. Current indication of all critical motors required for operation of unit shall be made available at DCS. Drive ,motor logic shall be made at DCS. However, drive control philosophy shall be as per Section-XIX-A, Annexure-2.

Energy Management system upto motor level shall be implemented in DCS.

4.20.00 **SCADA Control**

4.20.01 A supervisory control and Data Acquisition (SCADA) System shall be provided for implementing control monitoring and interlocks for 400 kV switchyard feeders.

Common DCS located in central control room shall take care control for all motors as well as electrical auxiliary power distribution breakers. Separate SCADA for switchyard shall be provided to control/monitoring for 400kV breaker/isolator located in switchyard control room. Switchyard SCADA shall be communicating with main plant DCS with respect to control/monitoring annunciation through two redundant fibre optic cable. Independent operating station & engineer station shall be provided at switchyard control room as well as plant control room. Switchyard can be controlled from both locations.

4.20.02 SCADA shall also help built in function of sequence of event recording. It shall show a mimic diagram complete with status equipment and values of voltage, current, MW, MVAR, frequency etc.

4.20.03 The remote terminal unit shall be located in 400 kV switchyard control room and in central control room. Field inputs from different equipment located in a different area are received I/O processing unit (Remote I/O Unit). Signal from RTU are transmitted to high-speed data highway through redundant communication controller and received at the MMI unit for further monitoring and control. Consoles at the operator stations and engineer's stations are provided with CPU, color VDU with keyboard, Track ball/Mouse, printers and interface for control, alarm and data acquisition of the equipment / system in the plant. Monitoring and control of feeders shall be from Main Machine Interface (MMI) of electrical SCADA system.

4.20.04 The SCADA system shall also function as a data acquisition system for all the feeders. The SCADA shall also store and log information. The information useful

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for maintenance planning shall be compiled by SCADA system. This shall include for example equipment outage time, number of routine outages, number of tripping etc. SCADA system shall assist the operator by ensuring proper interlocking ad by promoting for the next step in a sequence of steps.

4.20.05 Overall functions of the SCADA system shall include:

- Analog Inputs: Monitoring currents, voltages, frequency, power flows, power factor, transformer temperatures, etc. (SCADA system shall display the values and give audio and visual alarms when values exceed set limits). Transducer inputs from current transformers, voltage transformers usually of 4-20 mA DC and RTD (pt 100) inputs shall be wired to RTUs for this purpose.

- Digital Input: Monitoring the digital input viz. Alarm inputs, status inputs and event inputs. Typical digital inputs are Circuit Breaker (CB), CB monitoring system contacts, protection system contacts, status inputs from equipment like generator and its auxiliaries, transformers, DG sets, Switchgear, UPS, DC system etc. to generate the alarms/ indicating status of the equipment.

- Periodic logging of the above parameters.

- Classifying alarm in order of priority and / or any other manner of classification.

- Controlling circuit breakers in switchyard after ensuring interlocks or help the operator in sequential control.

- Maintain data of handing over of equipment to maintenance crews while following safety tagging. (The safety tagging shall be performed by the control room operator that shall force the tags via mouse and keyboard)

- Mimics and displays related to electrical system and plant.

- Historical storage of analog and digital input data for seven (7) days minimum.

- Event Logging: The RTUs of the Electrical SCADA system shall also function as Sequence of Event Recorder (SER – high resolution RTU with real-time clock). SER shall scan digital inputs, such as status of circuit breakers etc. in one millisecond resolution and shall provide a record of the time sequence in which circuit breakers operated.

SCADA RTUs shall have IEC870-5-103 / Mod bus interface for connecting intelligent electronic devices such as a Numerical relays etc. It shall be able to access data from these devices for monitoring, alarm and computing functions.

4.21.00 **Electrical laboratory equipment**

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CONTRACTOR shall supply all electrical laboratory equipment. The items covered include but not limited to the following, for the successful operation /maintenance of power plant of the size under consideration.

Insulation tester, various kind of meters, EHV discharge rod, vibration/sound level meters, portable infrared temperature scanners, secondary injection sets, single/three phase auto transformer, tan delta test kit, HV testing kit, clamp on watt meter, earth fault location, standard CT, oil resistivity measuring equipment, SF_6/ hydrogen/halogen gas detector, circuit breaker analyzer, oil filtration plant, Kelvin double bridge, cable fault locator, transformer trans ratio tester, RTD digital temperature indicator etc.

Please refer Annexure-V for Electrical Laboratory Equipments. Additional items as necessary shall be supplied by CONTRACTOR.

5.00.00 PAINTING

5.01.00 All surfaces shall be sand blasted, pickled and grounded as required to produce a smooth, clean surface free of scale, grease and rust.

5.02.00 After cleaning, the surfaces shall be given a phosphate coating followed by 2 coats of high quality primer and stoved after each coat.

5.03.00 The equipments shall be finished in Siemens grey (RAL-7032) with two coats of synthetic enamel paint, unless other wise stated.

5.04.00 Sufficient quantity of touch-up paint shall be furnished for application at site.

6.00.00 LAYOUT CONCEPTS

All equipments at site shall be able identify from far places also i.e. every equipments shall be labeled with paints and coloured back ground.

6.01.00 TRANSFORMER (INDOOR)

6.01.01 For indoor installation, use of oil filled transformer shall be avoided and dry type transformer shall be considered. Only dry type transformers shall be used for installation inside the buildings. Maximum rating of indoor/dry type transformer shall be 2500kVA.

6.01.02 The dry type transformer shall preferably the made integral with the switchgear / power control center. Being integral with the switchgear, the LV connections shall be with busduct. The length of LV bus duct shall be such that physical separation between transformer cubicle and PCC shall be minimum one meter ensuring separate cooling of two equipment. The dry type transformer being relatively heavy, the switchgear room shall be designed with stronger floor taking into account the movement of the transformer.

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6.01.03 No fire barrier wall is required for dry type transformer.

6.01.04 For indoor transformer, handling / removal arrangement of transformer shall be included.

6.02.00 **TRANSFORMER (OUTDOOR OIL FILLED)**

6.02.01 The level of transformer base shall be at least 150 mm higher than the highest flood or storm water level of that area.

6.02.02 Transformers having an individual or aggregate oil content of 2000 litre or more shall be located in a suitably fenced and locked enclosure separated on all sides by at least 6 meter from any building including the sub-station. Separating walls as indicated below shall also be provided.

The oil filled transformers shall be separated from each other and from all other apparatus by fire resistant walls of not less than 355 mm thick brick work or 230 mm thick RCC. The wall shall be extended at least 600 mm above the highest point of the equipment so separated and 600 mm beyond the width of the transformer and cooling radiators. However, for some practical constraint, the above requirement may be relaxed in case where the individual or aggregate oil capacity is less than 2000 litre.

If the number of oil filled transformer is more than one and installed side by side, they shall be separated by fire resistant wall.

If 6 meter distance can not be maintained then the building walls which are within 6 meter from the transformer shall be of minimum 355 mm thick brick work or 230 mm thick RCC. The doors if any, in that area shall be 2 hour fire proof type and the windows shall be of 6 mm thick wire glass in steel frame. However, the minimum clearance shall be as indicated below.

Minimum clearance of transformer outer edge from the walls shall be maintained as below :

0.75 meter if one side is closed
0.75 meter if two adjacent sides are closed
1.00 meter if three sides are closed
1.25 meter if all four sides are closed.

6.02.03 In case the individual transformer oil capacity is more than 5000 litre the following clear separating distance shall be maintained from any building:

Oil Capacity (Litre)	Clear Separating Distance (meter)
5,000 to 10,000	8.0
10,001 to 20,000	10.0
20,001 to 30,000	12.5
Over 30,000	15.0

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If the above distance cannot be maintained then the building walls which are within the above distance from the transformer shall be minimum 355 mm thick brick work or 230 mm thick RCC. The doors, if any, in that area shall be two hour fire proof type and the windows shall be of 6 mm thick wire glass in steel frame. However, the minimum clearance shall be as indicated above.

6.02.04 Where a fire wall is provided between the building / other apparatus and a transformer, it should be extended vertically and horizontally as under.

As a minimum, the firewall should extend at least 600 mm top of the transformer and oil conservator tank and at least 600 mm beyond the width of the transformer and its cooling radiators. If the columns supporting the turbine building roof at the exterior wall shall have 2 hour fire rated (minimum 355 mm thick brick work or 230 mm thick RCC) wall above the operating floor, the firewall need not be higher than required to obtain line-of-sight protection to the height of the operating floor.

6.02.05 If the oil capacity of any transformer exceeds 5,000 litre, oil soak pit under the transformer and common oil pit for all the transformers in the area shall be provided. Adequate provisions shall also be made for quenching the fire which may occur.

6.02.06 The fence of the transformer yard shall have two gates at opposite sides – one of which shall be suitable for handling the equipment and the other suitable for emergency escape.

6.03.00 **OIL PIT UNDER TRANSFORMER**

6.03.01 The pit shall be such that it can take oil / water surge of 1/3 of the volume of the transformer oil when filled with gravel of size 60 mm.

6.03.02 Each pit shall be connected to the drain line of at least 150 mm diameter stoneware pipe with a minimum slope of 1 : 96 leading to common oil pit. Level of the pit under the transformer shall be such that there shall not be permanent accumulation of oil / water.

6.04.00 **COMMON OIL PIT IN TRANSFORMER YARD**

6.04.01 Location of the common oil pit shall not be less than the distance specified above from the nearest Transformer unless protected by fire resistant wall.

6.04.02 The volume of the oil pit upto bottom level of the oil pit shall be calculated based on following:

- Oil quantity of the largest transformer.
- Quantity of the water for sprinkler system based on 10.2 litre / min. / sq. meter of the largest transformer surface area (Ref. TAC manual for water

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spray system) and 10 minutes operation of spray water system (ref. : NEPA 850).

- Quantity of rain water collected from all associated pits (assumed 5 – 7% of total oil quantity of associated transformers.

6.04.03 The common oil pit shall be closed type of water proof concrete construction.

6.04.04 Pit shall be provided with two (2) sump pumps such that discharge rate of each pump shall be at least equal to the discharge rate of high velocity water spray system provided for fire fighting of the largest transformer.

6.04.05 The sump pump outlet shall be connected to

a) Oil water separator, or
b) Sewage line of plant with leads to Sewage Treatment Plant.

6.04.06 The sump pump shall have automatic operation by float switch with manual over-riding facility.

6.05.00 **ELECTRICAL EQUIPMENT LAYOUT**

6.05.01 For finalizing room size, following points shall be considered:

a) Cable vaults shall be below switchgear and control rooms as well as local control room. In case of cable vaults, minimum 2.2M clear height shall be maintained from finished ground floor level.

b) Minimum clearance between two switchgear panels, facing each other shall be maintained as 3000 mm. These distances shall be maintained for all other panels located inside the room.

c) Clearance from any obstruction like column, wall and vertical raceway on back side of switchgears shall be maintained as 1200mm (minimum) and shall also comply with manufacture's standard.

c) Minimum Space between the sides of two switchgears, between any two panels or between switchgear and the wall shall be 1200 mm. Where access is not envisaged, clearance shall be 200 mm.

d) Clearance between front face of SWGR and any obstruction like column, wall, vertical raceway, etc. shall be maintained as 1500 mm (minimum) and shall also comply with manufacture's standard.

e) Clearance between switchgear panels and any other panels, facing each other shall be maintained as 2000 mm.

f) Minimum Clearance from top of bus duct to nearest obstruction shall be at least 1000 mm.

g) Access to Rooms, Doors, etc. to be provided in various floors shall consider movement of the panels during erection and later during maintenance.

h) Switchgear shall be arranged to minimize interference with floor beams. Where interference is unavoidable dummy panel shall be provided.

i) Switchgear room/MCC room and cable spreader room vault shall be pressurized above the atmospheric pressure to prevent ingress of dust.

j) Control Room, Switchgear room including cable vault shall be provided with separate entry and exit door. Rating of fire proof door at cable vault shall be 2 hours.

Equipment landing platform shall be provided at floor levels.

6.05.02 Air conditioning in local control room shall be adequate so that even in failure of one window AC others are to get 100% required AC.

6.05.03 Local PCC/MCC room and control room shall be away from coal and ash yard.

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ANNEXURE - I

GENERATOR INSTRUMENTATION

The following minimum instruments shall be provided for each generator.

A)	**Rotor winding Temperature monitoring**	:	Rotor winding temperature shall be calculated by rotor current in the excitation system. Once the calculated rotor temperature is higher than the alarm temperature, the excitation system shall send alarm signal to the DDCMIS.
B)	**On line water temperature Monitoring for Individual stator winding bars (Applicable for water system)**	:	Complete with all software and hardware required to detect any abnormalities in the temperature at any given generator operating point and shall be sensitive to generator loads, header flows, pressure, etc. This shall be realized in TG C&I part of DDCMIS.
C)	**Vibration monitoring System**	:	At least six (6) numbers of pickups at each end of over hang portion of the winding shall be provided, symmetrically located around the periphery with connection to Turbine Supervisory system for vibration monitoring and analysis.
D)	**Liquid leakage detector**	:	Shall be provided at all the low level points inside the generator casing including end shields along with provisions of indication and alarm during leakage of liquid in generator in case of water cooled machine.
E)	**Online partial discharge (PD) monitoring**	:	Permanently connected Independent sensing unit for each generator shall be provided. However evaluation unit for all generators shall be common. Latest software shall be provided to interpret the PD result. It shall also be suitably connected to TG MMI.

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ANNEXURE - II

WRITE UP ON BUS TRANSFER SCHEME

1.0 Bus transfer scheme (BTS) shall be provided, when specified, between two switchgears connected through tie-breakers (or bus coupler breaker between two bus sections) and fed independently from two upstream power sources.

1.1 Bus transfer could be manual (planned transfer) in the event of transfer of load from one source to the other or automatic when fault is characterized by operation of protective relay.

1.2 The manual and automatic bus transfer shall be arranged in such a way that any of the following modes of operation is possible.

2.0 **Manual Bus Transfer**

2.1 Without voltage interruption

This means by allowing momentary parallel operation of two sources.

2.2 With voltage interruption

a) Slow Transfer

b) Fast Transfer

3.0 **Automatic Bus Transfer**

3.1 With Voltage Interruption

a) Slow Transfer

b) Fast Transfer

4.0 The requirement under various modes of bus transfer are further detailed as under :

4.1 **Manual bus transfer without voltage interruption**

In this mode, two sources are allowed to operate in parallel for short duration. Facility shall be provided to bypass the normal interlock against parallel operation. The changeover involves 'check synchronizing' the two sources whenever the breaker for new source of supply is closed. Closure of 'new source breaker' gives tripping command to the 'existing source breaker' automatically.

However, this mode of operation is generally not used in normal course, as it involves paralleling of two sources, however briefly, which may give rise to the fault level beyond the specified withstand and rupturing capacity of circuit breakers. This scheme shall

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therefore be used, with due precautions, only in case of emergency when other modes of bus transfers are not available.

4.2 Manual bus transfer with voltage interruption

Under this condition bus transfer is either Slow Transfer or Fast Transfer.

Slow Transfer

This changeover consists in switching off the existing source of supply and allowing the residual voltage of motors connected to the bus to decay sufficiently, (about 20% of the rated voltage) where after only the impulse goes to the breaker of new source of supply for closure.

Necessary VTs and voltage sensing relays are used for sensing the appropriate voltage condition for bus transfer. This ensures that at the moment of bus transfer, even if residual voltage of motor is in phase opposition to the voltage of new source of supply, the motors shall not be subjected to magnetic shock.

To avoid the excessive voltage drop due to simultaneous restarting of all motors connected to the existing bus, some of the pre selected non-essential motors and other loads are switched off in this scheme along with the existing source breaker. This allows the bus voltage drop during restarting the motors to remain within acceptable limit. The details of selection scheme for automatic tripping of such motors is decided during detail engineering.

Fast Transfer

In this mode of bus transfer the existing source breaker is switched off and the new source breaker is closed. The switchover is so rapid that the vector difference between motor residual voltage and the new source voltage is very little so that closure of breaker against phase opposition is not encountered. On the other hand, at the time of closure, speed of connected motors drops down only marginally, with the result that at the moment of transfer of motors loads to the new source of supply, there is only a small rise in current as compared to the normal running current of motors. The voltage drop during this transfer is therefore marginal and bus transfer is satisfactory.

Since the closing time of breaker is considerably longer than the tripping time, this scheme gives the closing command to the new source breaker first and only after a preset time interval it gives the tripping command to the existing source breaker. The interval between these two commands is so selected that the actual interruption time is limited to few cycles.

4.3 Automatic bus transfer with voltage interruption

As compared to the bus transfer described under 4.2 above, the changeover in this mode of transfer is initiated automatically upon sensing under voltage in the existing bus. Thus with the help of appropriate sensing relays, the bus transfer takes place automatically when the existing bus voltage drops below a certain voltage level (about 80 % of the rated voltage) for a preset time. This scheme initiates bus transfer only in

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case of external faults responsible for voltage drop. In case of voltage drop due to internal fault, the transfer scheme is locked out.

The automatic bus transfer scheme is generally a fast bus transfer scheme and the sequence of operation are similar to that explained in fast bus transfer scheme in manual mode. However, if the fast bus transfer is found not responding to the command-, it shall automatically go for slow bus transfer scheme in a manner explained against slow bus transfer scheme under manual mode.

5.0 General requirement

The equipment for bus transfer scheme described above shall be wired in separate panels. The equipment shall include selector switches, indicating lamps, transfer circuit, supervising relays, microprocessor based fast acting voltage sensing relay and phase comparison relays etc. Necessary voltage transformers of required accuracy class shall be provided in appropriate high voltage switchgear panels. Auxiliary relays shall be incorporated with a view to enable inter panel wiring and easy fault location.

Testing facility shall be provided for on line testing of the operating circuits of each bus transfer scheme. However, in case need arises for automatic changeover, when testing of schemes are in progress the automatic changeover operation shall override the testing activities by resetting the test circuits.

Necessary selector switches shall be provided to select the mode of transfer i.e., manual or automatic. In case of manual transfer, there shall be additional selector switch for selecting manual without voltage interruption, manual fast and 'manual slow' changeover with voltage interruption. Mode selection and bus transfer initiation switches shall be located in the control panel.

The supervision of operating circuit of each mode of bus transfer shall be duly signalised in the control room. All relevant indication and annunciation with audible alarm, accept and reset facility shall be provided. Facility shall also exist in the form of potential free auxiliary contacts for remote annunciation. Similarly actuation of any mode of bus transfer either manual or automatic shall also be signalized together with an audible alarm in the control room. Certain important information of bus transfer event is to be recorded in the data acquisition system. Necessary potential free contacts shall be kept wired for event logging.

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ANNEXURE - III

OPERATION PHILOSOPHY FOR 415V PCC/PMCC

1.00.00 NORMAL OPERATING CONDITION

a) Under normal operating condition, the two incomers of the PCC/PMCC shall not be paralleled and the incomers shall remain close with bus coupler breaker open.

b) In case of supply voltage drop to 80% or below (sensed by respective bus under voltage relay) and if such drop is not of transient in nature (to be checked by slave time delay relay to the above U/V relay), then the particular incomer breaker of the unhealthy bus as well as all breaker controlled feeders of the bus shall trip automatically.

In this connection, it shall be specifically noted that the above tripping of breakers due to under-voltage shall be independent of position selection of 'AUTO-MANUAL' selector switch but shall be dependent on the sustained bus under voltage condition ensured by time delay relay connected to 80% bus U/V relay.

2.00.00 AUTO CHANGE-OVER

One (1) no. two (2) position, stay put type, lockable 'AUTO-MANUAL' selector switch (43 AM) shall be provided in Bus Coupler panel of PCC/PMCC. The automatic close of the Bus Coupler breaker shall take place if:

a) The AUTO-MANUAL selector switch is in 'Auto' position.

b) The voltage of unhealthy section of the bus is not more than 20%.

c) The Incomer breaker of unhealthy section of the bus is open.

d) The bus fault does not persist on unhealthy section of bus, the incomer breaker of which is opened (to be checked by non-operation of lockout relay of corresponding incomer breaker).

e) The voltage of the healthy section of the bus is above 80%.

3.00.00 LIVE CHANGEOVER BY MOMENTARY PARALLELING

Momentary paralleling of the two incomers (Incomer 1 &2) of the PCC/PMCC is necessary for live transfer of loads and such operation shall be carried out with the help of breaker control switch and one (1) no. of stay put type 'Trip Selector Switch'. Such momentary paralleling shall be achieved through synchronizing check circuitry provided in the PCC/PMCC. Therefore necessary synchro-check relay with required auxiliary & guard relays shall be provided.

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In manual mode, one breaker out of two closed breakers shall be selected for tripping by Trip Selector Switch. The third breaker shall be closed with breaker control switch, after getting permissive signal from check synchronism relay and the breaker earlier selected for tripping shall be tripped automatically with a preset time delay. This live changeover is applicable for Incomers-1 & 2 and bus coupler breaker.

4.00.00 **BREAKER OPERATION**

4.01.00 Breaker operation for 'NON-MOTOR' feeders.

4.01.01 In 'TEST' position of breaker, closing & tripping is possible by breaker control switch, only if the LOCAL-REMOTE selector switch in PMCC is in LOCAL mode.

4.01.02 In 'SERVICE' position of breaker, closing of breaker is possible from the PMCC if LOCAL-REMOTE selector switch is in LOCAL mode and from remote if the same is in REMOTE mode. Tripping of each breaker is possible from anywhere and shall be independent of position of LOCAL-REMOTE selector switch.

4.01.03 Auto changeover feature shall be effective in SERVICE position only and shall be independent of LOCAL-REMOTE selector switch. Momentary paralleling operation shall be effective in SERVICE position only shall be in LOCAL & MANUAL mode only.

4.02.00 Breaker operation for 'MOTOR' feeders

4.02.01 Each motor feeder shall house one 'TRIP-NEUTRAL-CLOSE' and one three discreet positions selector switch with inscription TEST-NORMAL-TRIAL which is lockable in each position.

4.02.02 TEST position of TEST-NORMAL-TRIAL selector switch would facilitate testing of breaker coils through breaker control switch and during testing, breaker shall remain in TEST position. Both process & safety interlocks shall remain by passed during testing.

4.02.03 Normal operation shall get executed when TEST-NORMAL-TRIAL selector switch is in NORMAL position and the motor shall be controlled from either DCS or LOCAL Control Station (LCS).

4.02.04 When TRIAL position is selected in TEST-NORMAL-TRIAL selector switch; the motor can only be controlled from field (near to a drive). During TRIAL operation, safety interlocks only shall remain enabled.

4.02.05 For both Normal & Trial operations, breaker position could be either SERVICE or TEST. The test position of the breaker would facilitate checking of various interlocks and protections without actual power supply to connected drive.

However, motor control philosophy shall be in line with 'Drive Control Philosophy' described in Section-XIX-A, Annexure-2 (C&I portion).

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ANNEXURE-IV

TECHNICAL SPECIFICATION FOR FIRE STOP MORTAR SEAL

Brief Description	:	Fire Seal shall be dry cement with other chemical ingredients capable of controlled swelling, non-shrinking, homogeneous and smoke / gas-tight fire seal for cable and pipe penetration.
Composition	:	It shall consists of inorganic binders, filters and light weight aggregates with special additives and agent.
Colour	:	Preferably – Grey colour
Bulk Density	:	Approx. 550 gm / litre (Minimum)
Toxicity	:	It shall be Non-toxic
Combustibility	:	It shall be Non-combustible
pH value	:	10.0 (at working consistency)
Storage temperature	:	+5 deg.C to 50 deg.C in dry conditions.
Shelf life	:	Minimum two years, in original unopened packing stored in a dry place.
Packaging	:	Shall be packed in Gunny bags containing not more than 50 kg Fire Seal compound.
Density of cured material	:	Approx. 0.6 gm per CC.
Compressive Strength	:	Approx. 6-7 N per sq.mm
Yield	:	1 kg Dry Fire Seal shall yield approx. 1.5 litre mixture of wet mortar.
Fire Resistance	:	Fire Seal shall provide 3 hrs. Fire Resistance.
Expansion	:	Approx. 3% by volume at 20 Deg.C
Recommended Users	:	Recommended for both wall openings and floor cut-outs.
Approval	:	The FIRE SEAL should have approval of the Institution like CBRI for its fire retardant properties.

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Experience	:	The application should have been done successfully preferably in Power Stations.

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ANNEXURE-V

TECHNICAL SPECIFICATION FOR FIRE RETARDANT COATING COMPOUND

Brief Description	:	Fire Retardant coating compound shall be a ready to mix and easily brush able one.
Composition	:	Fire Retardant coating compound shall be water based, solvant free coating comprising of thermoplastic resins, certain flame retardant chemicals and other inorganic incombustible fibers, filters and pigments. Fire Retardant should not contain asbestos fibers.
Colours	:	Preferably – Off White colour.
Density	:	1.25 to 1.35 gm per cc.
Solid contents	:	70 to 75% by weight
pH value	:	6 – 8
Odour	:	It shall be odourless
Toxicity	:	It shall be Non-combustible one
Storage temperature	:	Max. 50 Deg.C, must be protected from freezing
Shelf Life	:	Shall be 2 years, in original unopened packing & min. 18 months in unpacked condition, at room temperature.
Coating Thickness	:	Recommended Coating Thickness, min. 2.0 mm.
Packing	:	Shall be packed in Plastic drums containing not more than 50 kg Fire Retardant compound.
Thinning	:	Shall be only by water
Specific Gravity	:	1.5 to 1.6
Drying Time	:	8 hrs tough dry
Surface Gravity	:	Rough
Fire Resistance	:	Fire Retardant Coating shall provide minimum 30 minutes fire resistance.

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Approval	:	The FIRE RETARDANT COATING COMPOUND should have approval of the Institution like CBRI for its fire retardant properties.
Experience	:	The application should have been done successfully preferably in Power Stations.

FIRE RETARDANT COATING COMPOUND – SPECIAL FEATURES

Water Resistance	:	A Fire Retardant coated cables shall not show any effect when dipped in water at 40 Deg.C for 10 days.
Salt Water Resistance	:	A Fire Retardant coated cable shall not show any effect when dipped in salt water for 16 days.
Acid Resistance	:	A Fire Retardant coated cable shall not show any effect on application of 2% Conc. Sulphuric Acid.
Current Carrying Capacity of Cables	:	On application of Fire Retardant coating, there shall be no effect on the current capacity of the cable.
Resistance to Heat Cycle	:	15 to 80 Deg.C
Flexibility	:	Fire Retardant Coated HRPVC Cable may be bent 20 times radius without cracking or peeling off.
Hydrocarbon Solubility	:	Shall have no effect.
Mineral Oil Resistance	:	Shall be highly Resistance to immersion in mineral oil for 48 hours at room temperature. There shall be no physical and chemical changes observed.
Antirodent	:	Dry film of Fire Retardant shall be antirodent.
Effect of Atmospheric Conditions	:	Shall be Highly Resistant to moisture and humidity.

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ANNEXURE - VI

ELECTRICAL LABORATORY & TESTING EQUIPMENT

This section furnishes the owner's minimum requirements of electrical laboratory & testing equipments. The CONTRACTOR shall include any other equipment considered necessary for the satisfactory operation of the thermal power plant and associated 400 kV switchyard and other systems in the power plant. CONTRACTOR shall communicate with OWNER for non-usability of any of below equipments during detail engineering CONTRACTOR shall provide the list for OWNER approval: -

SL. No.	DEVICE	TYPE	RANGE	PURPOSE
1.	Insulation testers	500 V hand driven	0-50/500 M Ohms Min. Accuracy +/-2% of the full scale in each range	For checking insulation
		1000V, motorised	0-200/2000 M Ohms Min. Accuracy +/-2% of full scale in each range	For checking insulation
		2500V Battery operated Digital Megger with L.C.D display	0-250G-Ohms Min. Accuracy +/-2% of full scale in each range	For checking polarising index, Absorption index
		5000V Battery operated Digital Megger with L.C.D display	0-500G-ohm Min. Accuracy: +/-2% of full scale in each range	For checking polarizing index, Absorption index
2.	Earth tester	Portable with four terminals	0 to 2 / 20 / 200/ 2000/20,000 Ohms Accuracy: +/- 1% of full scale (min)	To test earth resistance

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
3.	Multimeter	Portable, Analog	-DC Volt. 250mV,2.5V,10V,50V,250V,1000V,2.5KV Min. Accuracy: +/-2% of full scale AC Volt: 2.5V, 10V, 50V, 250V, 1000V, 2.5KV Min. Accuracy: +/- 2% of full scale (min) DC Current: 50micro Amp to 10A Min. Accuracy: +/- 2% Current AC Amp: 10mA to 10A Min. Accuracy: +/-2% Resistance: 0-2kohm/ 200kohm/20Mohm Min. Accuracy: +/-2%	Rough measurement of resistance and voltage
4.	Multimeter	Portable, digital with LCD display	-DC Volt: 0-1000V Accuracy: +/-0.2% AC Volt: 0-750V Accuracy: +/-0.5% DC current: 1mA-10A Accuracy: +/-0.2% AC current: 1mA-10A Accuracy: +/-0.2% Resistance: 0-200Ω/ 2KΩ/20KΩ/ 200KΩ /2MΩ, Accuracy: ± 0.2%	Rough measurement of resistance and voltage
5.	Ammeter	AC moving iron	0 to 100A Accuracy class: 0.2.	To test panel ammeters
		-do-	0 to 2.5/5A Accuracy class: 0.2.	
6.	Ammeter	DC moving coil	0 to 7.5/75A Accuracy class: 0.5% of full scale	To test panel ammeters
7.	Clipon ammeter / Multimeter	AC having ins. strength of 650V & 2 kV/min	0-400-1000A Min Accuracy: +/-2%	For checking load current in service condition

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
		Digital clamp on multimeter	a) Current : 0.01mA-200A(AC) Freq. : 0.1Hz-1KHZ b) Voltage 1mV-750V(AC)	For checking load current in service condition
8.	Voltmeter	AC moving iron	0 to 150/300/600V Accuracy class: 0.2.	To test panel ammeters
9.	Voltmeter	DC moving coil	0-125/250/500V Accuracy class: 0.2.	To test panel ammeters
10.	Digital phase sequence indicator	100-600V Freq.: 25-65Hz		To test phase sequence
11.	Frequency meter	Digital	40 to 50 to 65 cycles Accuracy class: 0.1%	To calibrate / check frequency meter
12.	Reference meter for tariff meter	Portable	0-20A Accuracy class 0.1%	For testing of tariff meters
13.	Digital Tachometer	Non-contact type	0 to 75000 rpm	To check rpm
14.	Timer	Electronic	Multi range: 0-0.9999, 9.999, 99.99, 999.9 & 9999 sec Min. Accuracy: 0.01%	Timing purpose
15.	Micro ohm meter	Digital	20 micro ohm – 200ohm Accuracy: 0.03%	For accurate and easy measurement of resistance
16.	Oscillograph (Storage Type)	8 channel digital type	0 to 150 V 0 to 100A	For recording voltage and current under fault condition and timings of breaker
17.	Automatic Oil testing set	Portable	0 to 90 kV (single phase with Middle of HV winding earthed) Accuracy: +/-2%	For checking dielectric strength of insulating oil in transformers
18.	Portable Kelvin bridge	±0.05% accuracy. Least count 0.2 micro ohm	0.2 micro Ohms to 10 Ohms	For accurate measurement of low resistance
19.	Oil filter	-	1000 gallons/hr	For transformer oil maintenance

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
20.	Transformer Buchholz gas analyzer	-	-	For transformer diagnostic testing for analysis of gas collected inside Buchholz relay.
21.	High voltage testing set (portable)	AC	Upto 75 kV, 5 Amps Rating 150 KVA (continuous)	For testing of cables & equipment on HV. This shall be capable of testing generator also
		DC	Upto 90 kV 20mA	
22.	Wire gauge	-	-	For measuring size of wires
23.	Portable single phase primary injection test set with current transformer, ammeter & timer	8 KVA at 2000 Amps.	0 to 2.5/5/10/25/ 50/ 100/250/500/ 1000A/2000A Timer range 0.01 to 60 sec. with accuracy of ±0.005 sec.	Relay testing
24.	Auto transformer (Variac)	Single phase	0 to 300V, continuously variable AC 0-32A	For relay testing
		Three phase	0 to 500V, continuously variable AC 0-30A / 100A	For relay testing
26.	Portable numerical relay test set with phase shifter	-	110V/63V 1A/5A	For testing distance relays, differential relays etc.
27.	Portable secondary injection test kit of reputed make having the following facilities: • fully automatic, 3 phase	Mains operated	230V/110V upto 50 Amps	For relay testing

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
	• able to test impedance, voltage, frequency, current, phase angle, power factor etc. • carry out both static and dynamic tests • have 3 voltage and 3 current suitable for teting of all types of relays • varied output independ-ently by key board. • Laptop and required software to be supplied with the kit			
28.	Three phase test bench with phase shifter	-	0 to 110V AC 0 to 230V AC 0 to 50 Amp AC 0 to 250V DC 0 to 100V DC	For testing meters and relays
29.	Potential transformer test set		0-600V continuously variable	For testing of potential transformer
30.	Conductivity bridge	-	Upto 10 ppm	To measure water content in transformer oil
31.	Micrometer	-	-	To measure size of very fine copper wires upto 50 SWG
32.	Mercury in glass thermometer	-	0 to 150°C 12 inch long	To measure temperature
33.	Hand operated crimping m/c with tools set	Up to 95 sq.mm	-	For cable joints and terminations
34.	Stabilized DC power supply	0.5% regulation 0.2A DC ripple 50 mV	0 to 30V DC	For testing instruments

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
35.	Loading transformers	-	2000 amps with taps on HT 12V, 6V, 44V	For testing bi-metallic relays and for ratio test
36.	Soldering iron		35W	-
37.	AC universal bridge	Basic Accuracy: 0.5% Inductance: 1mH to 9999H Capacitance: 0.3pF to 9999mF Resistance: 0.003ohm to 100Mohm Q-factor: 0.1 to 99	-	Impedance measurement
38.	Thermo-imaging camera	Thermo vision scanning system including software, hardware, monitor/ printer for data processing of temperature measurement and infra-red imaging	Temp. range 10°C to 1000°C with a provision to extend upto 2000°C (if required)	To check hot-spot / thermal scanning in Swyd, Power Station and Transmission Lines
39.	Cable Fault Location Set	Surge Generator upto 15 KV (100mA) Surge capacity not less than 512 joules, 10/20 pulse per minutes	10 nano sec. to 2000 nano sec.	For locating cable fault in between core to core and core to earth fault.
40.	3 phase ckt. bkr. timing measuring kit	Digital display atleast 4 digits, 0.5" high bright LED/LCD Accuracy: ± 0.05% + 1 count.	220V to 400kV	To analyse the performance / operation of circuit bkr. during start-up and preventive maintenance
41.	Hydrogen Gas Leak Detector	Portable hand held type with Audio-visual indication	50-100 ppm	To detect the leakage of Hydrogen Gas
42.	SF6 Gas leak detector	Portable hand held type with Audio-visual indication	3-5 ppm	To detect the leakage of SF6 gas.
43.	High voltage detector	Electronic type with Audio-visual indication	i) Suitable upto 33kV system voltage ii) Suitable upto 400kV system voltage	Indicate the presence of high voltage / charge.

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
44.	Transformer turn ratio tester (Portable)	Digital	Ratio Measurement: 0-2000 Accuracy ± 0.1% to ± 0.3%	Testing of no-load turns ratio of single, three phase transformers, CT/ PT's including Phase Angle Error, Vector group & Magnetizing current.
45.	Decade Resistance boxes	Portable, CE marked	1 K. Ohms to 1 Tera Ohms.	For testing Megger / Insulation testers upto 5kV rating
46.	Computerized Relay Test bench	Digital	Provision for 6 phase current output to test the differential relays i.e. 6 x 0-12.5A 3 x 0-25 A 1 x 0 – 75 A Measuring voltage range 4 x 300V or 1x 600V Freq. Range: 10 to 1000 Hz	For Dynamic Testing of relays and Performance Testing of relays
47	Partial Discharge Test Set			
48	RSO-Recurrent Surge Oscillograph			For testing of inter-turn fault in generator rotor
49	Frequency response Analyzer (FRA)			
50	Ductor Ohm Meter			
51	ELCID – Electro magnetic core imperfection detection kit	Digital	Voltage: 220V AC Frequency: 50Hz.	For testing of inter-turn fault in generator stator
52	Analog Phase Sequence Indicator	Electromechanical	Operating Voltage 50 V to 500V AC. Frequency: 25 Hz to 60 Hz.	
53	DC Injection Kit-10 Amps.			
54	Wattmeter 0.2 Class			

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SL. No.	DEVICE	TYPE	RANGE	PURPOSE
55	Breaker Contact Resistance Measurement Kit			
56	Tan delta Capacitance Measurement Test		Voltage : 0-12kV Current: 200mA (max) Voltage: 0-25kV Current: 2.5A (max)	

CONTRACTOR shall indicate the recommended quantity of electrical laboratory equipment with unit price. CONTRACTOR shall also indicate the type and make of each electrical laboratory equipment with technical features.

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ANNEXURE - VII

PRE-COMMISSIONING CHECK LIST OF ELECTRICAL EQUIPMENTS

1.0 TEST AT WORKS

Routine, Type and Special tests on all equipments shall be carried out as per the relevant standards and specifications enclosed.

2.0 PRE-COMMISSIONING TESTS AT SITE

2.1 The installation of different types of equipment and accessories shall be tested by the CONTRACTOR after completion of his erection work with an advance notice to the OWNER so that he may witness the same.

2.2 The CONTRACTOR shall prepare pre-commissioning test pro-forma of each equipment/work/system indicating the data of each equipment/work/system. The tests results are to be tabulated. The pro-forma shall be submitted to OWNER for approval. Reference shall be made to manufacturer requirements/recommendation of tests and procedure to be followed for site tests.

2.3 The test result of any installation or equipment or its parts, if considered unsatisfactory to the OWNER, the concerned installation/equipment and its accessories shall be properly rectified and tested again to the satisfaction of the OWNER by the CONTRACTOR at his own cost.

2.4 The site tests to be carried out by the CONTRACTOR on completion of installation/erection of equipment are broadly listed below for ready reference and guideline only. The CONTRACTOR shall submit a detailed list of site tests of various equipment/system for OWNER's approval. Additional tests may have to be carried out without any extra charge, if desired by the OWNER.

2.5 **Pre-Commissioning Test on Electrical Equipments**

1. Generator & Associated Equipment

The generator, excitation system, AVR and associated auxiliary systems shall be commissioned to an approved procedure.

The site commissioning tests shall include;

a) A dry out, PI followed by high voltage tests at the levels specified in IEC 34-3.

b) Full functional checking and setting up of equipment with the generator at standstill.

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c) Open circuit testing, Short circuit testing, including terminal voltage response measurements and the testing of all control and protection facilities.

d) On-load testing, including terminal voltage response measurements at full load rated leading and lagging power factors, tuning and testing of the MVAR limiter and power system stabilizer (PSS). The PSS shall be tested under the appropriate grid system conditions. The CONTRACTOR shall provide detailed information on his proposals for on loading testing for compliance with this requirement.

e) Not Applicable.

f) On load excitation system parameter identification tests. The CONTRACTOR shall state in detail his proposals for compliance with this requirement.

g) Air and gas tightness test.

2. Busduct

The busduct shall be erected as per good engineering practice and all checks/tests necessary to ensure receipt of correct material component, proper storage of material/component, correctness of erection as per drawing/specification including check/tests on welds as done at shop shall be carried out. Further the assembled bus duct shall be tested for following but not limited to same.

a) Functional and performance test of various auxiliary panels etc. including hot air blowing system and pressurisation equipment.

b) Air and water tightness test.

c) Milli-volt drop test of bolted joints.

d) Insulation Resistance of equipment & wiring and High Voltage Test of busduct and it's auxiliaries at reduced value (70%).

e) Ratio and polarity tests on current and voltage transformer.

3. Power Transformers

Pre-commissioning tests and checks shall include but not limited to the following.

a) Physical checking of various parts/equipments,

b) Drying out by using Stream line filter, centrifuge and heater set.

c) Insulation resistance of oil.

d) Insulation Resistance of windings, PI value

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e) Checking of Phase Sequence Test

f) Continuity Test

g) No load voltage ratio at all tap positions

h) Checking of Vector Group

i) Tap changer operation check

j) Magnetising Current Check at 415V, 3 Phase, 50 c/s, supply for all the three phases.

k) Magnetic balance test

l) Measurement of Winding resistance.

m) Cooler control, indication and alarm circuits

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n) Breather (Check for Silicagel)

o) Buchholz's relay operation

p) Low oil level for Main tank

q) Physical line connections as per phasing diagram

r) Neutral connection to earth effectively.

s) Calibration of different temperature indicators, relays and switches.

4. L.T. Transformer

a) Insulation Resistance of windings, P.I. Value

b) Checking of Phase Sequence Test

c) Continuity Test

d) No load voltage ratio at all tap positions

e) Checking of Vector Group

f) Magnetizing Current Check at 415V, 3-Ph, 50 c/s, supply for all the three phases.

g) Measurement of Winding resistance

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h) Physical line connections as per phasing diagram

i) Neutral connection to earth effectively.

j) Calibration of temperature indicator.

5. **Motors**

Motors shall be subjected to the following site tests as minimum.

a) Physical checking of various parts/connections

b) Insulation resistance test of winding, PI value and drying out, if required.

c) Direction of rotation

d) Starting current

e) No load & load current measurement.

f) No load run for 4 hours

g) Check motor mounting.

h) Check motor is rotating freely by manual effort.

i) Check motor cooling fan installed properly.

j) Check motor body is grounded at two points. Check terminal box grounding.

k) Check all components installed as per approved final CONTRACTOR drawing.

l) Check motor power supply cable connected to proper level of voltage.

m) Check terminal box cover closed properly and unused entries plugged.

n) Check alignment of motor with the driven equipment. To ensure no undue force is imposed on bearings.

o) Check greasing of bearings at both ends.

p) Check endplay in bearings.

q) Check oil level in gearbox.

r) Check bimetallic relay setting at MCC module.

s) For breaker fed motor check all relay settings and CT polarity.

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The PCC/MCC/DBs shall be erected as per good engineering practice and assembled equipment shall be subjected to following site tests as minimum

a) Physical checking of various parts/connections

b) I.R. test

c) Checking of control circuit

d) Checking of overload relay & other protective devices

e) Measurements of contact resistance (in micro- ohms) for all the three phase of circuit breaker.

f) Measurement of resistance of the closing and tripping coils

g) Checking the close trip operation at 70% and 100% of the rated auxiliary D C Voltage.

h) Checking the auxiliary power circuits

i) Checking of interlock provided and tripping of breaker through relay

j) Space heater operation check

8. Cables

Cables shall be subjected to the following site tests as minimum.

a) Physical checking of laying & termination

b) Checking continuity of connections

c) I.R. Test

d) High Voltage test, if applicable.

9. Battery & Battery Chargers & DC Boards

The following points shall be checked before commissioning.

a) Check mounting or battery bank and battery charger.

b) Check power cable termination/glands.

c) Check control cable termination, interlock, wiring, loose connections.

d) Check earthing of battery charger panel.

e) Check all safety interlocks.

f) Check specific gravity of electrolyte in battery bank.

g) Check battery voltage in charged condition.

h) Check rating and type of all power and control circuit fuses.

i) Check the `Megger' value of power and control circuit.

j) Check supply voltage of battery charger.

k) Check operation of battery charger and load on the charger. Check all annunciations under stimulated condition.

l) Check changeover from mains supply to battery and vice versa.

m) Check DC distribution board mounting, earthing.

n) Check feeder schedule of DC distribution board and their correct description.

o) Check all cable terminations/glands.

p) Check 'Megger' value.

q) Check incoming supply to DC distribution board.

r) Check all fuse ratings in DC distribution.

9. UPS system

a) Check power cable termination/glands.

b) Check control cable termination, interlock, wiring, and loose connections.

c) Check safety earthing and system earthing.

d) Check all safety interlocks.

e) Check rating and type of all power and control circuit fuses.

f) Check continuity of power supply cables, battery cables, control cables.

i) Check `Megger' value of power and control circuit.

j) Check the voltage available at battery bank is adequate.

k) Check ACDB mounting, its feeder schedule, all cable connections and rating of different outgoing feeders from ACDB. Check incoming connection to ACDB from UPS.

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l) Check calibration of all indicating instruments.

m) Check UPS voltage & frequency on no load.

n) Check functionally all controls and alarms provided in the UPS system for correct operation & setting. Check correct remote alarms also.

o) Check protective devices of the UPS.

p) Check the transient response of the UPS for the followings.

- Simulation of AC Power failure.
- Simulation of rectifier failure
- Simulation of battery failure
- Simulation of one inverter failure
- Simulation of both inverter failure
- Manual return from bypass to inverter.

10. Neutral Grounding Resistor

The neutral grounding resistor shall be inspected for any damage to the resistor grid and other components. The resistor shall be leveled and installed. All covers, etc. shall be checked for tightness to ensure that the enclosure of the resistor is dust, vermin and weatherproof. Two earthing conductors shall be taken from the neutral terminal of the resistor, one being directly connected to an earth electrode and the other being connected to the main grid. Proper connection is to be made between transformer neutral & NGR as per direction of engineer incharge. NGR enclosure is to be grounded at two distinct & separate points.

11. EHV Circuit Breaker

The outdoor EHV CB shall be transported to the erection site in dismantled condition. The CONTRACTOR shall check, clean and assemble all the different units as per manufacturer's instructions. The three poles of the circuit breaker shall be erected on the base steel structure previously installed and leveled by the CONTRACTOR. The operation mechanism shall be installed on the steel structure pedestal/concrete pedestal to be provided by other agency and connected to the three poles of the circuit breaker. The breaker shall be operated slowly to the closed position and all adjustments carried out as per manufactures instructions. The poles and operating mechanism shall be accurately positioned so as to cause no undue strain on the terminals. Each pole of the breaker and operating mechanism shall be earthed.

12. EHV Current Transformers

The EHV Cts shall be shipped to the erection site as hermeticaly sealed single phase units. The CONTRACTOR shall inspect and install these on the base structure previously fabricated and leveled by him. The phase to phase clearance

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between three units of each set shall be accurately adjusted so as to cause no strain on the terminals. Each unit shall be checked for proper oil. Arcing horns shall be adjusted to the recommended gap setting.

13. EHV Isolators

The isolators shall be transported to site in the dismantled condition. All the insulators shall be also supplied loose. The CONTRACTOR shall inspect, clean, assemble and install the isolator on the base structure previously fabricated, erected and leveled by him. The operating mechanism shall be installed on the structure and connected to the isolator poles. The operating mechanism shall be tested by slowly bringing the isolator to the closed position and carrying out the necessary adjustment as per manufacturer's instructions. The earthing switches, frames and operating handles, etc shall be earthed. Arching horns shall be adjusted to the recommended gap setting.

14. EHV Lightning Arrestor

Lightning arrestors shall be in single phase unit to be installed on structural framework and tightened with nuts, bolts & spring washers. The CONTRACTOR shall inspect and install lightning arrestors on the base structure previously fabricated, installed and leveled by him. The phase to phase clearance between three units of each set shall be accurately adjusted so as to cause no strain on the terminals. Efficient earthing shall be done as per code of practice and/or directions of engineer-in-charge.

It is not the intent to cover all the pre-commissioning checks exhaustively here. Any checks/tests to be done as per manufacturer's guidelines and/or directions of Engineer-in-charge shall be carried out by the CONTRACTOR.

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ANNEXURE-VIII

WARDHA POWER CO. PVT. LTD. (WPCPL)
3600 MW COAL BASED POWER PROJECT
AT NARIYARA, CHHATTISGARH

LIST OF STANDRADS - ELECTRICAL

Electrical equipments / systems shall comply the following International Standards

Standards	Descriptions
IEC-60034 (Part-1 to Part-19)	Rotating electrical machines
IEC-60044-1	Current transformers
IEC-60044-2	Voltage transformer
IEC-60044-4	Instrument transformers: Measurement of Partial Discharges
IEC-60051(Part-1 to Part-9)	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60076 (Part-1 to Part -5)	Power transformers
IEC-60076-10	Determination of transformer and Reactor Sound Levels
IEC-61095	Electromechanical Contactor for household and similar purposes
IEC-60099-425	Metal oxide surge arrestors without gaps
IEC-60129	Alternating Current Disconnectors (Isolators) and Earthing switches
IEC-1129	Alternating Current Earthing Switches induced Current switching
IEC-60137	Insulated bushings for alternating voltages above 1000V
IEC-60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V.
IEC-60183	Guide to the selection of high voltage cables
IEC-60189 (Part-1 to Part- 7)	Low frequency cables and wires with PVC insulation and PVC sheath
IEC-60214	On-Load-Tap-Changers
IEC-60233	Tests on hollow insulators for use in electrical equipment
IEC-60255 (Part-1 to Part-23)	Electrical relays
IEC-60265 (Part-1 to Part 2)	High voltage switches
IEC-60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC-60289	Reactors
IEC-60297 (Part-1 to Part- 4)	Dimensions of mechanical structures of the 482.6mm(19 inches) series
IEC-60376	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	Radio interference Test on high voltage insulators
IEC-60507	Artificial pollution tests on high voltage insulator to be used on AC systems
IEC-60694	Common specification for high voltage switchgear & control gear standards
IEC-60815	Guide for selection of insulators in respect of polluted conditions

14/9/09

2009.11.14

WARDHA POWER CO. PVT. LTD. (WPCPL)
3600 MW COAL BASED POWER PROJECT
AT NARIYARA, CHHATTISGARH

Standards	Descriptions
IEC-60865 (Part-1& Part-2)	Short Circuit Current – Calculation of effects
IEC-60354	Loading Guide for oil –immersed power transformers
IEC-62271-100	High voltage alternating current circuit breakers
IEC-62271-102	Alternating current disconnectors and earth switches
IEC-60427	Synthetic Testing of High Voltage alternating current circuit breakers
IEC-61264	Pressurized Hollow Column Insulators
IEC-60358	Coupling capacitors and capacitor dividers
IEC-60481	Coupling Devices for power line carrier systems
IEC-60529	Degree of protection provided by enclosures
IEC-60947-4-1	Low voltage switchgear and control gear
IEC-60439 (Part-1&2)	Low voltage switchgear and control gear assemblies
IEC-60353	Line traps for A.C. power systems
IEC-60495	Single sideboard power line carrier terminals
IEC-60683	Planning of (single side-board)power line carrier systems
IEC-60359	Expression of the performance of electrical and electronic measuring equipment
IEC-60387	Symbols for alternating-current electricity meters
IEC-60447	Man Machine Interface (MMI)-actuating principles
IEC-60521	Class 0.5,1,and 2 alternating current watt hour meters
IEC-60547	Modular plug-in unit and standard 19-inch rack mounting unit based on NIM standard(for electronic nuclear instruments)
IEC-60305	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for ac. Systems characteristics of string insulator units of the cap and pin type
IEC-60372 (1984)	Locking devices for ball and socket couplings of string insulator units: dimensions and tests
IEC-60383 (Part-1&2)	Insulators for overhead lines with a nominal voltage above 1000V
IEC-60433	Characteristics of string insulator units of the long rod type
IEC-60471	Dimension of clevis and tongue couplings of string insulator units
IEC-60227(part 1 to 7)	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750
IEC-60228	Conductor of insulated cables
IEC-60230	Impulse tests on cables and their accessories
IEC-60287 (Part-1 to 3)	Calculation of continuous current rating of cables (100% load factor)
IEC-60304	Standard colours for insulation for low- frequency cables and wires
IEC-60331	Fire resisting characteristic of electric cables
IEC-60332 (Part-1 to 3)	Tests on electric cables under fire conditions
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from

WARDHA POWER CO. PVT. LTD. (WPCPL)
3600 MW COAL BASED POWER PROJECT
AT NARIYARA, CHHATTISGARH

Standards	Descriptions
	1kV up to 30kV
IEC-754 (Part-1 to 2)	Tests on gases evolved during combustion of electric cables
IEC-60071	Insulation Co-ordination
IEC-60060	High voltage test techniques
IEC-60270	Partial discharge measurement
IEC-61233	Guide for inductive load switching
IEC-60298	AC metal enclosed switchgear and control gear up to 52kV
IEC-105	Bus bars (Aluminium)
IEC-61641	Enclosed low voltage switchgear and control gear assemblies. Guide for testing under conditions of arcing due to internal fault
IEC-60292	Starters
IEC-60146	Semiconductor converters and Pulse transformer
IEC-61000-1995	Electromagnetic compatibility (EMC)
IEC-60148	Semiconductor rectifier assemblies and thyristor converters
IEC-60034-34	Guide for testing three phase induction motors
IEC-60079	Classification of hazardous areas
IEC-60896	Lead acid type – With Plante positive plate
IEC-60309	Plugs, socket-outlets and couplers for industrial purposes
IEC-60598	Luminaries : General requirement
IEC-60726	Dry type power transformers
IEC-60870	Telecontrol equipment and systems
IEC-60874	Conductors for optical fibres
IEC-60921	Ballasts for tubular florescent lamps – Performance requirements
IEC-60929	AC-supplied electronic ballasts for tubular fluorescent lamps – Performance requirements
IEC-61850	Communication networks and systems in sub stations
IEC-60364	Electrical installations of buildings
IEEE-80 Std. 2000	Guide for safety in Alternating Current Sub station grounding
IEEE-665	Guide for generating station grounding
IEEE-446	Emergency standard power systems
IEEE-485	Recommended practice for sizing large lead acid storage batteries for generating stations and sub-stations
IEEE-519	Harmonic limits in power systems
IEEE-32	Requirements, Terminology and test procedure for Neutral Grounding Devices.
IEEE-48	Test Procedures and Requirement for High Voltage Alternating Current Cable terminations.
IEEE-81	Measuring Earth Resistivity Ground Impedance and Earth Surface Potentials of a Ground System.
ANSI/IEEE-242	Protection and Co-ordination of Industrial and Commercial Power Systems.

14/9/09

2009.3.14

WARDHA POWER CO. PVT. LTD. (WPCPL)
3600 MW COAL BASED POWER PROJECT
AT NARIYARA, CHHATTISGARH

Standards	Descriptions
IEEE-422/1986	Guide for the Design and Installation of Cable Systems in Power Generating Stations.
IEEE/ 450-1995	Recommended Practice for maintenance, testing and replacement of Large lead Storage Batteries for Generating Stations and Substations.
IEEE-484	Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Sub-stations.
IEEE/ 605 1998	Guide for Design of Sub-station Rigid Bus Structures.
IEEE/ 979 -1979	Guide for Sub-station Fire Protection.
IEEE/ 62.1/1984	IEEE Standard for Surge Arrestors for AC Power Circuits.
IEEE PAS VOL-97	Generator Neutral Grounding Some Aspects of Application for Distribution Transformer with Secondary Resistor and Resonant Types.

All electrical installation shall comply the following statutory regulations / acts / standard.

Indian Electricity Act 1910
Electricity Supply Act, 1948
Indian Electricity Rules
Indian Electricity Act 2003
Tariff Advisory Committee (TAC)
Central Bureau of Irrigation and Power (CBIP)
Protection of buildings and allied structures against lightning (IS-2309)
Other local statutory requirement

14/7/09

2009.3.16

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
1	Generator	Retaining Rings	Chemical Prperties	
			Mechanical Properties	
			Elec / Electromagnetic	
			Liquid Penetration Inspection	
			Ultrasonic Test	
			Visual & Dimensional	
		Hubs	Chemical Properties	
			Mechanical Propeties	
			Heat Treatment	
			Ultrasonic Test	
			Visual & Dimensional	
		Complete rotor	Chemical Prperties	
			Mechanical Properties	
			Elec / Electromagnetic	
			Heat Treatment	
			Micro Structure	
			Magnetic Particle Inspection	
			Ultrasonic Test	
			Residual Stress	
			Visual & Dimensional	
		Bearing Shells	Chemical Properties	
			Mechanical Properties	
			Heat Treatment	
			Ultrasonic Test	
			Visual & Dimensional	
		Machine Assembly and Testing	Mechanical Performance	
			Electrical Performance testing as per IEC-60034 and Tender Specification (Including HV Test on Stator & Rotor after Performance Test)	

14/9/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
2	HT Transformer	Routine Test	Measurment of winding resistance	
			Measurment of voltage ratio & check of voltage vector relationship	
			Measurment of impedance voltage / short circuit impedance (principal tapping) and load loss.	
			Measurment of no load loss and current	
			Measurment of insulation resistance	
			Dielectric Test	
			Oil leakage Test	
			Vacuum Test	
			Pressure Test	
		Type Test	Temperature rise test	
			Pressure Relief device test	
			Measurment of capacitance and tan delta	
		Special Test	Measurment of zero sequence reactance	
			Measurment of acoustic noise level	
			Measurment of power taken by fans and oil pumps	
			Measurment of harmonic level on no load current	
			One Cooler control cabinet of each type	
			HV withstand test on auxiliary equipment and wiring after complete assembly.	

14/3/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
3	LT Transformer	Routine Test	Measurment of winding resistance	
			Measurment of voltage ratio & check of voltage	
			Measurment of impedance voltage / short circuit	
			Measurment of no load loss and current	
			Measurment of insulation resistance	
			Dielectric Test	
			Oil leakage Test	
			Vacuum Test	
			Pressure Test	
		Additional Test	Temperature Rise Test	
			Measurment of Zero Sequence impedance	
			Measurment of acoustic noise level.	
4	HT Switchgear	Routine Tests	Completeness including internal clearance	
			Dimensional Checks including paint thickness	
			Physical Condition	
			Power frequency test on main and auxiliary circuit	
			Rack - in and out operation	
			Verification of wiring and ferruling	
			Paint shade thickness and adhesion	
			Functional and operational test on compartments, Earthing truck including interlock	
			Contact alingment - By breaker rack in / rack out	
			Interchangibility of breakers	
			Earthing arrangement	
			Bus bar tightness by torque wrench method	
			BOM checking	

14/9/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
5	LT Switchgear	Routine Tests	Visual /Dimensional Checks BOM checking Functional Checking IR test Dielectric test	
6	HT Cables	Routine Test	1. Acceptance Testing: a) Conductor Resistance test b) High Voltage test c) Partial Discharge test d) Test on Insulation test i) Thickness ii) T.S and Elongation iii) Volume Resistivity at room temperature and at rated temperature iv) Hot Set test 2. F.R.L.S Test: a) Test on outer sheath i) Thickness ii) T.S and Elongation iii) Smoke Density Test iv) Thermal Stability (PVC) test v) Oxygen Index test vi) Temperature Index test vii) HCL gas generation test viii) Flammability test ix) Swedish Chimney test (Not applicable for cables having overall diameter above 70mm)	

14/3/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
7	LT Cables	Routine Test	1. Acceptance Testing: a) Conductor Resistance test b) High Voltage test c) Partial Discharge test d) Test on Insulation test i) Thickness ii) T.S and Elongation iii) Volume Resistivity at room temperature and at rated temperature	
			2. F.R.L.S Test: a) Test on outer sheath i) Thickness ii) T.S and Elongation iii) Smoke Density Test iv) Thermal Stability (PVC) test v) Oxygen Index test vi) Temperature Index test vii) HCL gas generation test viii) Swedish Chimney test (Not applicable for cables having overall diameter above 70mm)	

14/3/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
8	HT Motors	Material	Shaft (Blank) : i) Dimensional and Visual check ii) Ultrasonic Test	
		Fan	D.P checks on welds	
		Fabrication	Stator frame, Shaft fabrication i) D.P Checks on welds of stator frame	
		S.C. Ring (Forged)	D.P Checks on welds / joints	
		Machhinig	Stator Frame: Final dimensional Checks Shafts: Final dimensional and visual check for bearing, seating diameter, coupling seating diameter, run out (eccentricity)	
		Bearing Housing Final Machining	Final dimensional Checks	
		Rotor / Stator Core Punching and vent spacers	a) Dimensional & Visual Check b) Burr Closing c) Quality Check of welding of vent spacers	
		Rotor complete including brazing of SC ring	a) UT of brazed joints and visual checks b) Dynamic balancing at rated speed	
		Stator Core assembly	Hot Spot test if filing is done	
		Wound Stator capsule	a) Measurement of resistance of RTDs b) Interturn insulation surge voltage test c) Resistance Measurement after wiring connection d) Ensure putty to be below bore level e) IR, HV DC test after assembly	
		VPI Process	a) Tan Delta, Delta tan delta test on indivudial phase of winding after VPI b) IR, HV AC test after VPI c) Resistance Measurement (After VPI)	

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
	HT Motors	Routine Test	Visual Checks : i) Marking on rating plates ii) Appearance and painting iii) Location and details of T.B and Accessories iv) Check of phase sequence and terminal marks v) Dimensional checks ar per OGA drawing	
			Measurement of winding, Space heater and RTDs resistance	
			Reduced voltage running test in actual direction of rotation	
			No load running and reading of current, voltage, power, bearing temperature during steady state condition	
			Shaft voltage measurement at rated frequency and voltage	
			Measurement of IR on stator winding before HV	
			IR value of space heater, RTDs and BTDs	
			Polarisation Index at 5kV	
			HV test on stator winding	
			Measurement of IR on stator winding after HV	
			IR value of space heater and winding RTDs after HV	
			Over speed Test	

14/3/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
	HT Motors	Type Test	All the tests listed under routine test	
			Measurement of noise at no load	
			Momentary over current test duing heat run	
			Full load test	
			Temperature rise test	
			No load running and reading of current, voltage, power, breaing temperature during steady state condition and preparation of no load saturation and loss curve up to approx. 115% or rated voltage	
9	LT Motors	Routine Test	GA & Dimensional Test	
			Winding Resistance Test	
			Locked Rotor Test	
			Open Circuit Test	
			HV Test (In main ckt and space heater)	
			IR Test (In main ckt and space heater before and after HV test)	
			Over Speed Test	
			Vibration Test	
			DOP Test	
			Noise Level Test (If applicable)	

14/2/08

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
10	Busduct		Impulse Voltage withstand Test	
			Temperature Rise Test	
			Short circuit mechanical strength and thermal withstand test.	
			Air Leakage and water tightness test	
11	Isolator	Routine Test	Power Frequency Voltage Withstand Dry Test on the Main Circuit.	
			Voltage Withstand test on auxiliary and control circuits	
			Measurment of resistance of the main circuit	
			Mechanical operating Test	
		Type Test	Dielectric Test	
			Radio Interference Voltage Test	
			Temperture Rise Test	
			Shot time and peak withstand current test	
			Test to prove the short circuit making performance of earth fault	
			Operating and mechanical endurance test	
			Operation under severe ice condition	
			Opeertaion at the temperature limits	

14/3/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
12	Current transformer (Outdoor)	Routine Test	Polarity Test	
			Power frequency high voltage test	
			Inter turn overvolatge test	
			Resistance Measurment	
			ISF / Composite Eror	
			Knee Poiint Voltage Measurment for PS Class CTs	
			Accuracy Test	
			Capacitance & tan delta measurments	
			Partial Discharge test	
		Type Test	Short Time Current tests	
			Temperature Rise Test	
			Lightning Impulse test	
			Switching Impulse Voltage Test	
			High Voltage power frequency wet withstand voltage tset	

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
13	Circuit Breaker	Routine Test	Mechanical Operation test	
			Operating speed, time and travel test	
			Contact Resistance test	
			Power frequency voltage withstand test for 1min. on main circuit	
			HV test of 2kV for 1min. On auxiliary circuit	
			Visual inspection and dimensional check	
			Spare parts checking	
			Control and auxiliary circuit checking	
			Stored energy check	
			Safety valve operation test	
			Air and Gas pressure switch check	
			Additional type test: a) Out of phase closing test as per IEC- 267 and IEC-56 b) Line charging breaking current test. The breaker shall be able to interrupt the line charging current with a test voltage of 1.4p.u instead of 1.2 p.u as per IEC- 56 c) Seismic withstand test in unpressurised condition d) Corona extinction voltage test	

14/2/05

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
14	Lightning Arrester	Routine Test	Measurement of power frequency, voltage at reference current	
			Measurement of reference current	
			Measurement of partial discharge	
			Test on discharge counter	
			Visual and dimensional checks	
15	Voltage Transformer	Type test	Temperature rise test	
			Lightning impulse test for voltage transformer for service in electrially exposed installation	
			Switching impulse voltage test for voltage transformer of 420kV and above	
			High voltage power frequency wet withstand voltage test on outdoor voltage transformers up to and including 245kV	
			Determination of errors or other characteristics according to the requirements of the appropriate designation or accuracy class	

14/7/09

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
		Routine Test	Verification of terminal marking and polarity	
			Power frequency dry withstand test on primary winding	
			Power frequency dry withstand test on secondary winding	
			Partial discharge measurement	
			Determination of errors or other characteristics according to the requirements of the appropriate designation or accuracy class	
16	Capacitive Voltage Transformer	Type Test	Temperature rise test	
			Impulse test	
			Ferroresonance test	
			Transient response test	
			Test for Accuracy	
		Routine Test	Power frequency test	
			Capacitor voltage divider	
			Low voltage terminal of the capacitor voltage divider	
			Electromagnetic unit	
			Test for accuracy	

14/2/08

SCADA Points

Pl. Specify/ mention-

1. Time Synchronization Accuracy.
2. Sequence of Event Logging Time resolution.
3. Fault recording Time resolution.
4. History storage for Analog & Digital Data I/P & O/P.
5. Network Isolation during relay testing & other switchyard equipment testing.
6. Nos. of command output, Analog signal Input and Digital signal Input for each Bays i.e I/O module signal capacity.
7. Self diagnosis facility for Power supply & other components.
8. Extension provision in Rack.
9. Bought out Items make.

SCADA Points

Pl. Specify/ mention-

1. Time Synchronization Accuracy.
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REVISION INDEX SHEET

FOR

CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

REV.	DATE	REVISION	BY	APP'D	REV.	DATE	REVISION	BY	APP'D

SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.
1	–	11	–						
2	–	12	–						
3	–	13	–						
4	–	14	–						
5	–	15	–						
6	–	16	–						
7	–	17	–						
8	–								
9	–								
10	–								

FOR INFORMATION

25/3/09

APPVD.	REVWD.	CHKD.	REV.	DATE

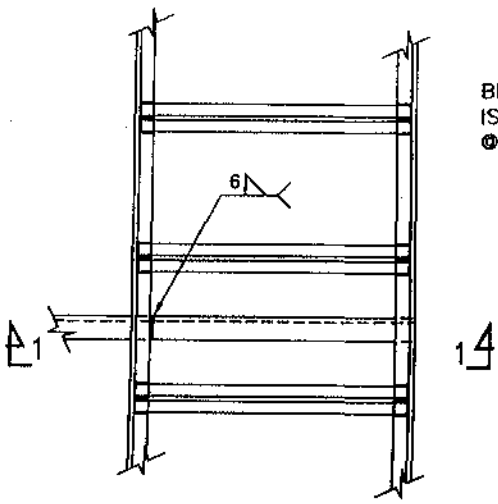
CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

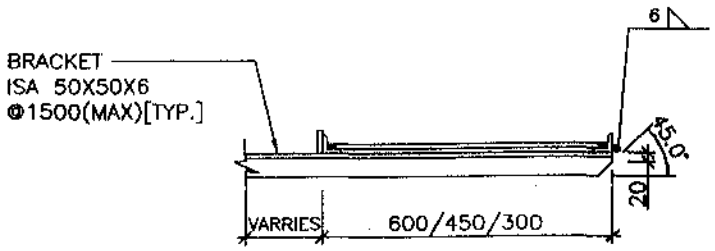
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 1 OF 17

DWG. NO. K7V12-000-DWG-E-0400 | REV. _



PLAN VIEW : HORIZONTAL TRAY



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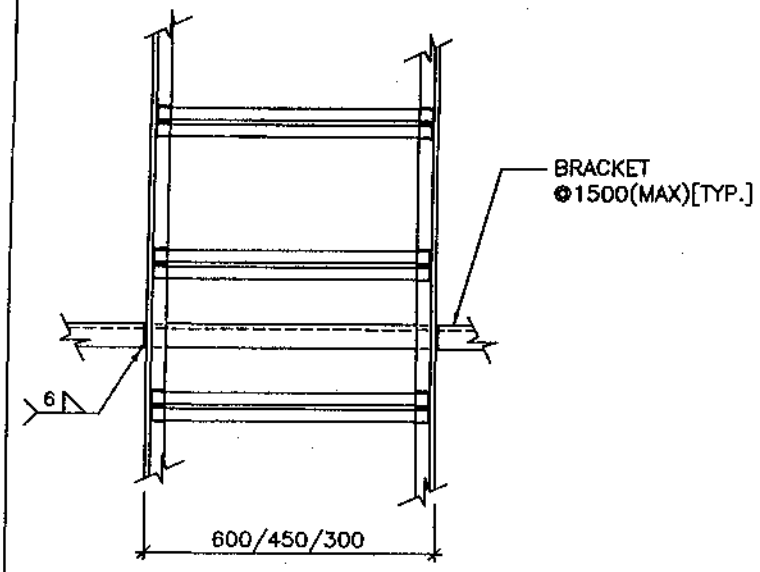
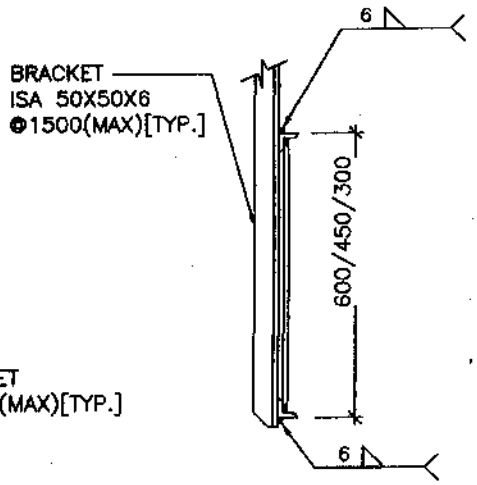


ELEVATION : CABLE SHAFT



END VIEW
VERTICAL CABLE TRAY

NOTE:

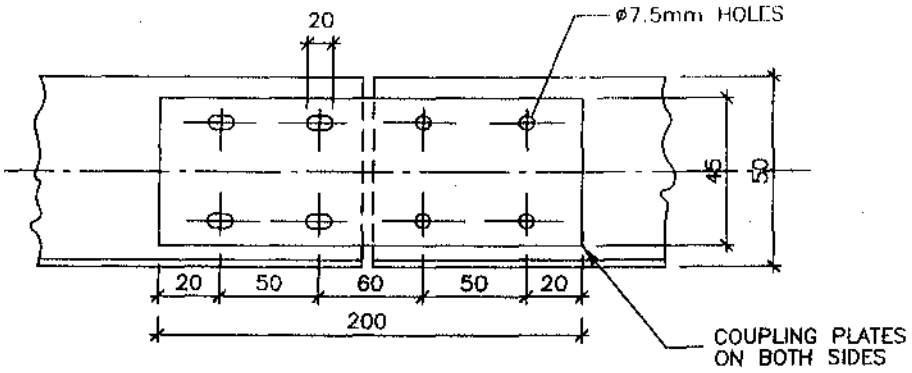
1. ALL DIMENSIONS ARE IN MM.
2. THE BRACKET SHALL BE PAINTED AFTER FABRICATION.

CABLE TRAY BRACKET

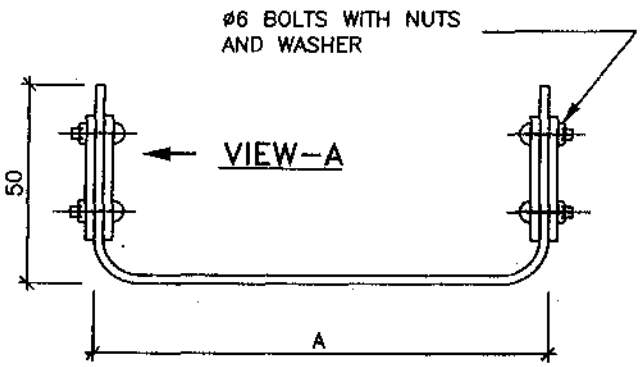
FOR INFORMATION

Cnl 25/3/09

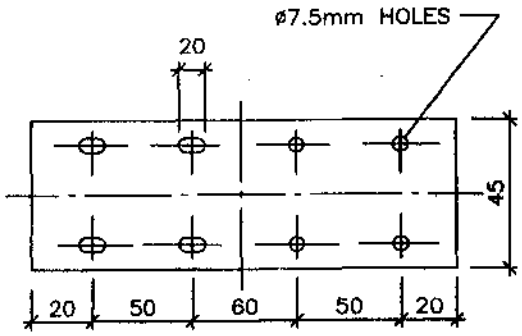
					CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 2 OF 17
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. K7V12-000-DWG-E-0400 REV. _



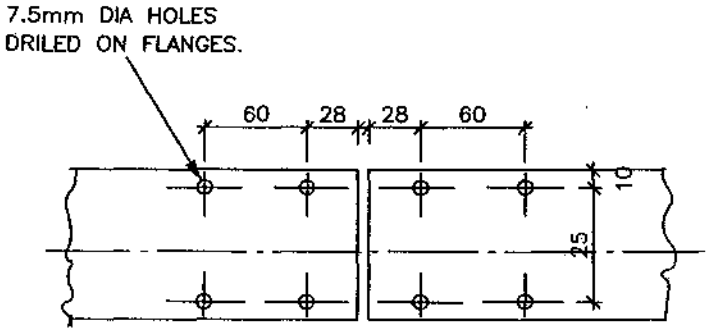
VIEW–A



END ELEVATION



COUPLING PLATE



PERFORATED TRAY JOINING BY COUPLING PLATES

NOTES:–

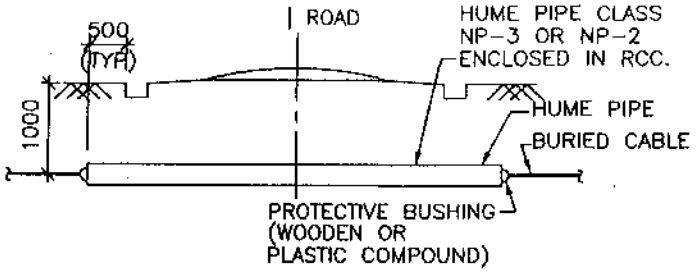
1. COUPLING PLATES 2 MM THICK M.S.
2. ALL DIMENSIONS ARE IN MM.

FOR INFORMATION

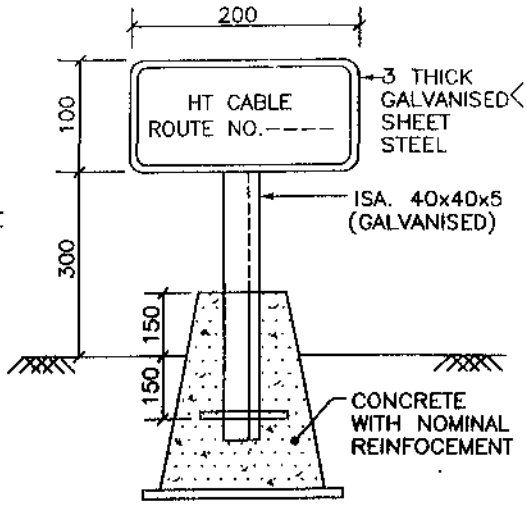
25/3/09

20.3.09

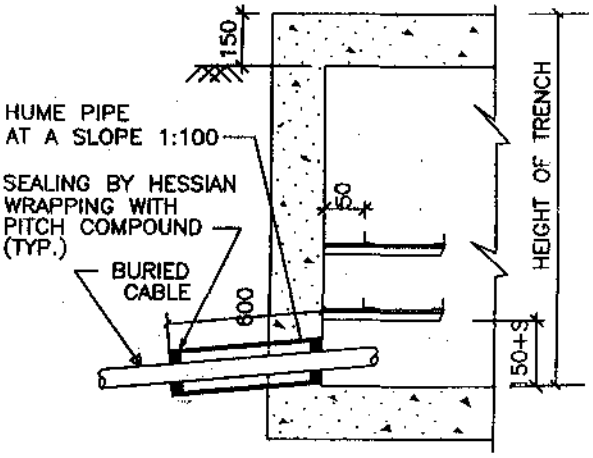
					CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 3 OF 17
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. K7V12–000–DWG–E–0400 REV. _



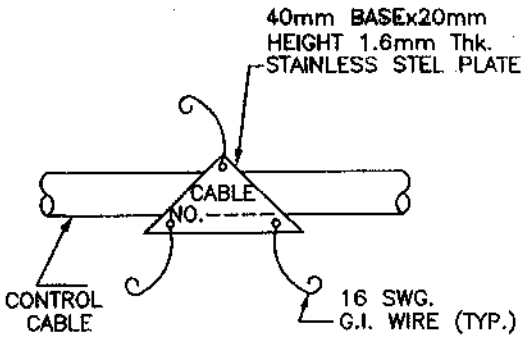
ROAD CROSSING OF BURIED CABLE



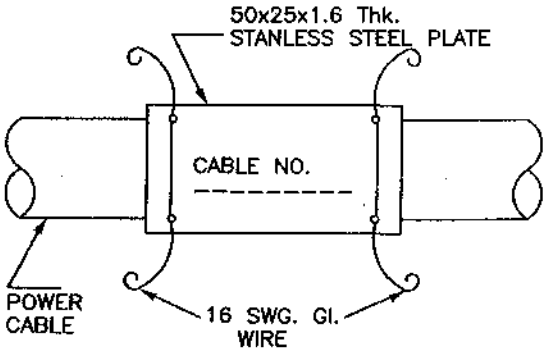
CABLE ROUTE MAKER
(VOLTAGE TO BE MARKED)



TYP. DETAILS OF BURIED CABLE ENTRY TO BLDG. OR CABLE TRENCH



CABLE TAG CONTROL CABLE

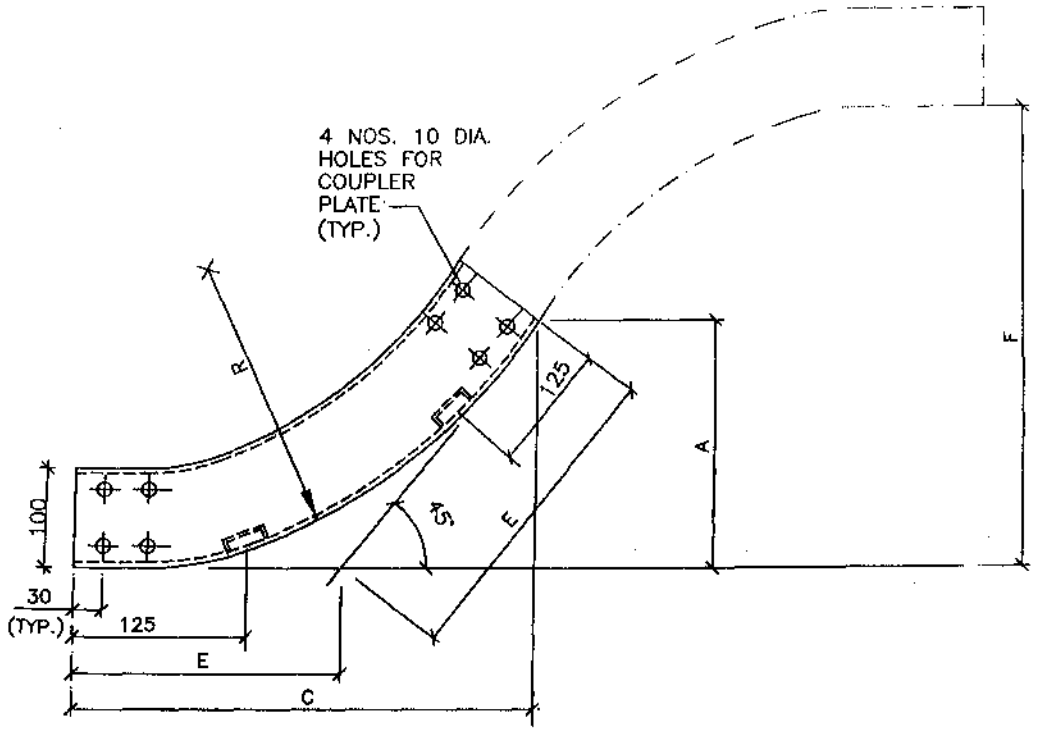


CABLE TAG POWER CABLE

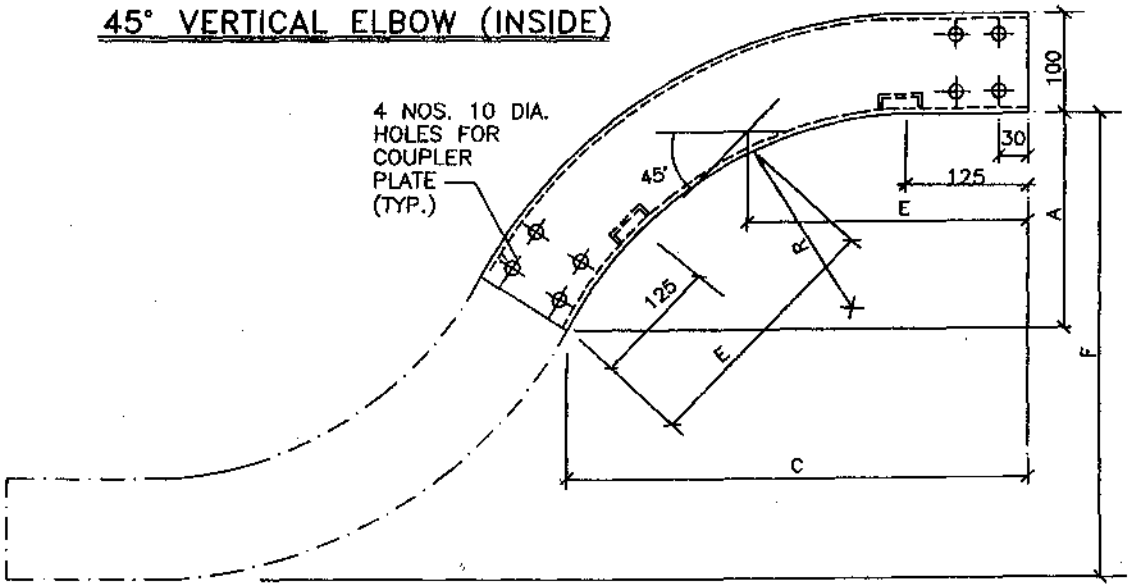
FOR INFORMATION

NOTE:
ALL DIMENSIONS ARE IN 'MM'.

APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 4 OF 17
						DWG. NO. K7V12-000-DWG-E-0400	REV. _



ELEVATION
45° VERTICAL ELBOW (INSIDE)



WIDTH(W)	RADIUS(R)	A	C	E	F
600 450 & 300	1050	395	955	560	790
	600	265	640	375	530
	450	220	530	310	440
	300	175	425	250	350

ELEVATION
45° VERTICAL ELBOW (OUTSIDE)

FOR INFORMATION

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

APPVD.	REVWD.	CHKD.	REV.	DATE

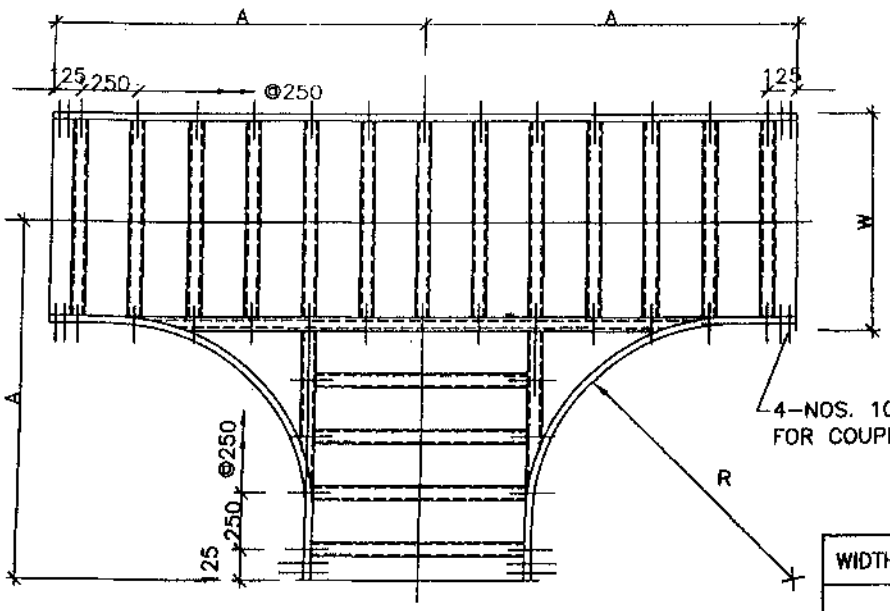
CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

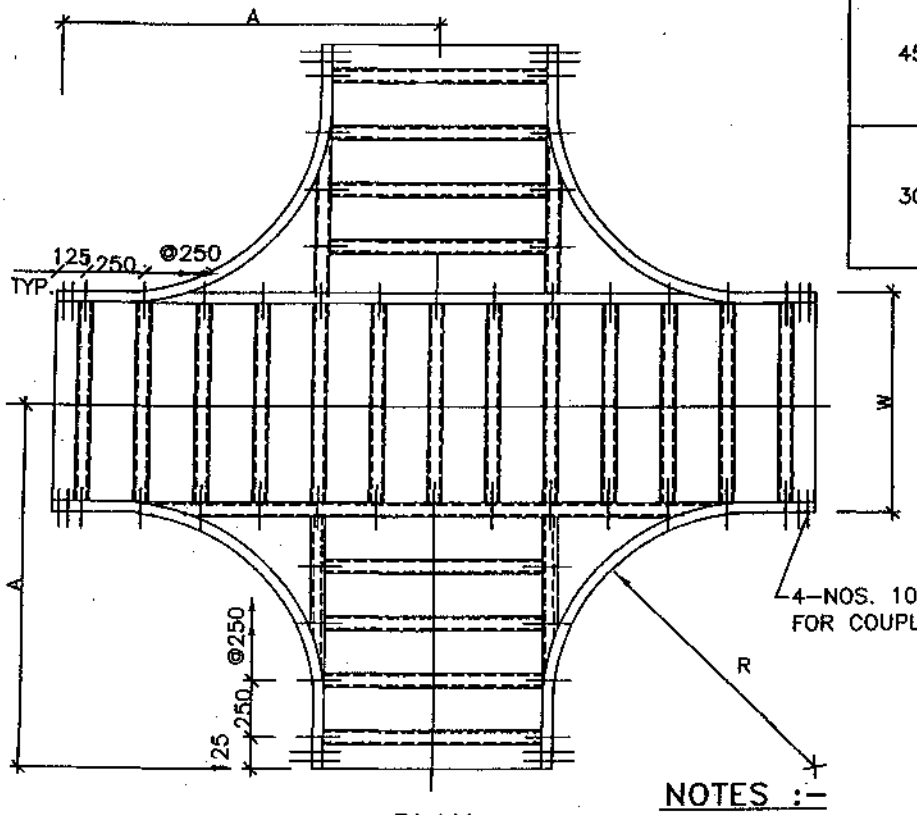
JOB NO. K7V12 | SHEET 5 OF 17

DWG. NO. K7V12-000-DWG-E-0400 | REV. _



PLAN
HORIZONTAL TEE

WIDTH (W)	RADIUS (R)	A
600	1050	1475
	600	1025
	450	875
	300	725
450	1050	1400
	600	950
	450	800
	300	650
300	1050	1325
	600	875
	450	725
	300	575



PLAN
HORIZONTAL CROSS

FOR INFORMATION

NOTES :-

1. ALL DIMENSIONS ARE IN MM.
2. FOR MULTITIER CABLE TRAY, THE BENDING RADIUS AT THE BENDS SHALL BE SAME FOR ALL TRAYS AND THIS RADIUS SHALL BE AS PER THE RECOMMENDED BENDING RADIUS OF LARGEST CABLE IN THE ROUTE.

APPVD.	REVWD.	CHKD.	REV.	DATE

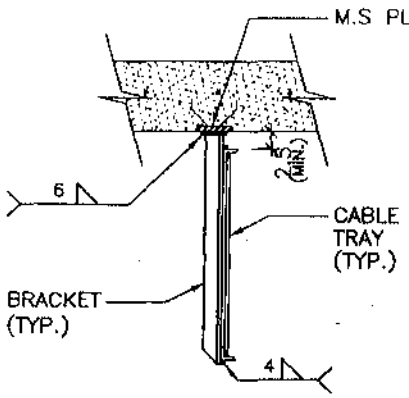
CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

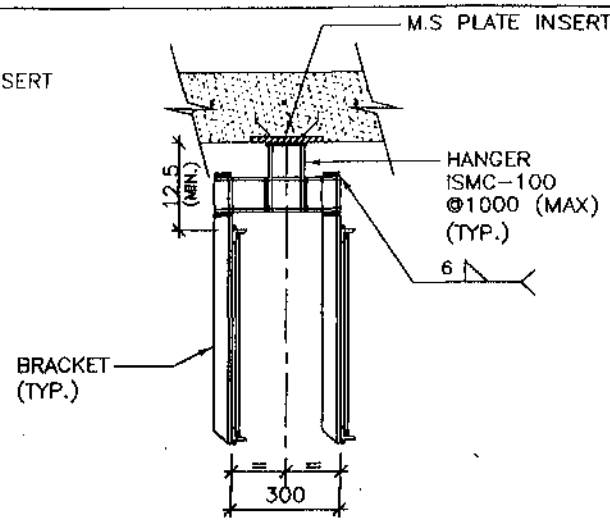
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA - MUMBAI - CHENNAI - NEW DELHI

JOB NO. K7V12 | SHEET 6 OF 17

DWG. NO. K7V12-000-DWG-E-0400 | REV. _

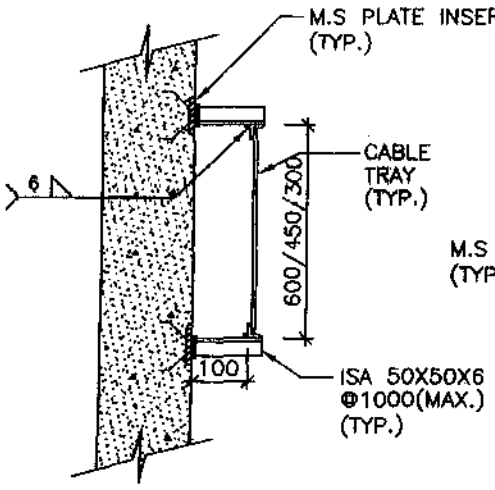


TYPE : RK-A/A1/A2

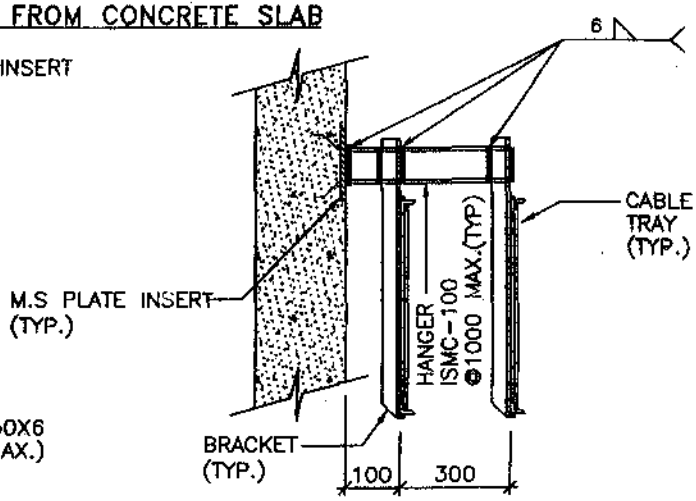


TYPE : RK-B

VERTICAL TRAY SUPPORTED FROM CONCRETE SLAB

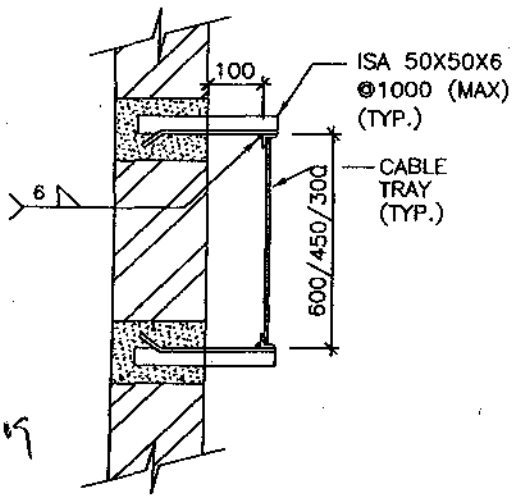


TYPE : RK-A/A1/A2



TYPE : RK-B

VERTICAL TRAY SUPPORTED FROM CONCRETE COLUMN



SINGLE VERTICAL TRAY ON BRICK WALL

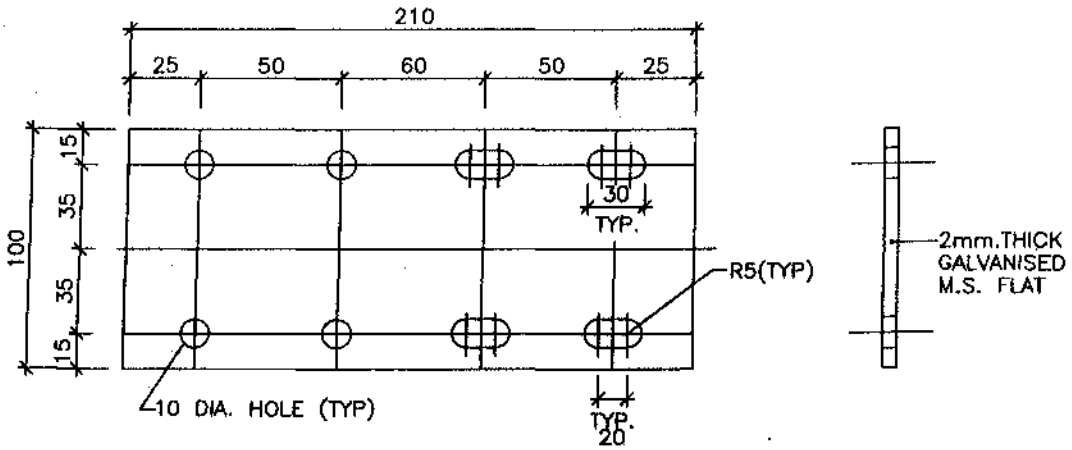
NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. ISMC-100 HANGER MAY SIMILARLY SUPPORTED FROM STEEL BEAM / COLUMN IF AVAILABLE.
3. MOUNTING ARRANGEMENT FOR RACK TYPE RK-C, RK-D SHALL BE SIMILAR.

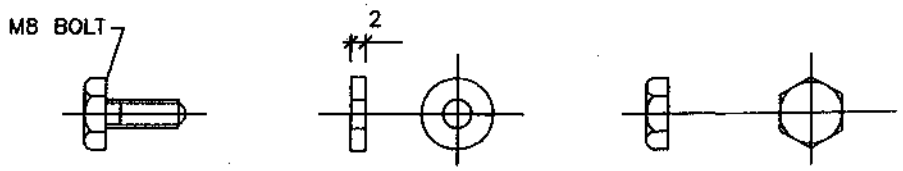
FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 7 OF 17
						DWG. NO. K7V12-000-DWG-E-0400 REV. _

CAD FILE : K7V12-000-DWG-E-0400 NIRANJAN/08.03.08



SIDE COUPLER PLATE



M8 BOLT, WASHER & NUT

(FOR CABLE TRAY JOINT)

FOR INFORMATION

25/3/09

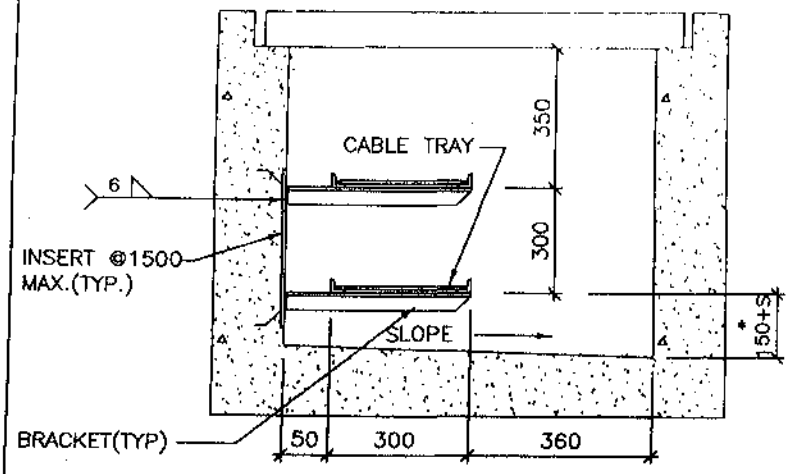
NOTE :-

1. ALL DIMENSIONS ARE IN MM.

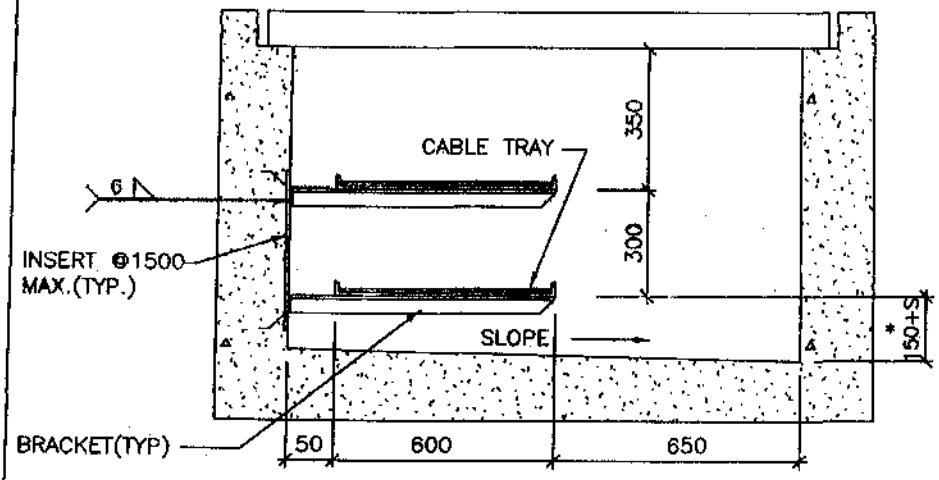
APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 8 OF 17
						DWG. NO. K7V12-000-DWG-E-0400	REV. _

NOTES:

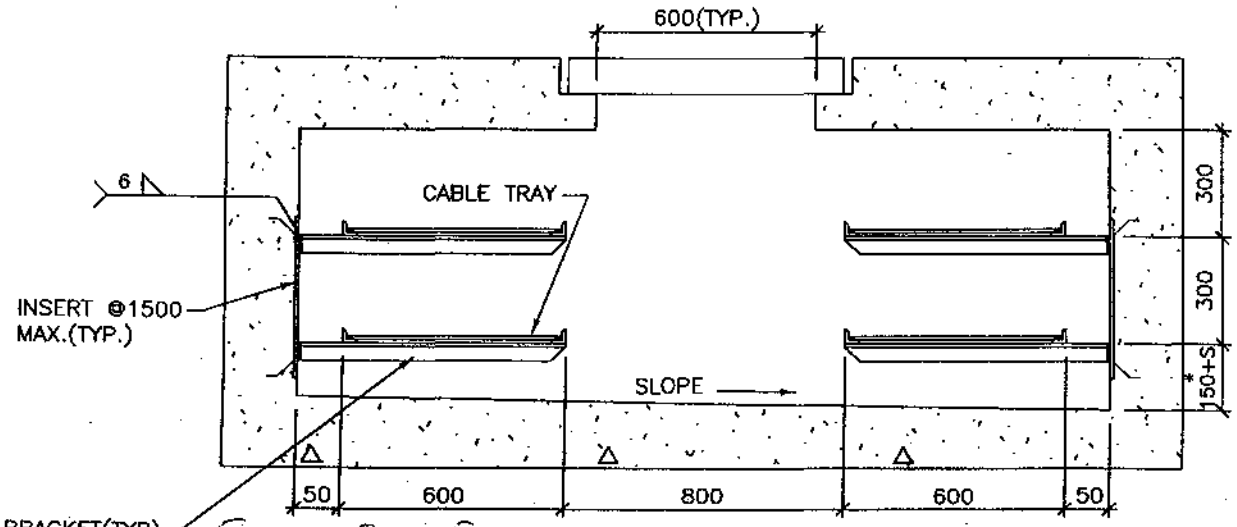
1. ALL DIMENSIONS ARE IN MM.
2. * S INDICATES THE INCREMENTAL DEPTH TO MATCH THE SLOPE OF THE TRENCH.
3. THE CABLE TRAY MOUNTING ARRANGEMENT FOR TRENCH TYPE TR-C, TR-CC, TR-D, ETC. SHALL BE SIMILAR.



TYPE : TR-B



TYPE : TR-B



FOR INFORMATION

TYPE : TR-BB

MOUNTING ARRANGEMENT
(IN CABLE TRENCH)

25/3/09

APPVD.	REVWD.	CHKD.	REV.	DATE

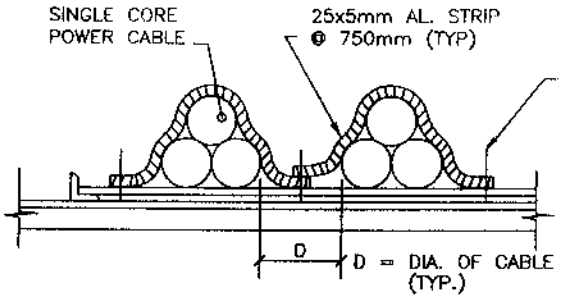
CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

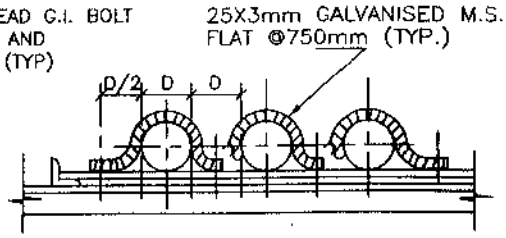
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 9 OF 17

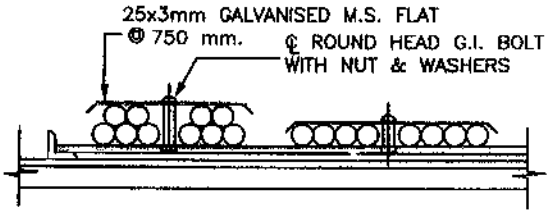
DWG. NO. K7V12-000-DWG-E-0400 | REV. _



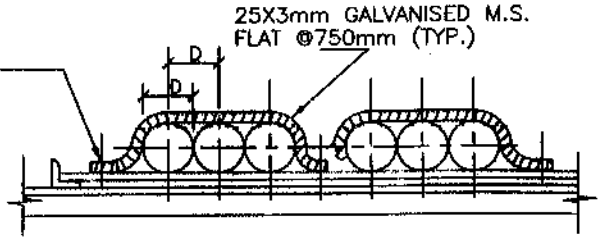
CABLE CLAMPS IN TREFOIL FORMATION FOR SINGLE CORE POWER CABLES



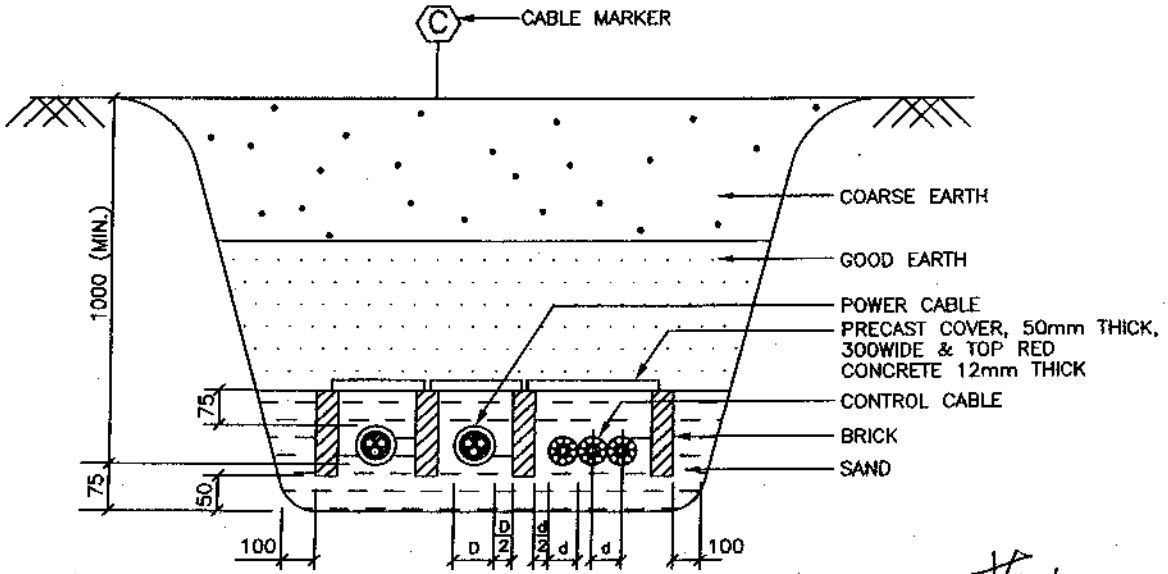
CABLE CLAMPS FOR MULTICORE POWER CABLES (NOT TOUCHING EACHOTHER)



CLAMPING ARRANGEMENT OF CONTROL CABLES



CABLE CLAMPS FOR MULTICORE POWER CABLES (TOUCHING EACHOTHER)

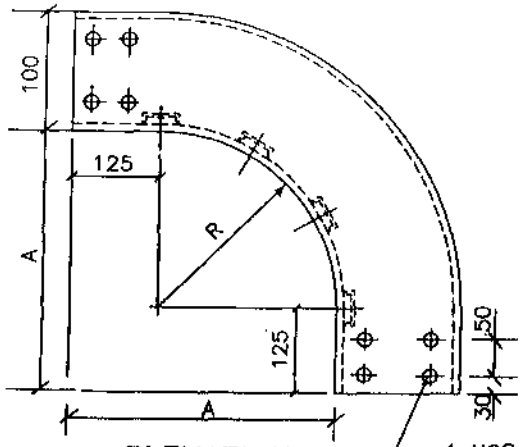


BURRIED CABLE LAYING DETAILS

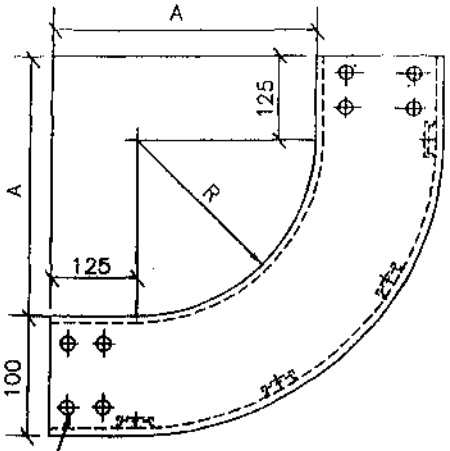
FOR INFORMATION

NOTE:
ALL DIMENSIONS ARE IN 'MM'.

					CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 10 OF 17
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. K7V12-000-DWG-E-0400 REV. _



ELEVATION
90° VERTICAL ELBOW
(OUTSIDE)

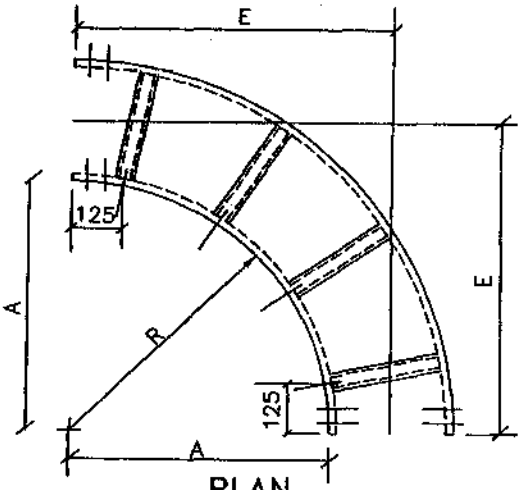


4 NOS. 10 DIA. HOLES FOR COUPLER PLATE

ELEVATION
90° VERTICAL ELBOW
(INSIDE)

VERTICAL ELBOW		
WIDTH (W)	RADIUS (R)	A
600 450 & 300	1050	1175
	600	725
	450	575
	300	425

HORIZONTAL ELBOW			
WIDTH (W)	RADIUS (R)	A	E
600	1050	1175	1475
	600	725	1025
	450	575	875
	300	425	725
450	1050	1175	1400
	600	725	950
	450	575	800
	300	425	650
300	1050	1175	1325
	600	725	875
	450	575	725
	300	425	575



PLAN
90°HORIZONTAL ELBOW

NOTES :-

1. ALL DIMENSIONS ARE IN MM.
2. FOR MULTITIER CABLE TRAY, THE BENDING RADIUS AT THE BENDS SHALL BE SAME FOR ALL TRAYS AND THIS RADIUS SHALL BE AS PER THE RECOMMENDED BENDING RADIUS OF LARGEST CABLE IN THE ROUTE

25/3/09

FOR INFORMATION

09.3.25

APPVD.	REVWD.	CHKD.	REV.	DATE

CABLING DETAILS AND
CABLE TRAYS & ACCESSORIES

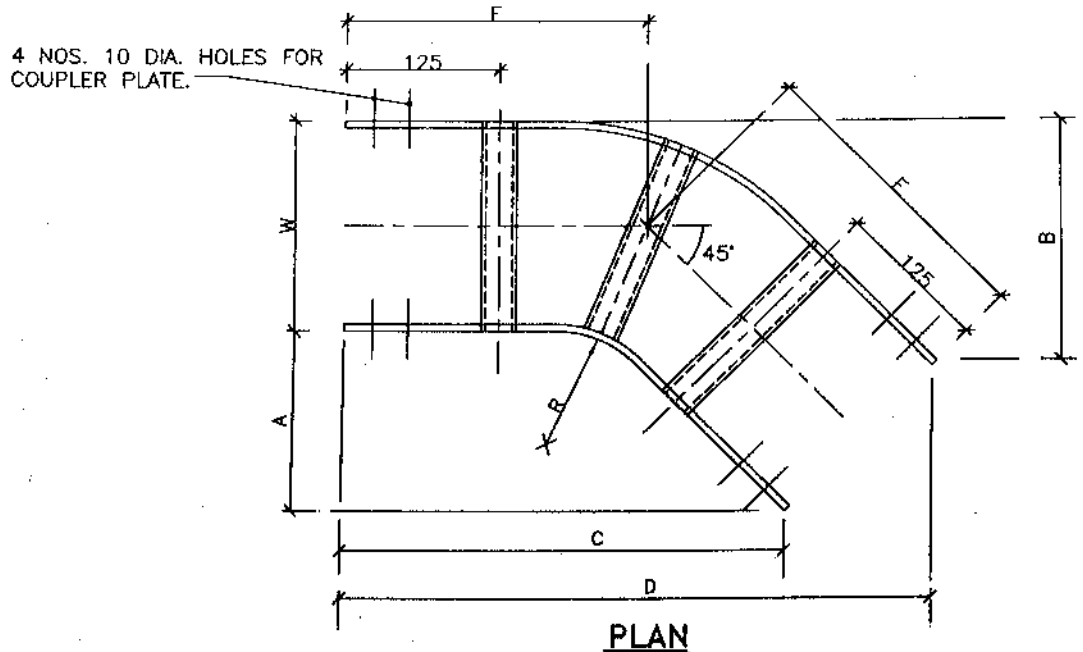
3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 11 OF 17

DWG. NO. K7V12-000-DWG-E-0400 | REV. –

CAD FILE : K7V12-000-DWG-E-0400



PLAN
45° HORIZONTAL ELBOW

WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	395	570	955	1380	685
	600	265	440	640	1065	535
	450	220	395	530	955	470
	300	175	350	425	850	410
450	1050	395	530	955	1275	690
	600	265	395	640	955	500
	450	220	350	530	850	440
	300	175	310	425	745	390
300	1050	395	485	955	1165	655
	600	265	350	640	850	470
	450	220	310	530	745	410
	300	175	265	425	635	345

FOR INFORMATION

25/2/09

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

2009.4.15

APPVD.	REVWD.	CHKD.	REV.	DATE

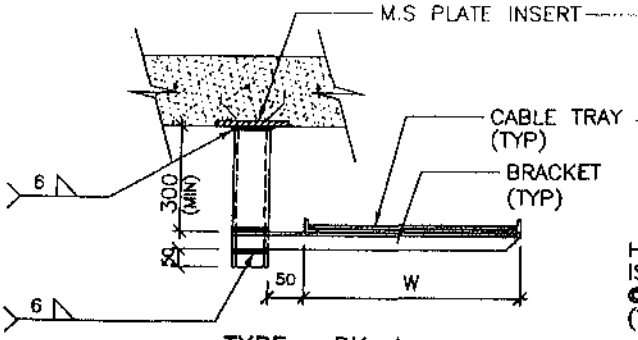
CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

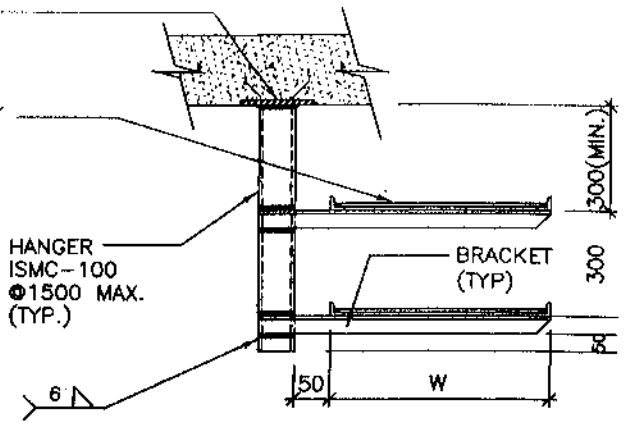
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 12 OF 17

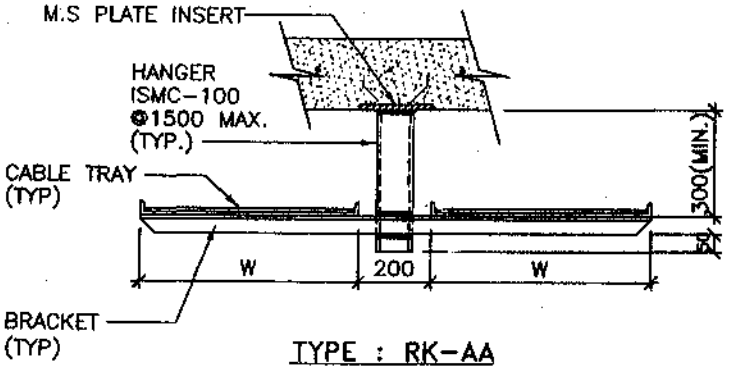
DWG. NO. K7V12-000-DWG-E-0400 | REV. _



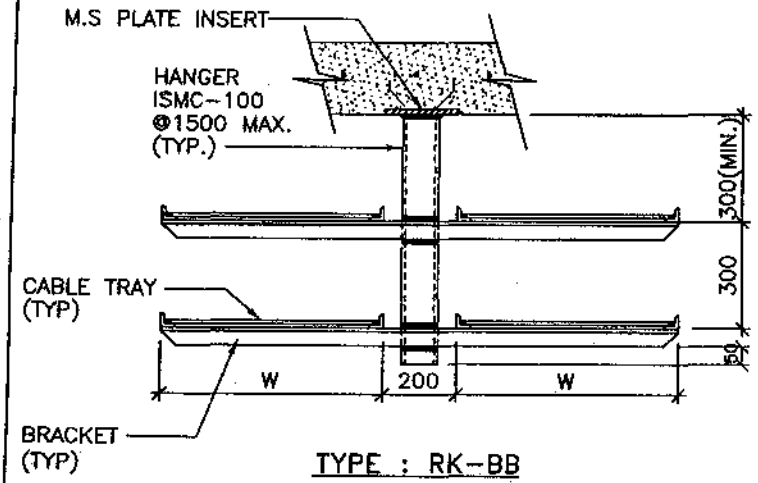
TYPE : RK-A



TYPE : RK-B



TYPE : RK-AA



TYPE : RK-BB

NOTES:-

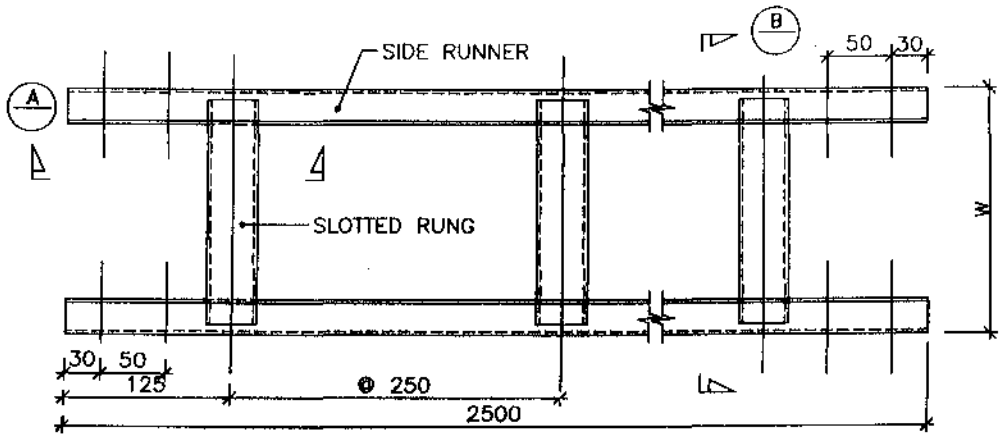
1. ALL DIMENSIONS ARE IN MM.
2. MOUNTING ARRANGEMENT OF TRAYS FOR RACK TYPE RK-C, RK-CC, RK-D & RK-DD SHALL BE SIMILAR.
3. ISMC-100 HANGER MAY BE SIMILARLY SUPPORTED FROM STRUCTURAL STEEL BEAM/ COLUMN, IF AVAILABLE, IN PLACE OF PLATE INSERT.

MOUNTING ARRANGEMENT- HORIZONTAL TRAY (FROM CONCRETE SLAB)

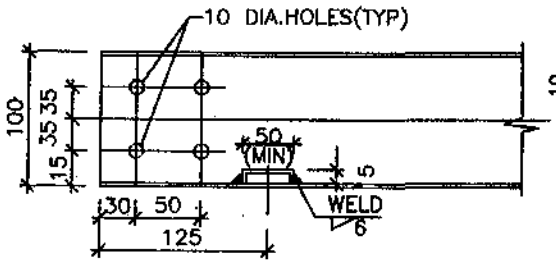
25/3/09 FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA - MUMBAI - CHENNAI - NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 13 OF 17
						DWG. NO. K7V12-000-DWG-E-0400 REV. -

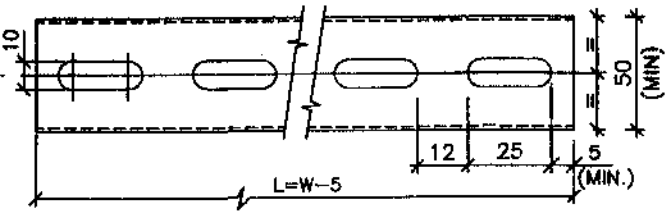
CAD FILE : K7V12-000-DWG-E-0400 NIRANJAN/09.03.09



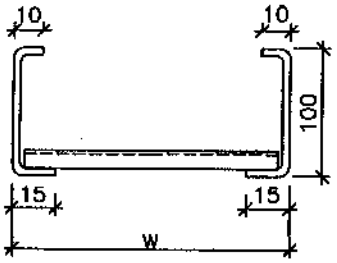
LADDER TYPE CABLE TRAY



SEC – (A)

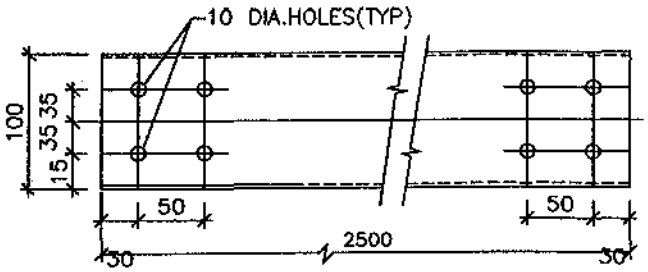


SLOTTED RUNG



SEC – (B)

W	150	300	450	600
L	145	295	445	595



SIDE RUNNER

MATERIAL : M.S. SHEET 14 SWG.(2mm.THK.)
FINISH : HOT DIP GALVANISED

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

25/3/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE

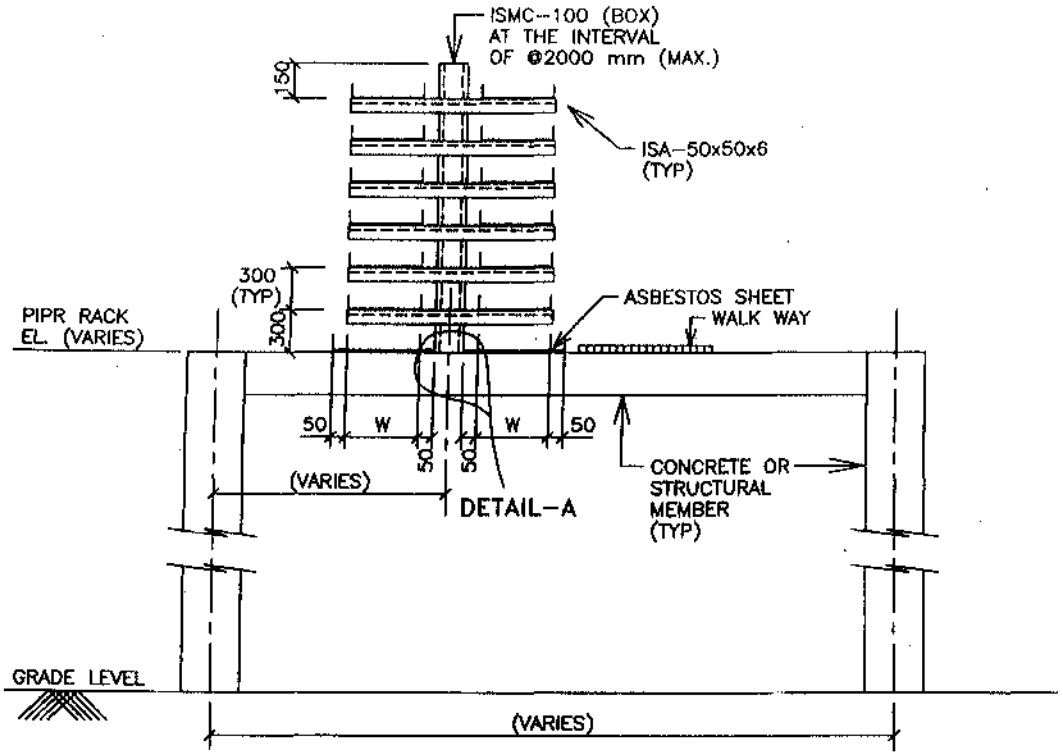
CABLING DETAILS AND CABLE TRAYS & ACCESSORIES

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

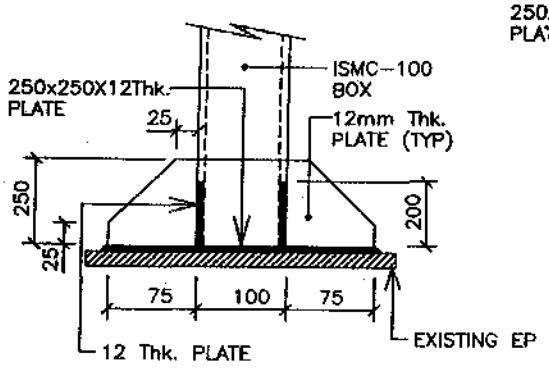
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 14 OF 17

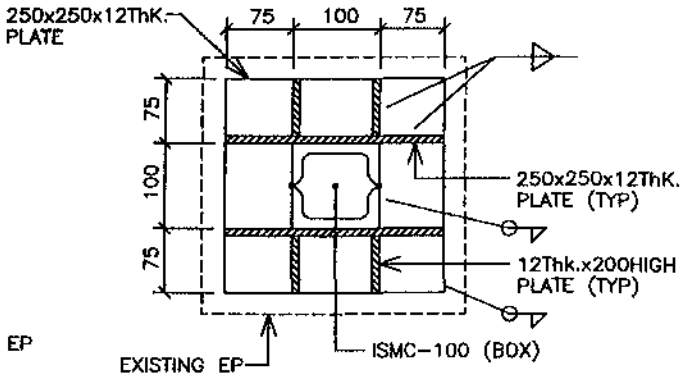
DWG. NO. K7V12-000-DWG-E-0400 | REV. _



TYPICAL SUPPORTING ARRANGEMENT FOR HORIZONTAL RUN OF CABLE TRAYS ON PIPE RACK



DETAIL - A



FIXING ARRANGEMENT

NOTE :-

1. UNLESS OTHERWISE NOTED ALL WELDS ARE ARE 6mm SIZE OR EQUAL TO THE MINIMUM Thk. OF THE MEMBER, WHICHEVER IS SMALLER.

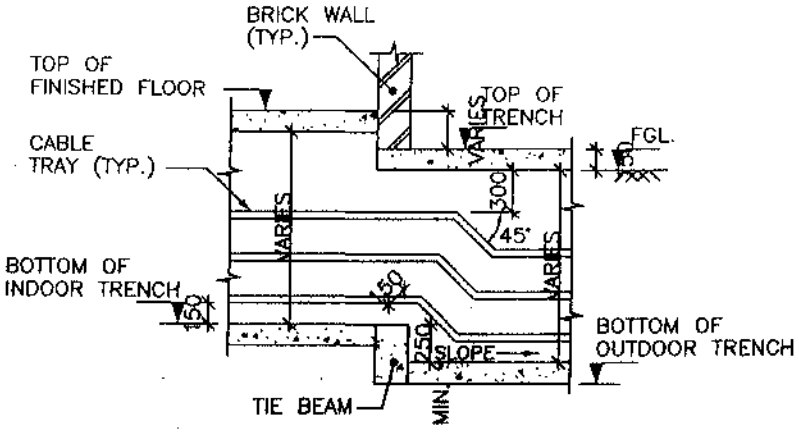
W = WIDTH OF TRAY

25/10/09

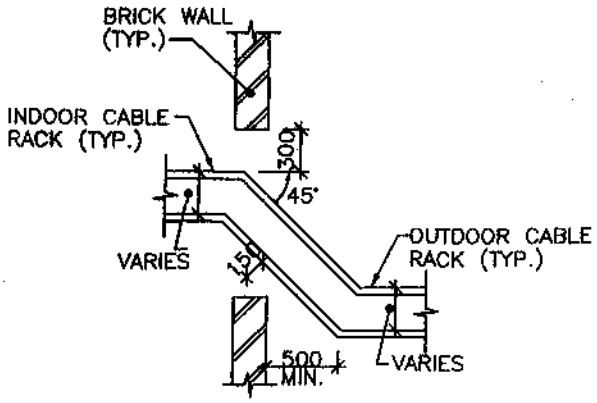
FOR INFORMATION

2009.3.25

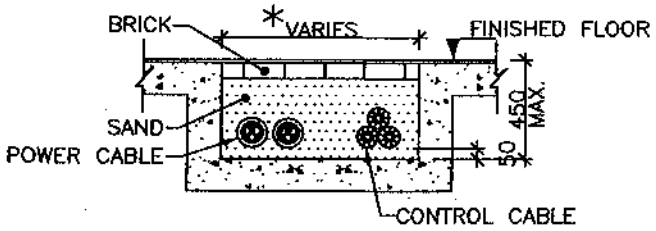
APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA - MUMBAI - CHENNAI - NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 15 OF 17
						DWG. NO. K7V12-000-DWG-E-0400	REV. -



TYPICAL DETAILS OF CABLE TRENCH ENTRY TO BUILDING



TYPICAL DETAILS OF CABLE RACK ENTRY TO BUILDINGS



CABLE LAYING IN SHALLOW TRENCH (INDOOR)

NOTE:

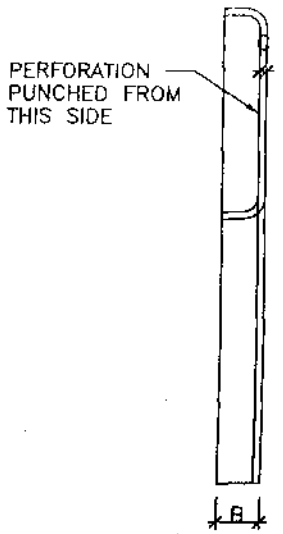
1. ALL DIMENSIONS ARE IN 'MM'.
2. THE PORTION OF FLOOR ABOVE THE TRENCH MARKED '*' SHALL BE FINISHED WITH WEAK MORTER.

25/3/09

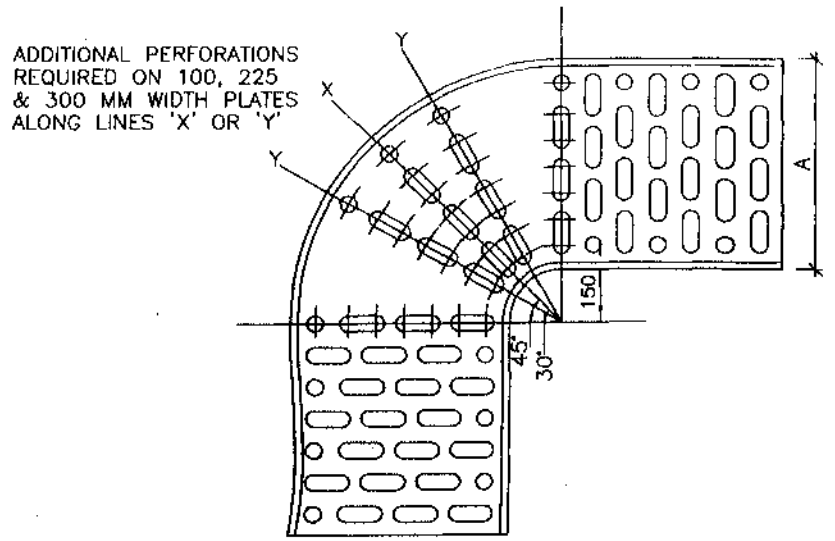
FOR INFORMATION

20.3.09

APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 16 OF 17
						DWG. NO. K7V12-000-DWG-E-0400	REV. _



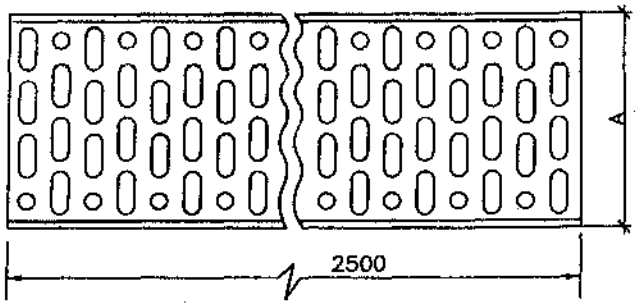
END ELEVATION



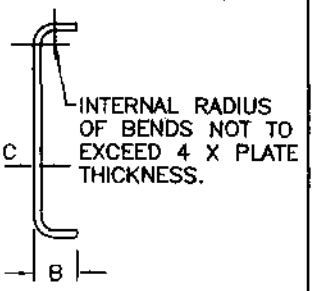
PLAN

90° HORIZONTAL ELBOW

DIMENSIONS IN MM	
WIDTH–A	DEPTH–B
100	50
150/225	
300	50

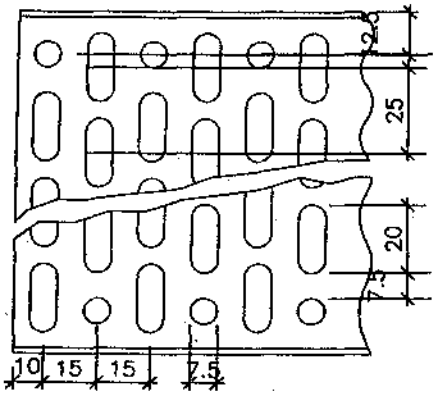


PLAN



END ELEVATION

STRAIGHT LENGTH



DETAILS OF PERFORATION

NOTES :

1. ALL CUTTING & FORMING OPERATIONS TO BE COMPLETED PRIOR TO GALVANIZING.
2. FINISHED TRAYS TO BE FREE FROM BURRS AND SHARP EDGES.
3. ALL DIMENSIONS ARE IN MM.

PERFORATED TYPE CABLE TRAY

20/3/09

FOR INFORMATION

20.03.09

APPVD.	REVWD.	CHKD.	REV.	DATE	CABLING DETAILS AND CABLE TRAYS & ACCESSORIES	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 17 OF 17
						DWG. NO. K7V12–000–DWG–E–0400	REV. –

REVISION INDEX SHEET

FOR

EARTHING NOTES & DETAILS

REV.	DATE	REVISION	BY	APP'D	REV.	DATE	REVISION	BY	APP'D

SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.
1		11		21					
2		12		22					
3		13		23					
4		14							
5		15							
6		16							
7		17							
8		18							
9		19							
10		20							

25/2/09

FOR INFORMATION

20.09.3.25

APPVD.	REVWD.	CHKD.	REV.	DATE

EARTHING DETAILS

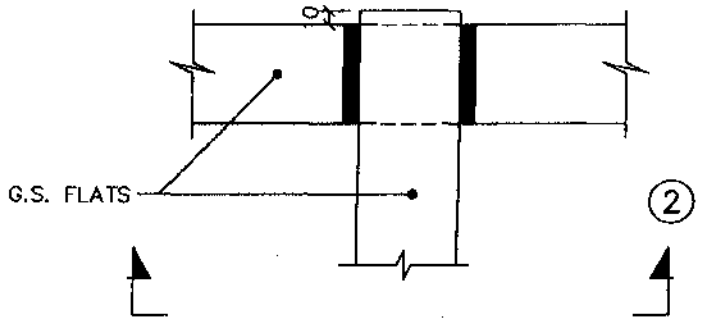
3600 MW COAL BASED POWER PROJECT

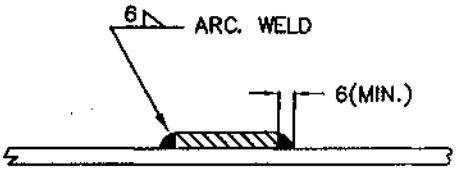
WARDHA POWER COMPANY PVT. LTD.

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 1 OF 23

DWG. NO. K7V12-000-DWG-E-0600 | REV.





SECTION – ②

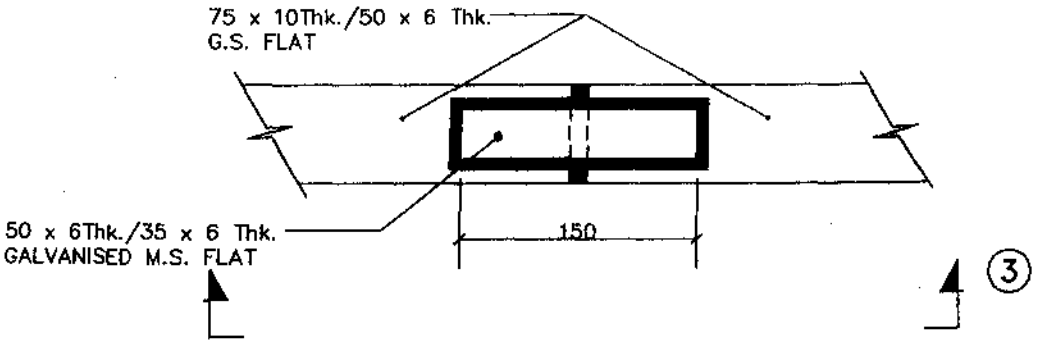
CROSS JOINT BETWEEN FLATS

25/3/09

FOR INFORMATION

20.3.09

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12 SHEET 2 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE	WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0600 REV.



SECTION - (3)

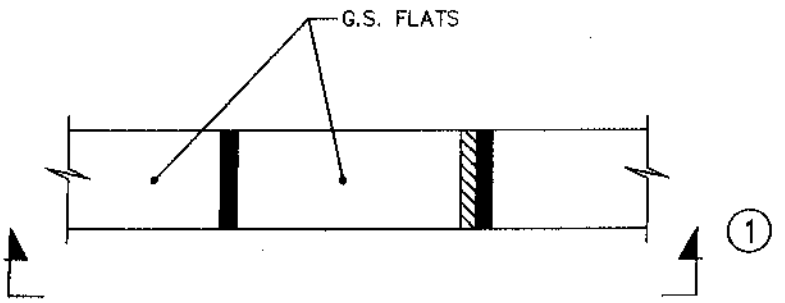
BUTT JOINT BETWEEN FLATS

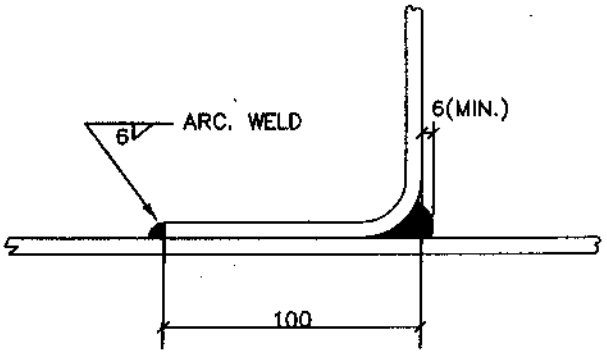
Cng 25/3/05

FOR INFORMATION

2009.3.29

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12	SHEET 3 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE	WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0600	REV.





SECTION – (1)

ANGULAR JOINT BETWEEN FLATS

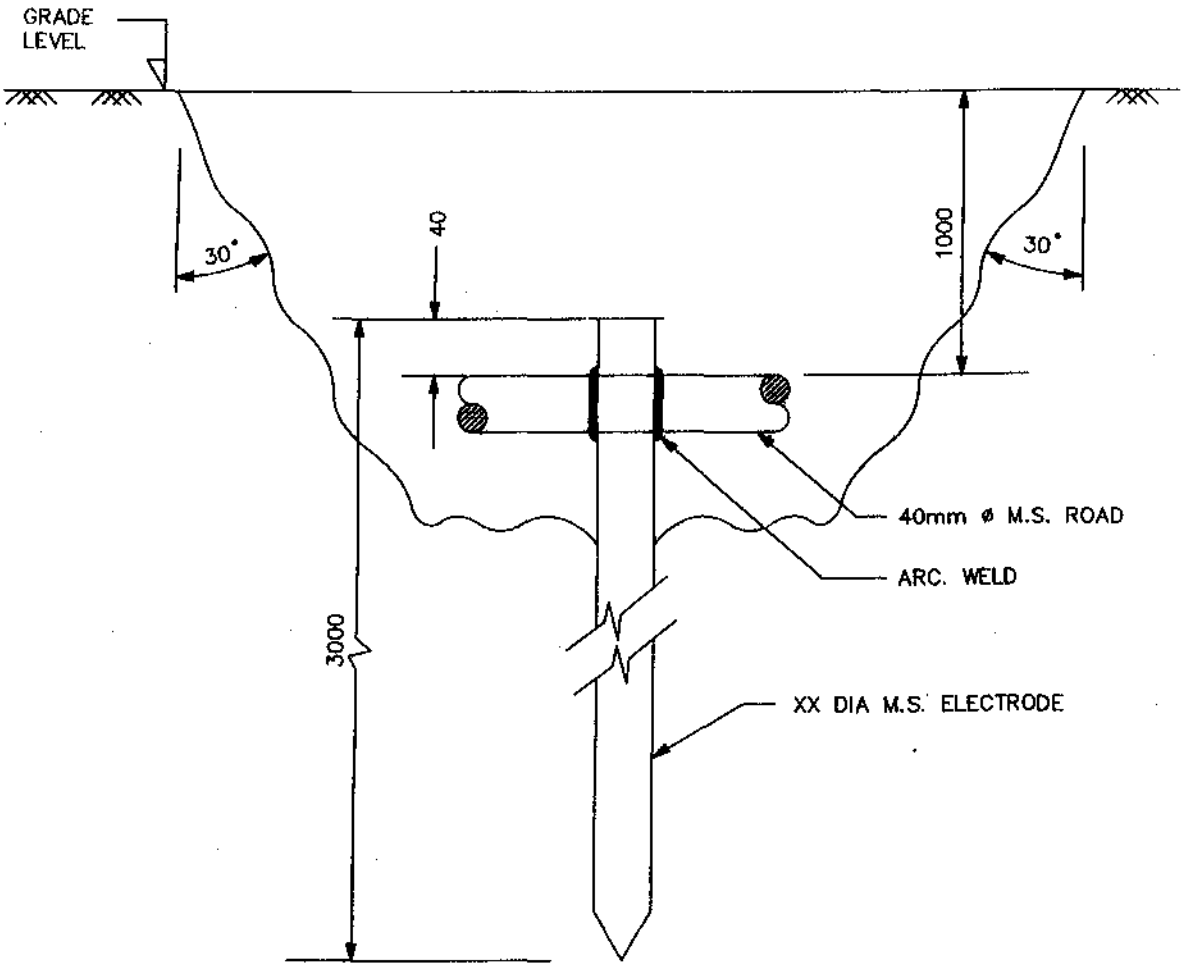
25/3/09

FOR INFORMATION

20.3.09

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 4 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. K7V12-000-DWG-E-0600 REV.

CAD FILE : K7V12-000-DWG-E-0600 MODIFIED ON 09.03.09



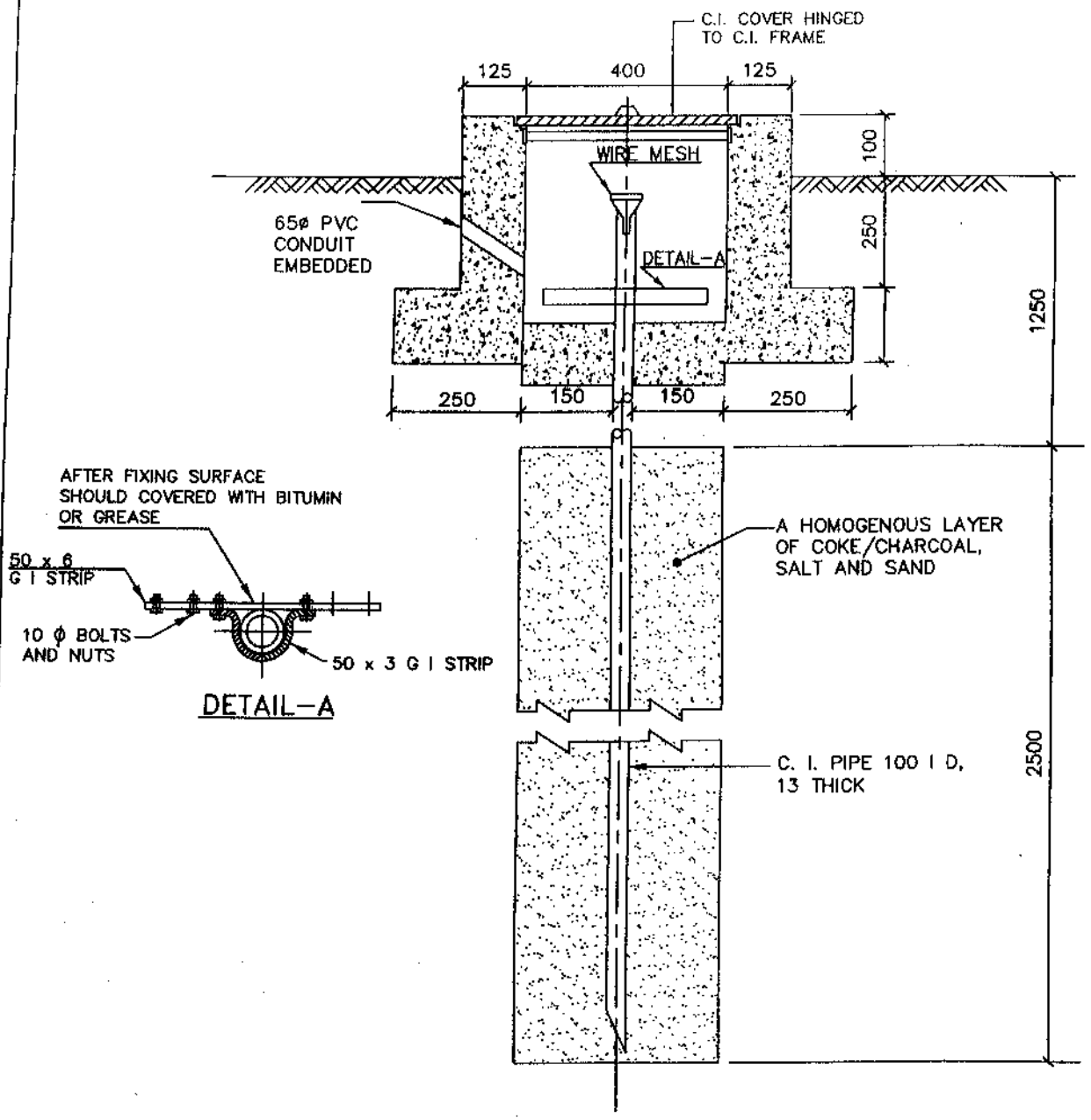
EARTH ELECTRODE

25/2/19

FOR INFORMATION

2019.3.25

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 5 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.



TREATED EARTHING PIT

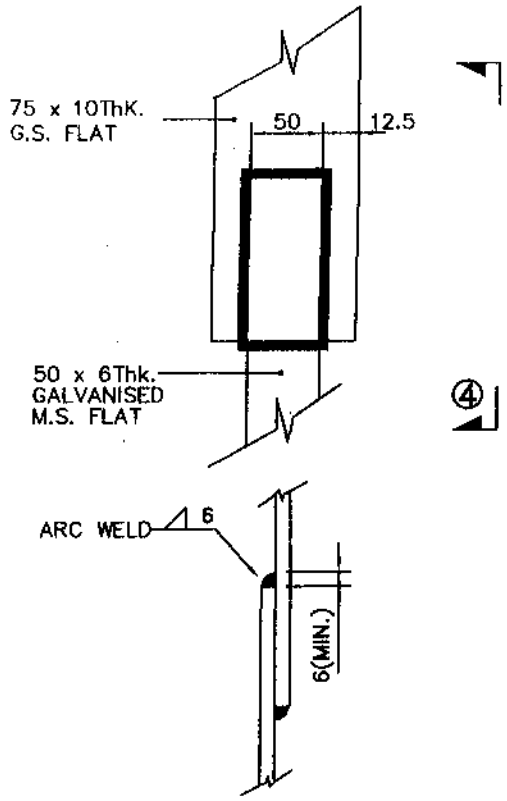
25/3/09

FOR INFORMATION

2009.3.25

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 6 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.

CAD FILE : K7V12-000-DWG-E-0600



SECTION – ④

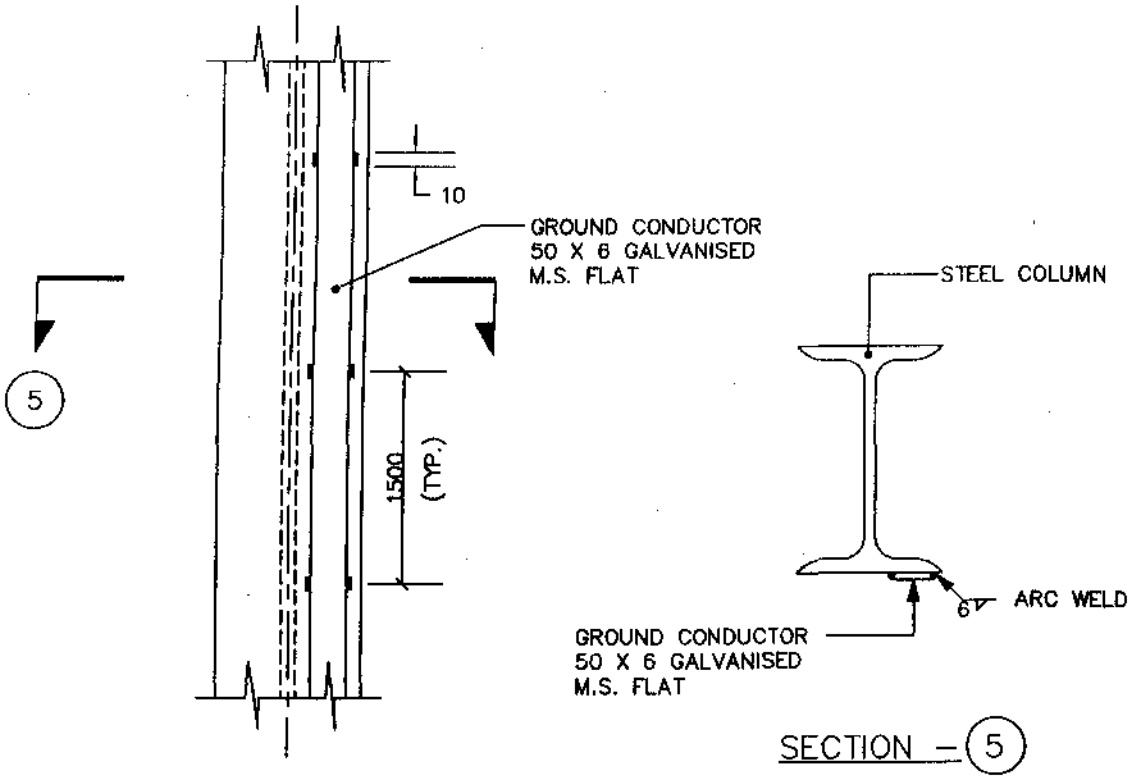
STRAIGHT JOINT
BETWEEN FLATS OF DIFFERENT SIZES

25/7/09

FOR INFORMATION

2009.3.25

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12 SHEET 7 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE	WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0600 REV.



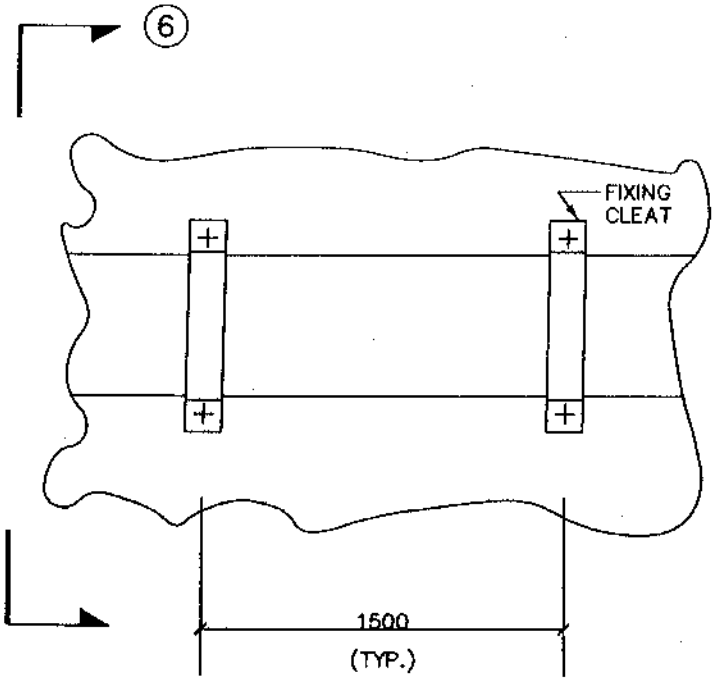
EARTHING CONDUCTOR ALONG STEEL COLUMN

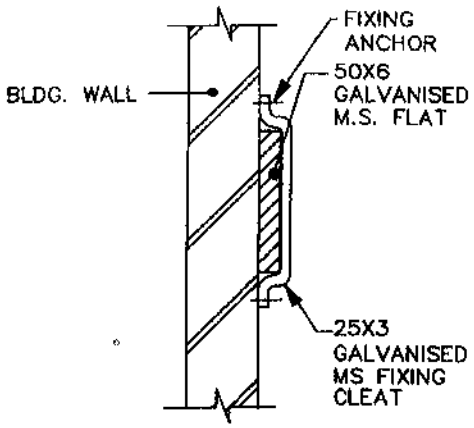
25/3/09

For Information

20.9.09

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 8 OF 23
						DWG. NO. K7V12-000-DWG-E-0600	REV.





SECTION – ⑥

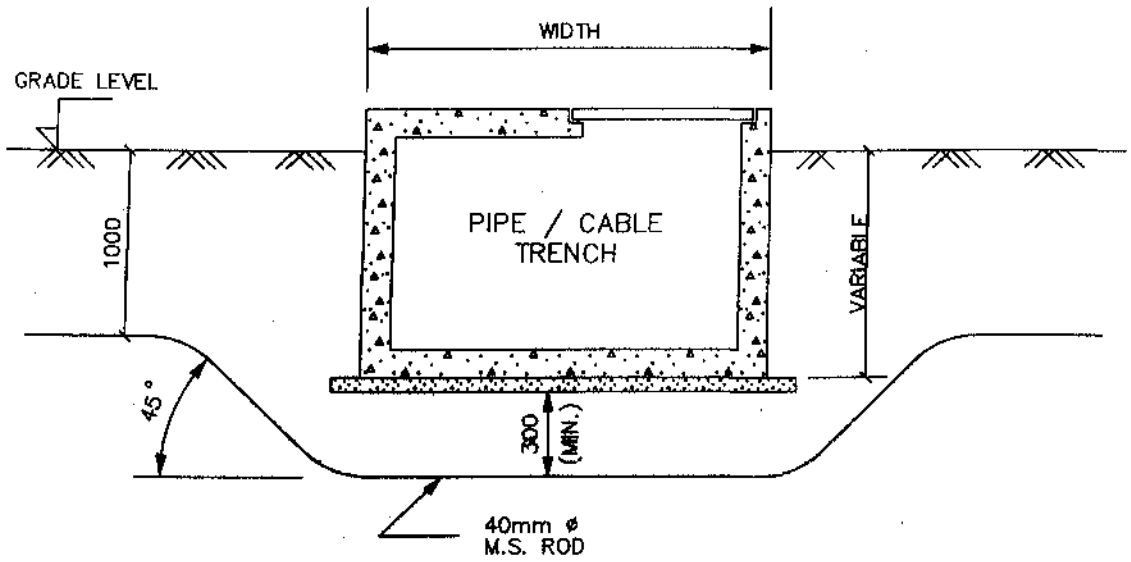
EARTHING CONDUCTOR ALONG BUILDING WALL

FOR INFORMATION

25/3/05

20.3.25

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 9 OF 23
						DWG. NO. K7V12-000-DWG-E-0600	REV.



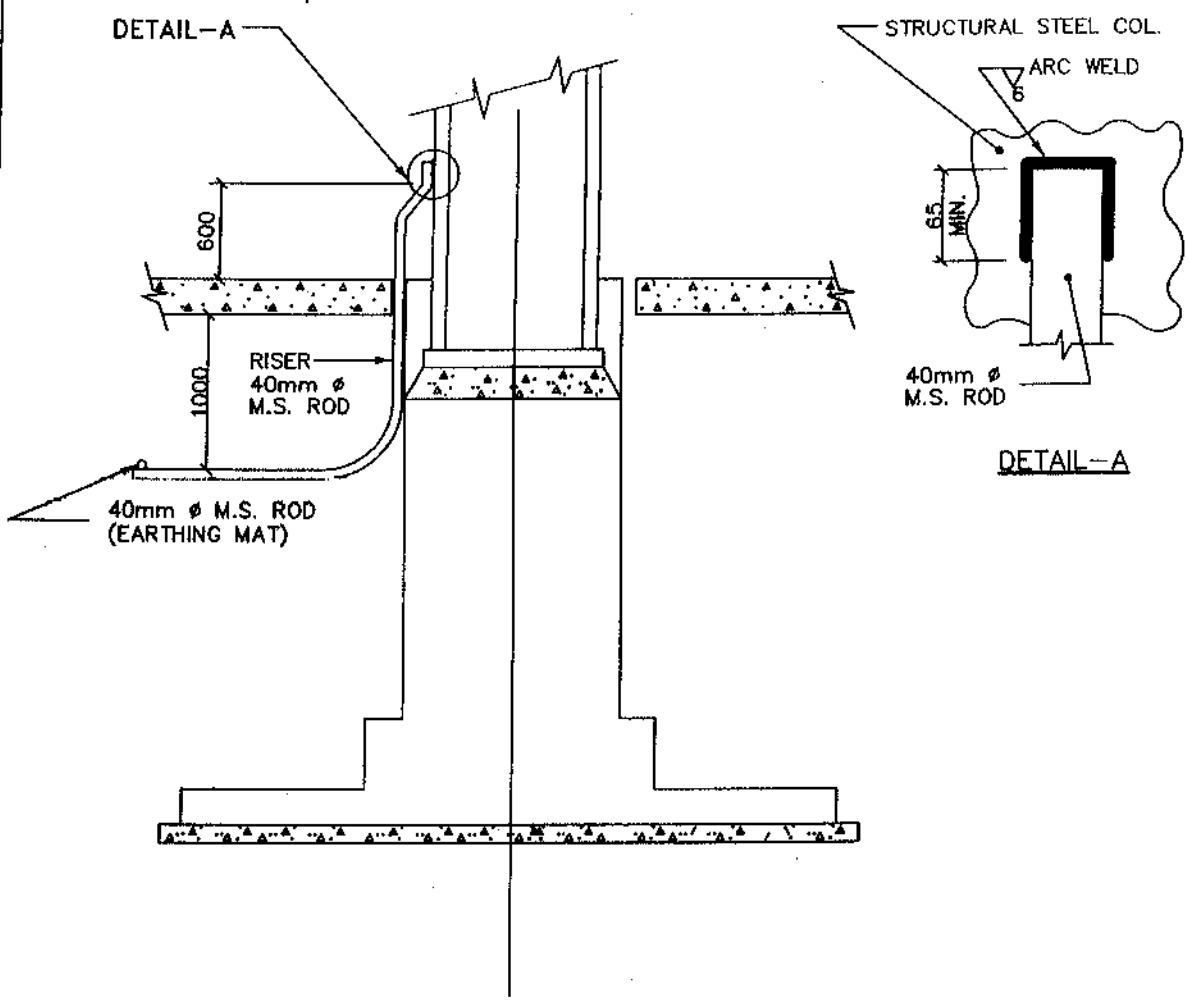
TRENCH/TUNNEL CROSSING OF EARTHING CONDUCTOR

25/3/09

FOR INFORMATION

2009.3.25

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12 SHEET 10 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE	WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0600 REV.

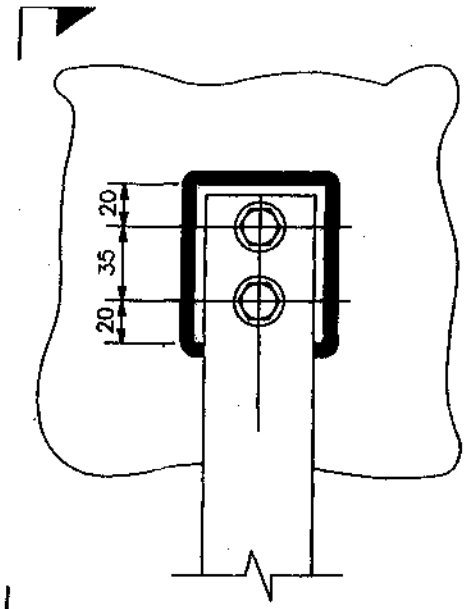


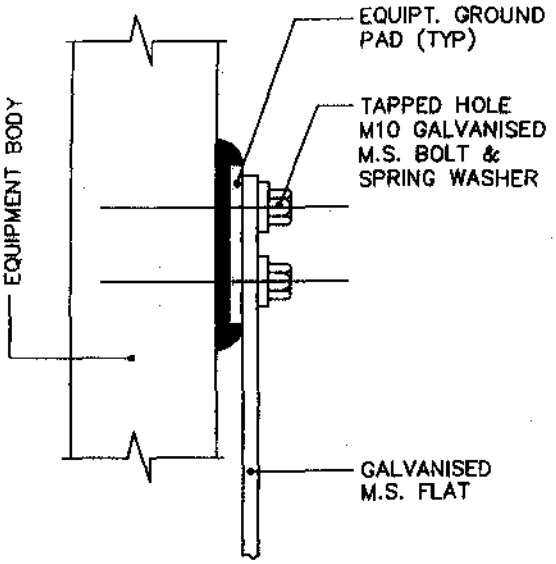
EARTHING OF STEEL COLUMN

25/2/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 11 OF 23
						DWG. NO. K7V12–000–DWG–E–0600 REV.





SECTION – (7)

TANK/VESSEL EARTHING WITH EARTH PAD

Cmy 25/2/09

FOR INFORMATION

24.2.09

APPVD.	REVWD.	CHKD.	REV.	DATE

EARTHING DETAILS

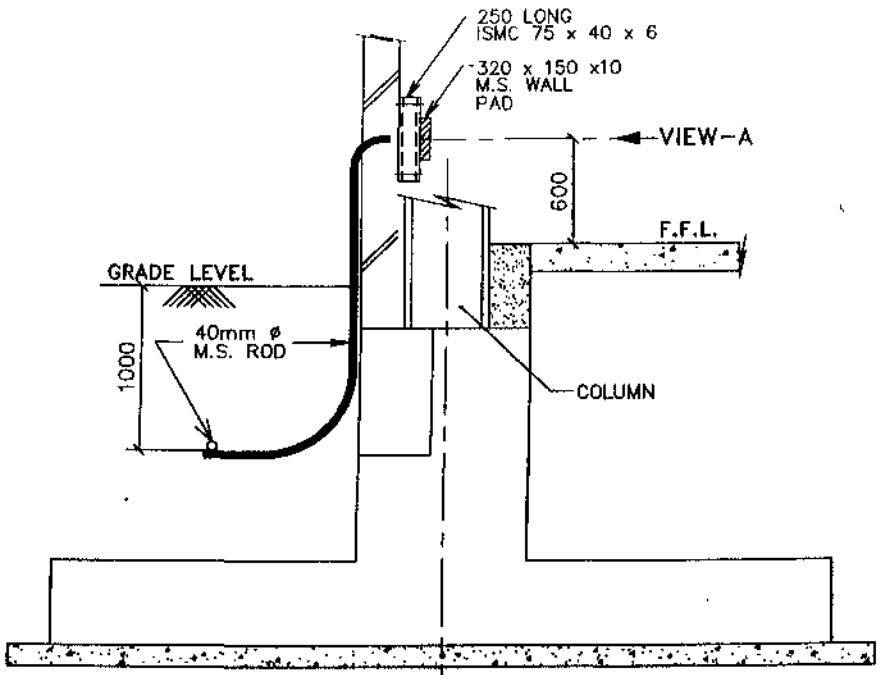
3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

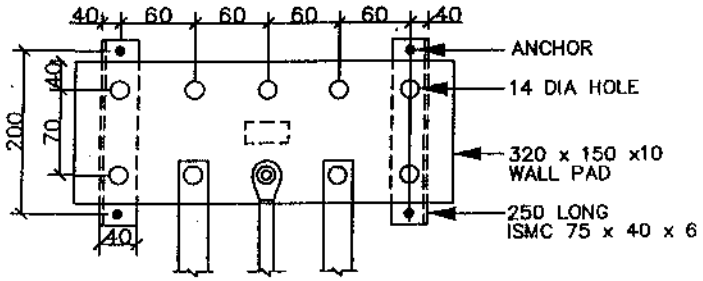
JOB NO. K7V12 | SHEET 12 OF 23

DWG. NO. K7V12-000-DWG-E-0600 | REV.

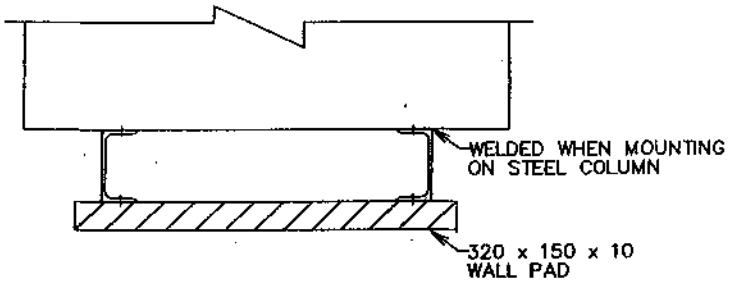
CAD FILE : K7V12-000-DWG-E-0600



GROUND PAD CONNECTION
WITH EARTH CONDUCTOR



VIEW – A

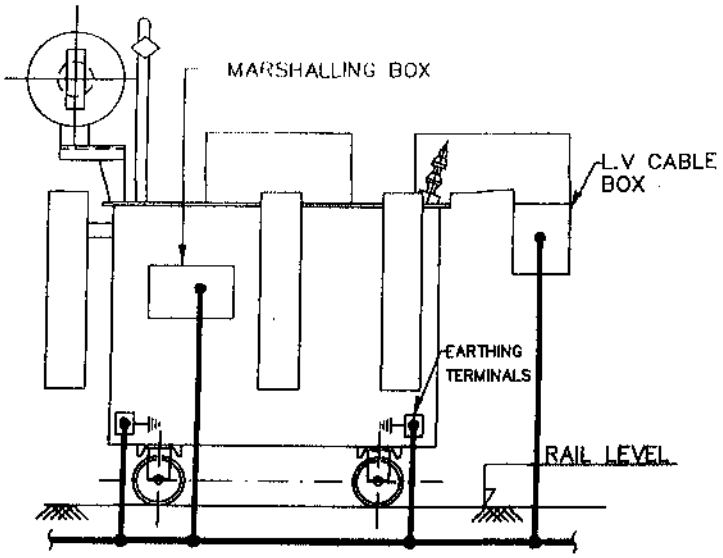


25/2/09

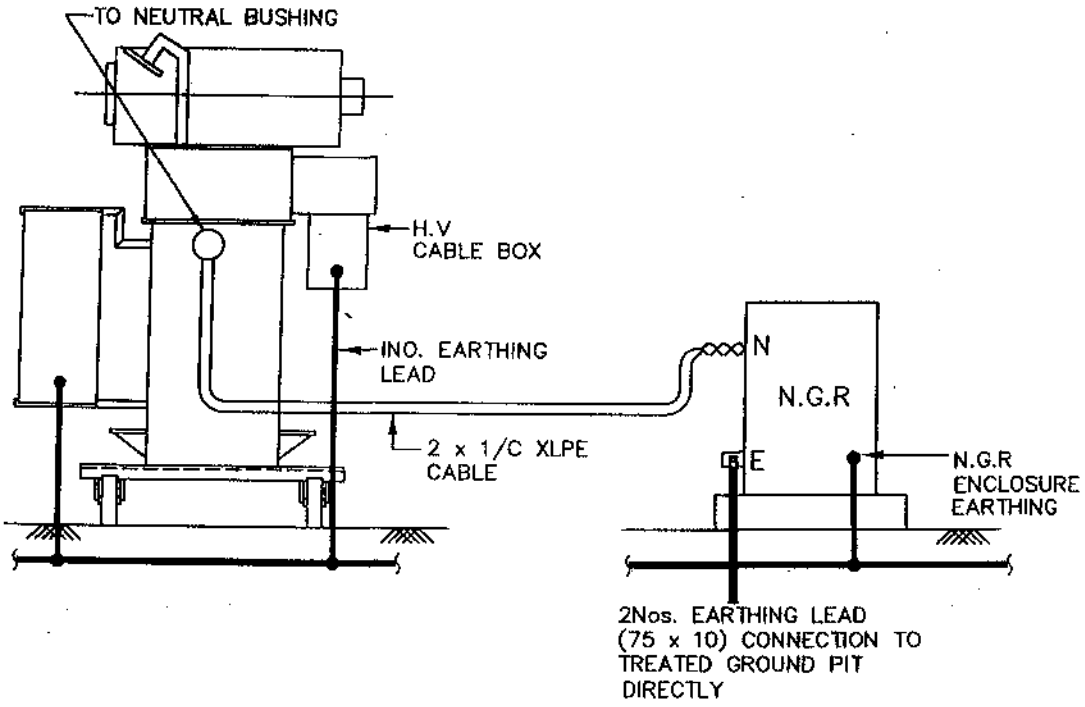
FOR INFORMATION

20.2.09

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12 SHEET 13 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE	WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0600 REV.



ELEVATION



SIDE VIEW

TRANSFORMER EARTHING WITH NEUTRAL RESISTANCE EARTHED

25/2/09 FOR INFORMATION 20.2.09

APPVD.	REVWD.	CHKD.	REV.	DATE

EARTHING DETAILS

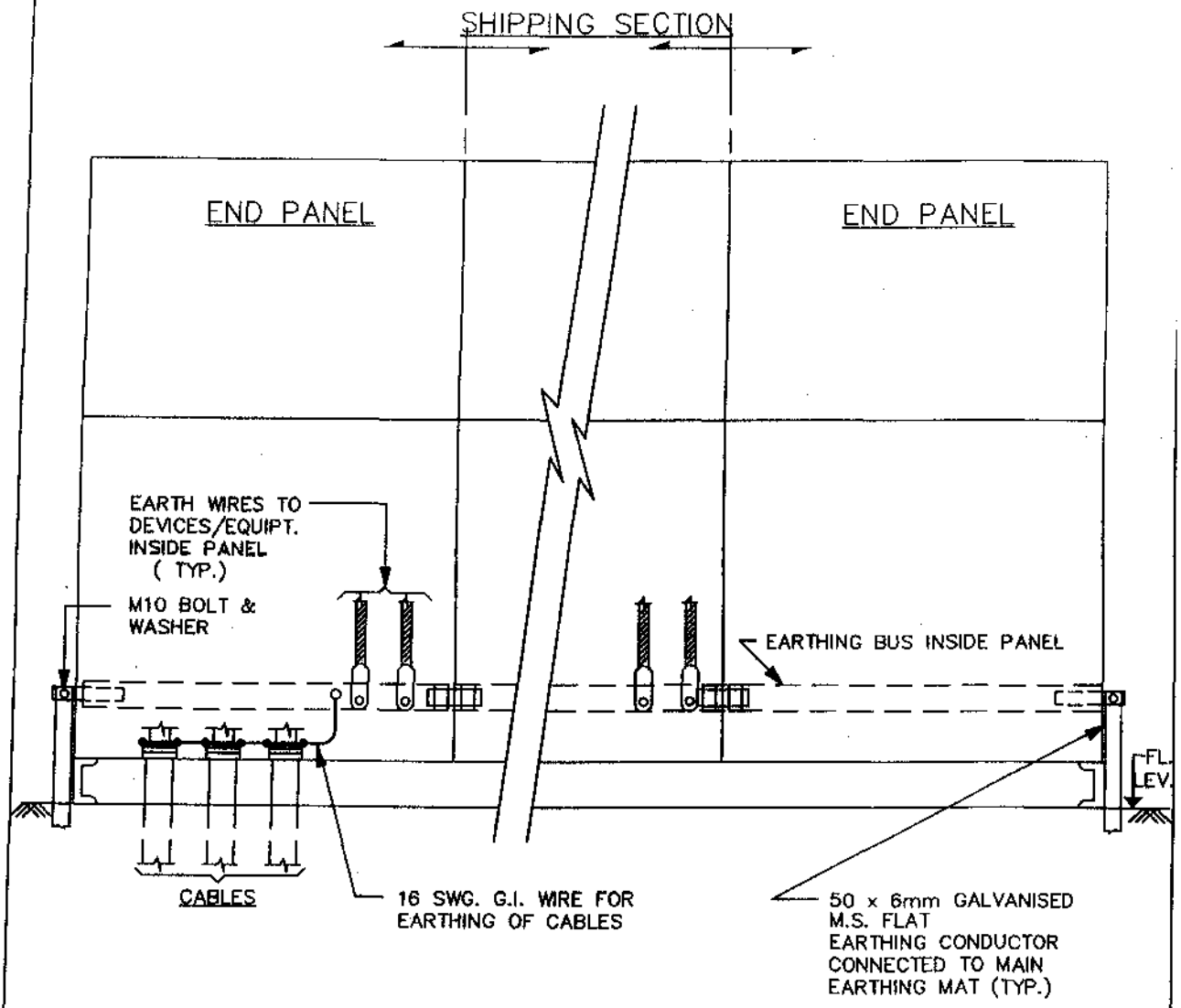
3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 14 OF 23

DWG. NO. K7V12-000-DWG-E-0600 | REV.

CAD FILE : K7V12-000-DWG-E-0600



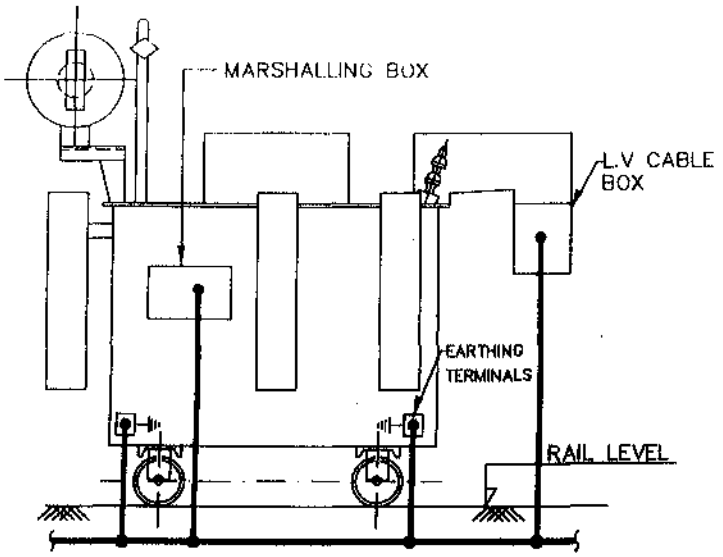
EARTHING OF MCC, SWITCHGEAR & DISTRIBUTION BOARD

25/3/09

FOR INFORMATION

20.3.09

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 15 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.



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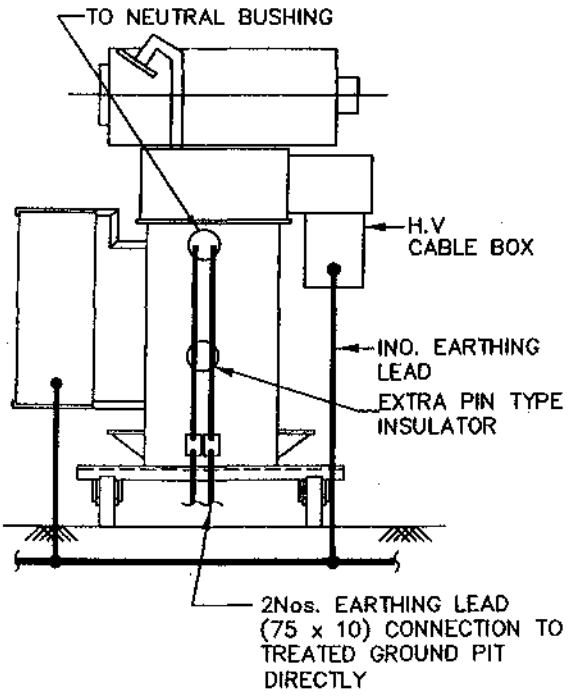
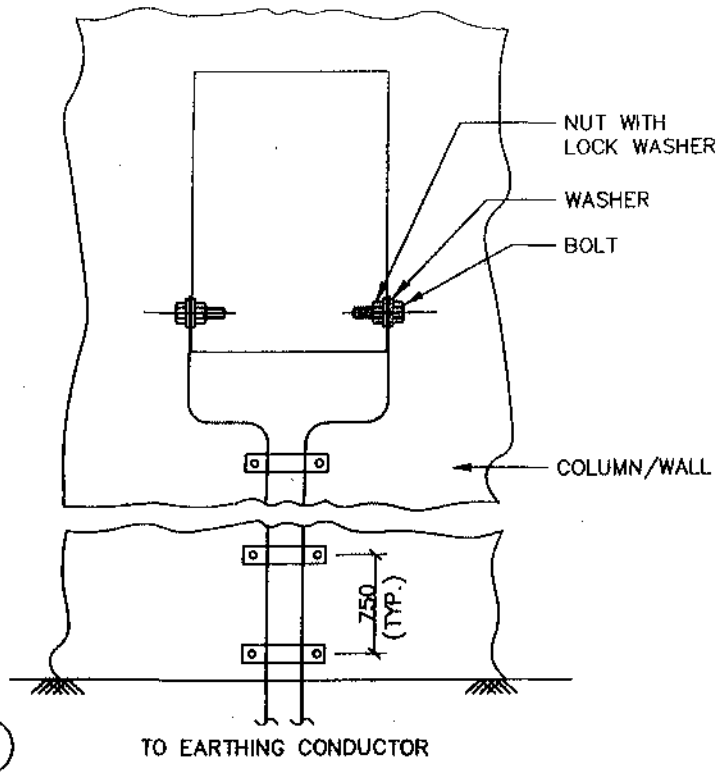


SIDE VIEW

TRANSFORMER EARTHING WITH SOLIDLY EARTHED

25/3/09 For Information 20.3.09

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 16 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.



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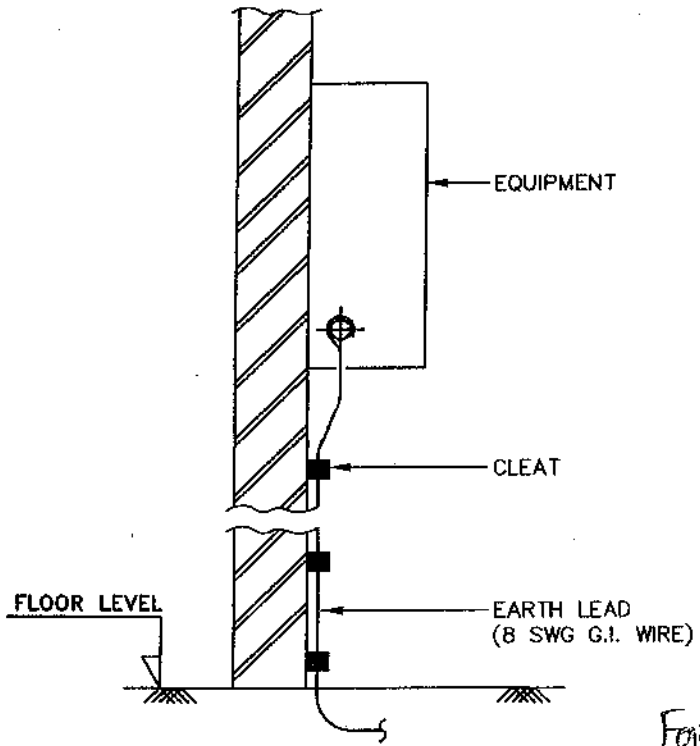


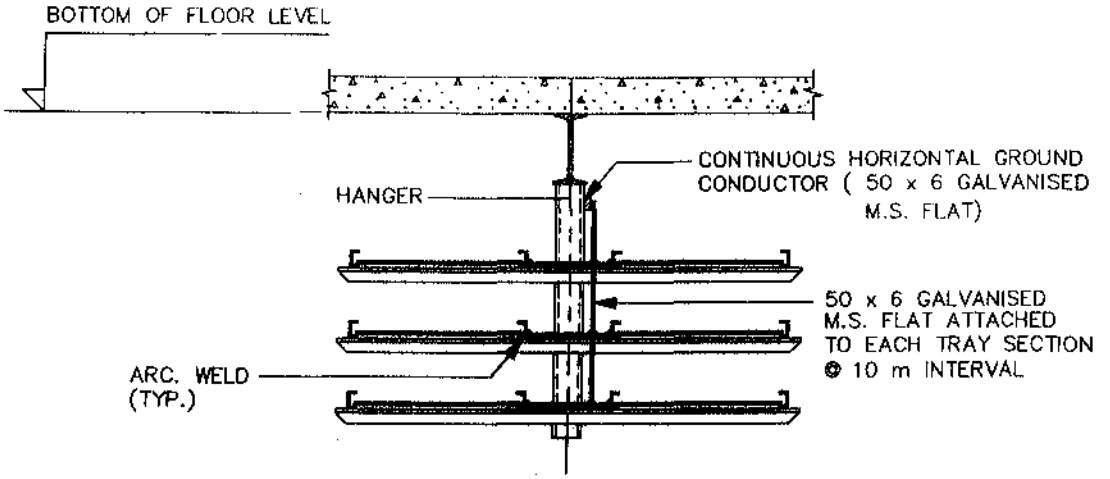
SECTION - (8) - (8)

FOR INFORMATION

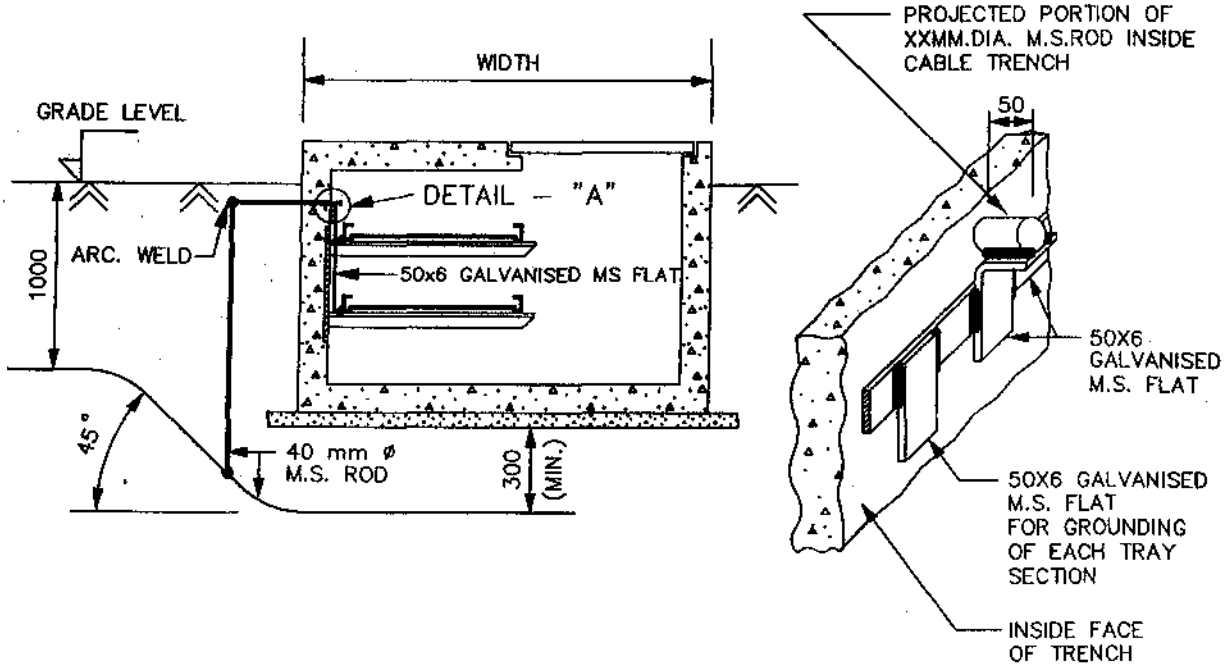
25/2/09

EARTHING OF PUSH BUTTON, LOCKOUT SWITCH & RECEPTACLE

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA - MUMBAI - CHENNAI - NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 17 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.



OVERHEAD CABLE TRAY EARTHING



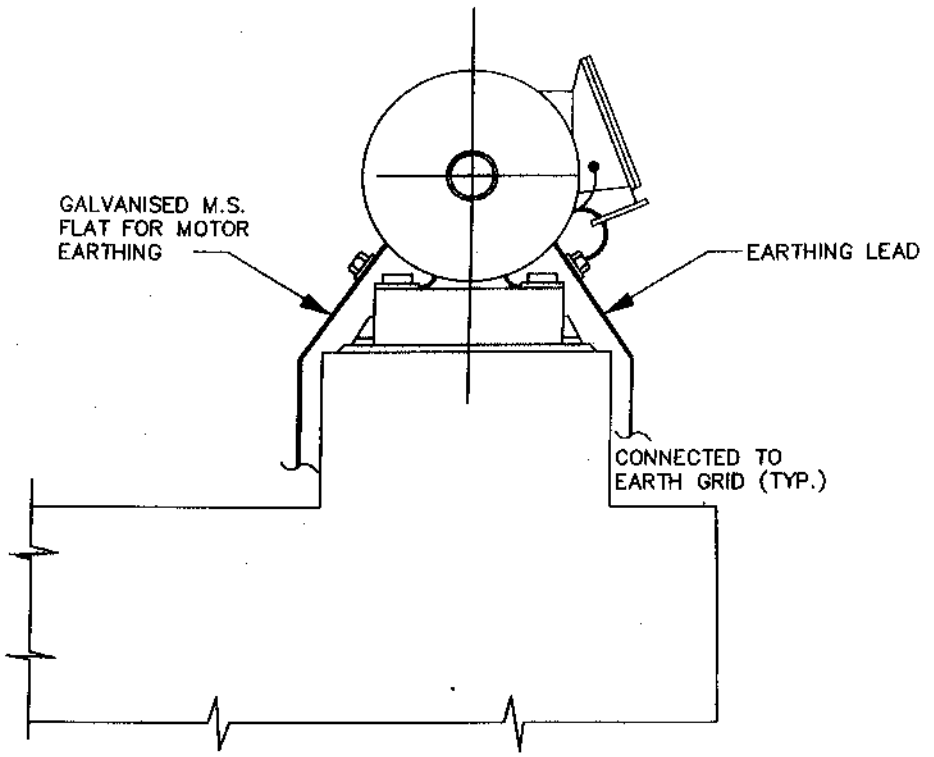
CABLE TRENCH EARTHING

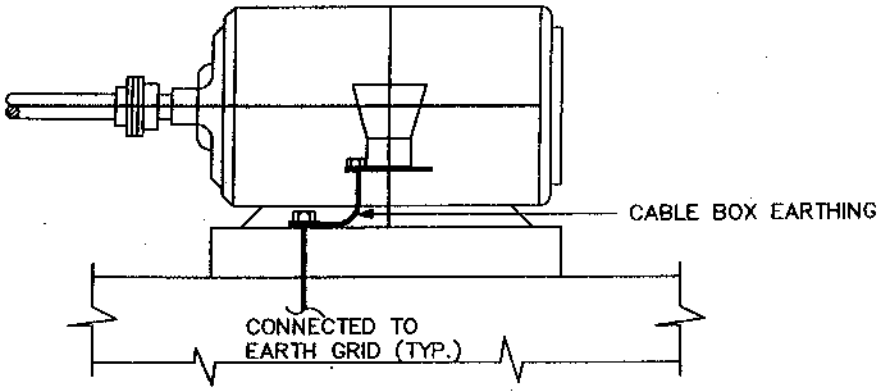
25/3/09

FOR INFORMATION

20.3.09

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 18 OF 23
						DWG. NO. K7V12-000-DWG-E-0600	REV.



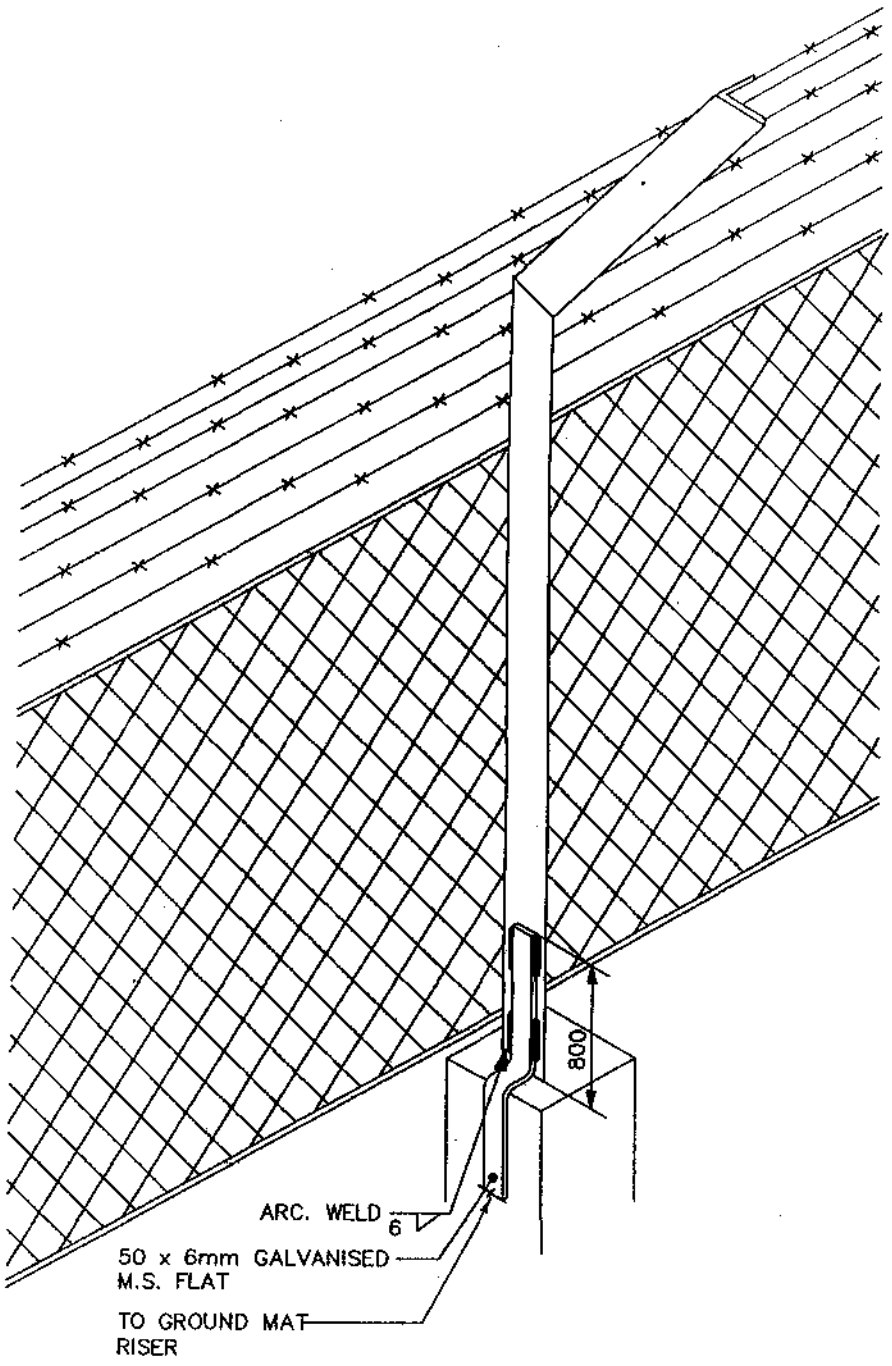


MOTOR EARTHING

25/2/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 19 OF 23
						DWG. NO. K7V12-000-DWG-E-0600	REV.



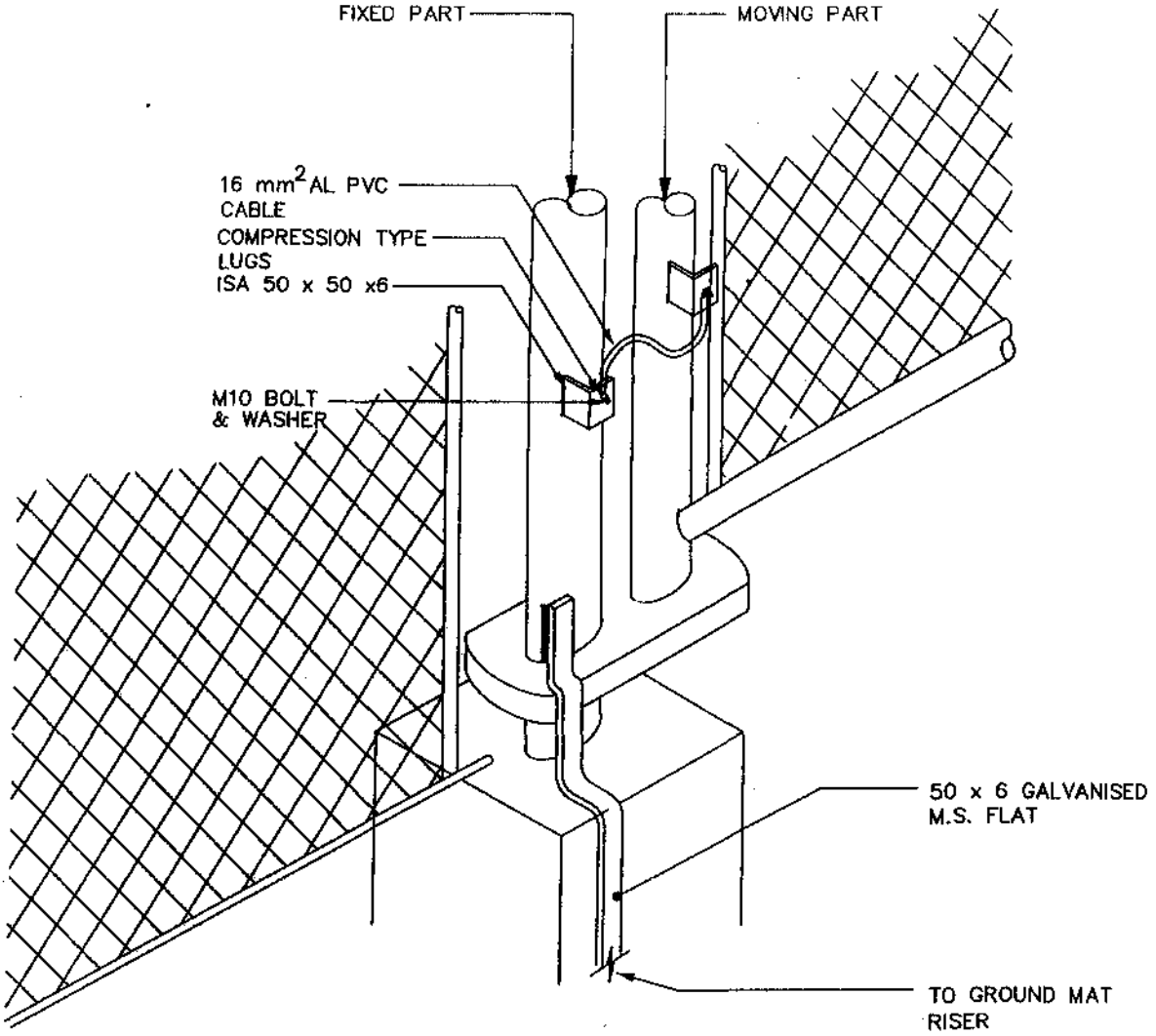
FENCE EARTHING

25/3/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 20 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.

CAD FILE : K7V12-000-DWG-E-0600



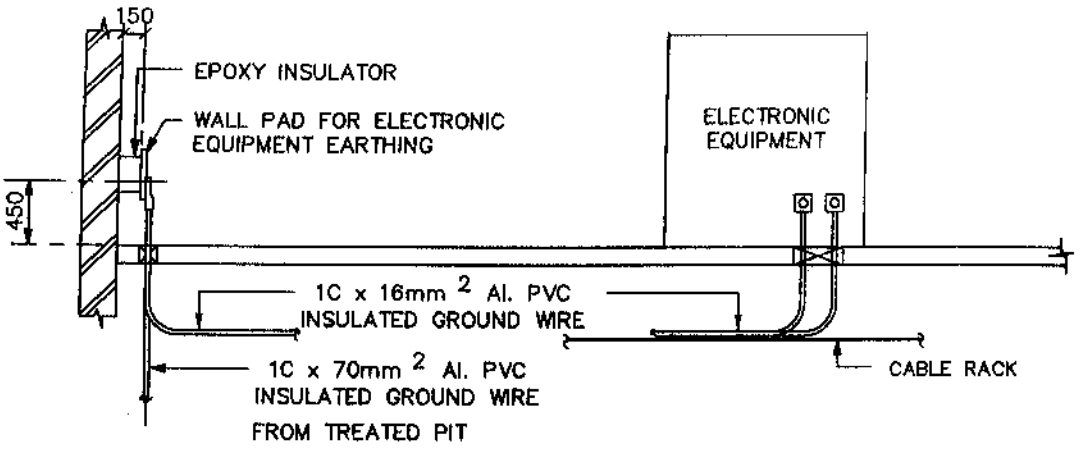
FENCE GATE EARTHING

25/3/09

FOR INFORMATION

20.9.09

APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 21 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.



NOTES :

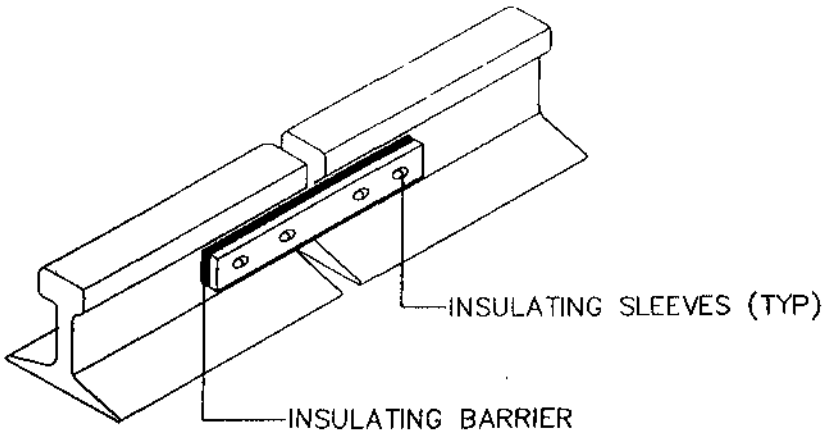
1. WALL PAD SHALL BE MOUNTED ON INSULATOR BASE AT TWO SUITABLE LOCATIONS.
2. TERMINAL PAD SHALL IN TURN BE CONNECTED BY MEANS OF 1C x 70mm. Al. PVC INSULATED CABLE TO SEPARATE TREATED GROUND PIT AS INDICATED IN LAYOUT DRAWING.

CLEAN BUS EARTHING

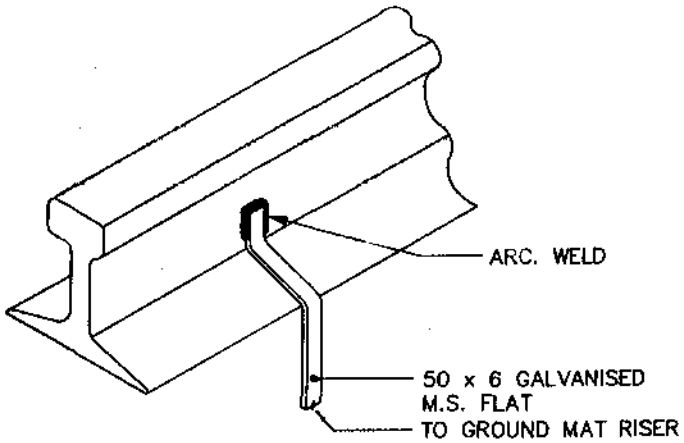
25/2/09

FOR INFORMATION

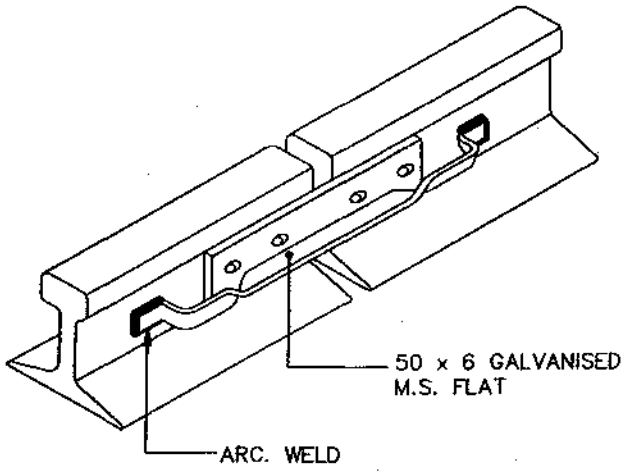
APPVD.	REVWD.	CHKD.	REV.	DATE	EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 22 OF 23
						DWG. NO. K7V12-000-DWG-E-0600 REV.



RAIL SECTIONS
LEAVING THE EARTH MAT



RAIL EARTHING



RAIL BONDING

25/3/15

FOR INFORMATION

					EARTHING DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 23 OF 23
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. K7V12-000-DWG-E-0600	REV.

REVISION INDEX SHEET

FOR

ILLUMINATION DETAILS

REV.	DATE	REVISION	BY	APP'D	REV.	DATE	REVISION	BY	APP'D

SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.	SHEET NO.	REV. NO.
1	–	11	–						
2	–	12	–						
3	–	13	–						
4	–	14	–						
5	–	15	–						
6	–	16	–						
7	–	17	–						
8	–	18	–						
9	–	19	–						
10	–	20	–						

25/7/09

FOR INFORMATION

7.7.09

APPVD.	REVWD.	CHKD.	REV.	DATE

ILLUMINATION DETAILS

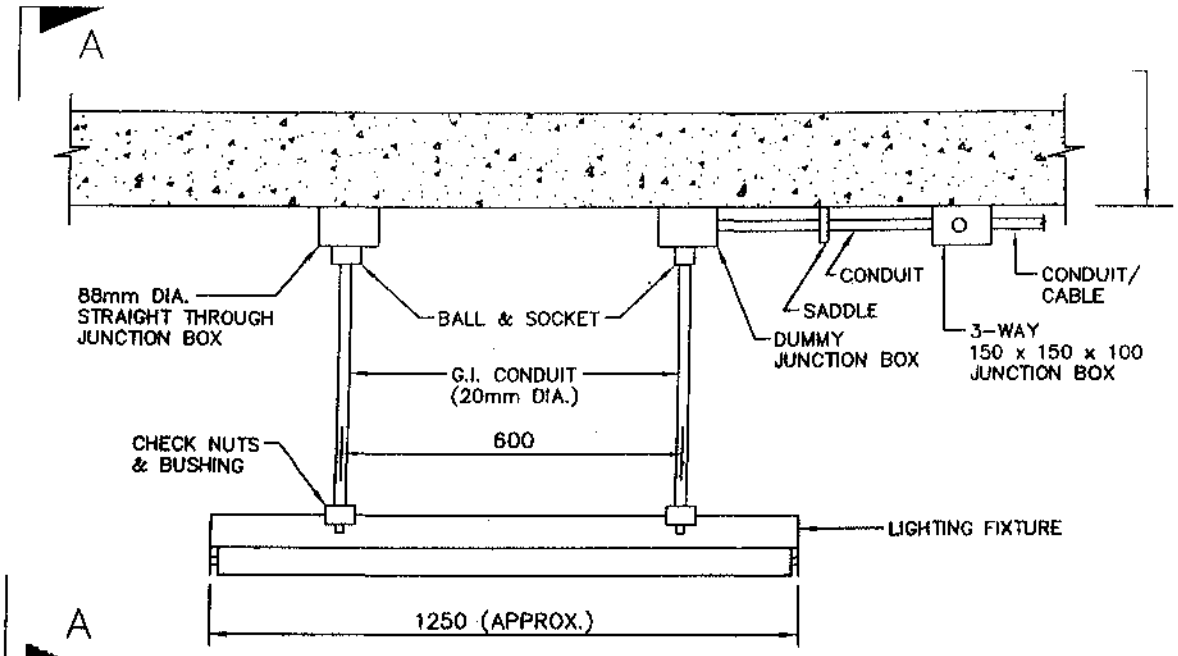
3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

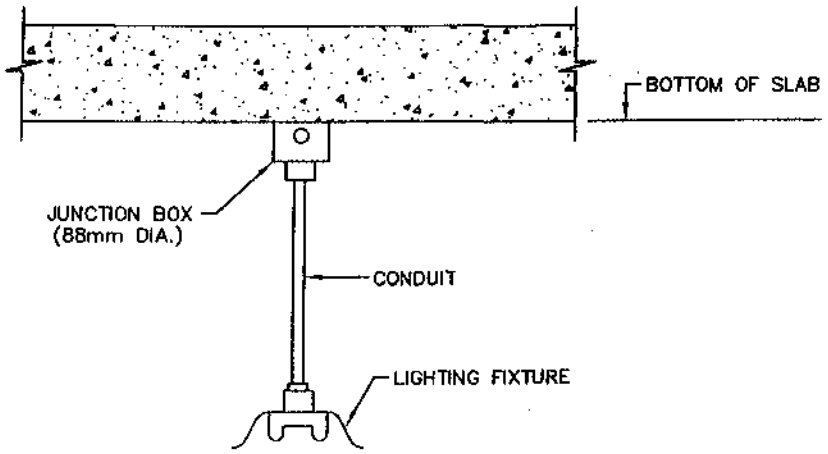
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 1 OF 20

DWG. NO. K7V12-000-DWG-E-0800 | REV. –

A4 (SHT. SIZE 210 x 297)





VIEW : A-A

CEILING MOUNTED LUMINAIRE WITH SURFACE CONDUIT CABLE WIRING WITH DOWN ROD

MOUNTING TYPE-1

25/3/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 2 OF 20
						DWG. NO. K7V12-000-DWG-E-0800	REV. –

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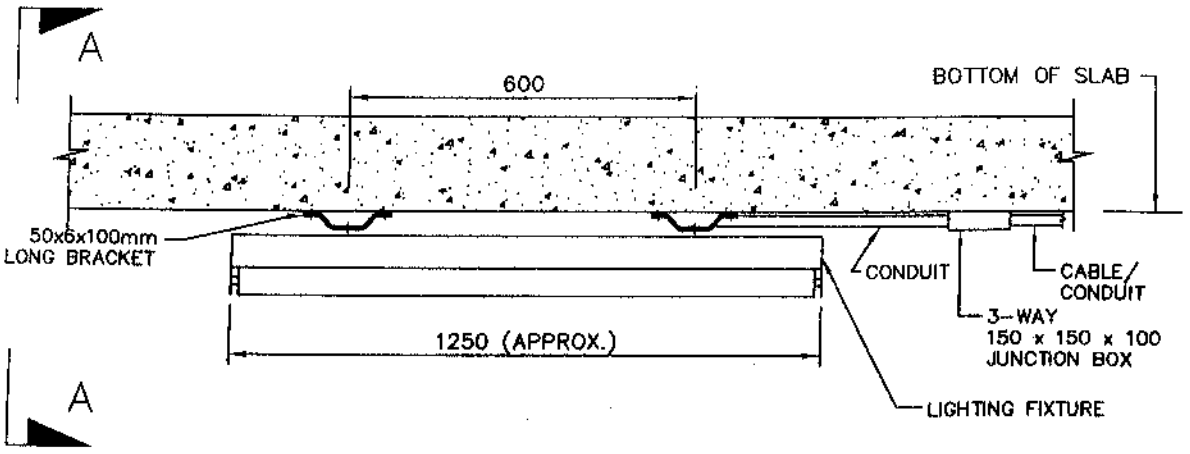

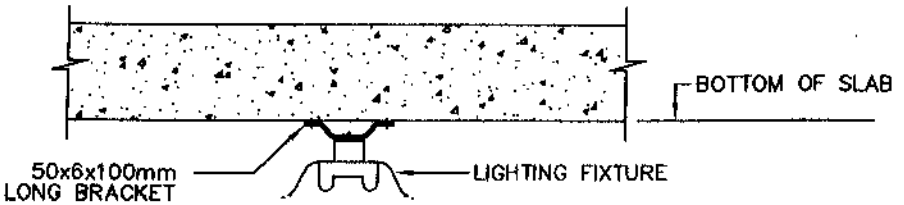

VIEW : A-A

CEILING MOUNTED LUMINAIRE
WITHOUT DOWN ROD

MOUNTING TYPE-2

25/3/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 3 OF 20
						DWG. NO. K7V12-000-DWG-E-0800 REV. _

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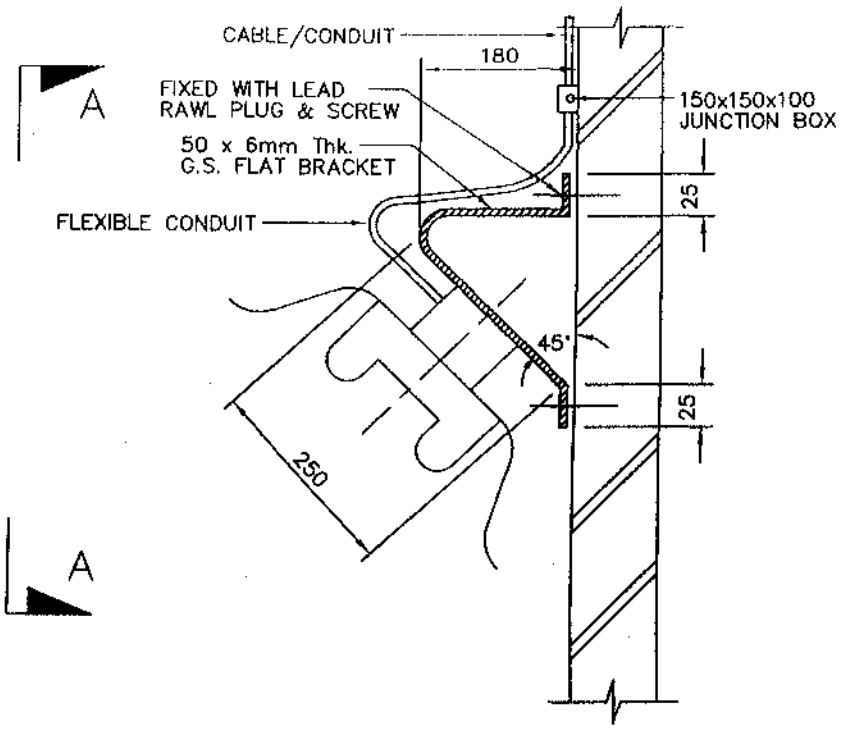

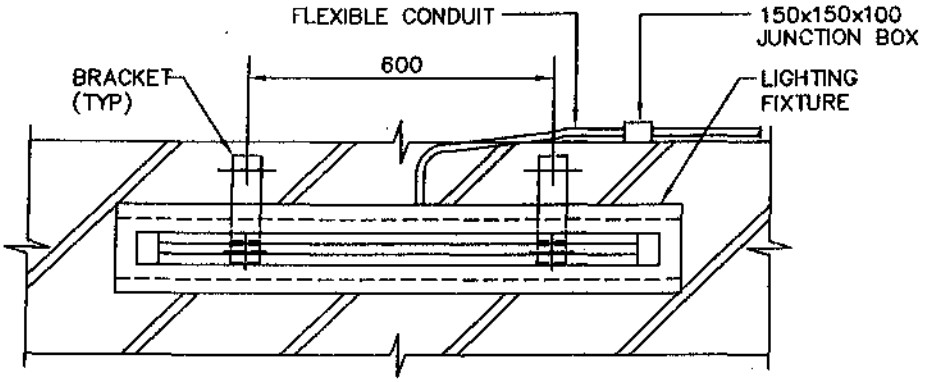

VIEW : A–A

LUMINAIRE SUPPORTED FROM WALL

MOUNTING TYPE–3

25/3/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 4 OF 20
						DWG. NO. K7V12–000–DWG–E–0800	REV. –

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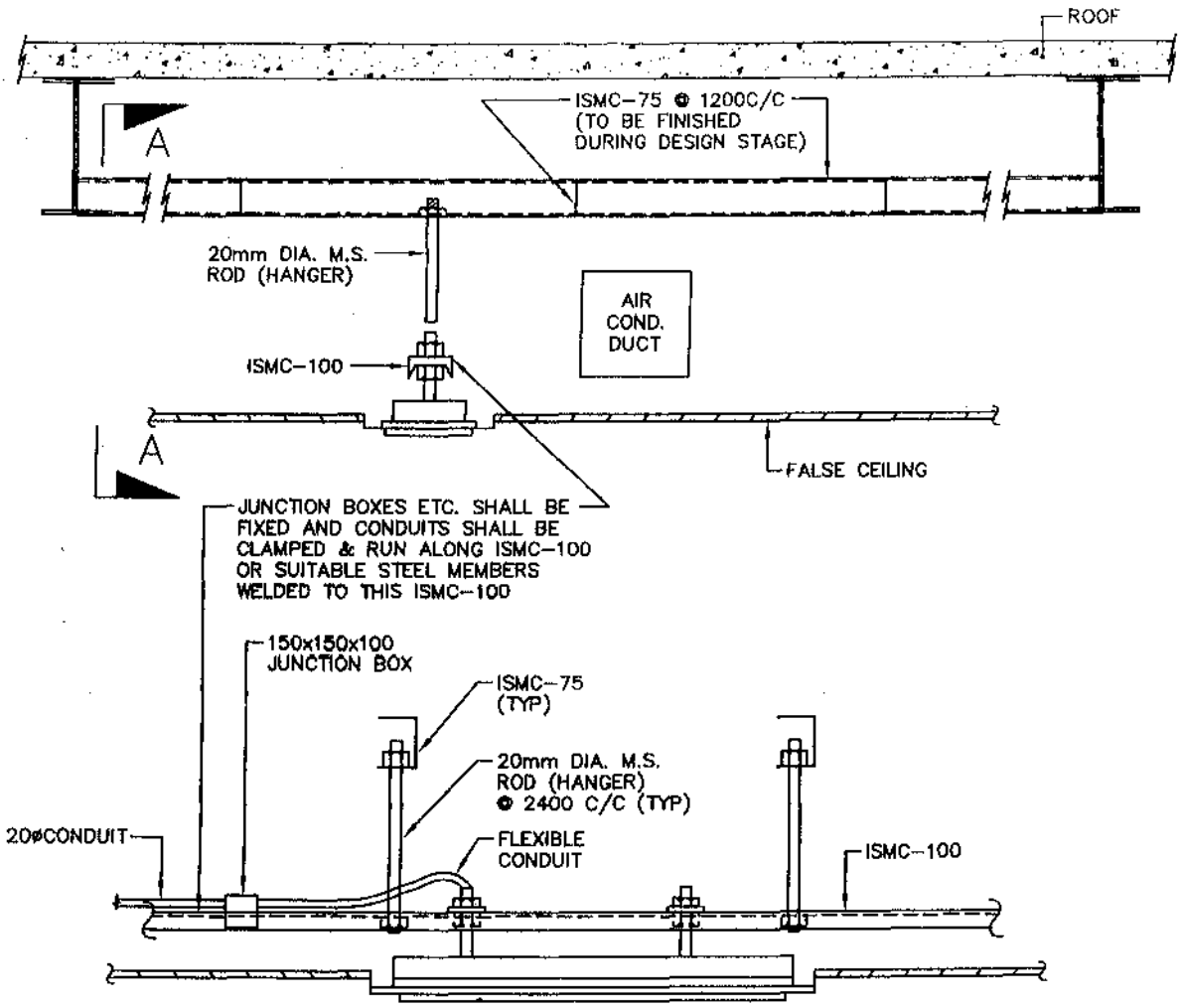

VIEW : A-A

RECESS TYPE FLUORESCENT LUMINAIRE
MOUNTED IN FALSE CEILING

MOUNTING TYPE-4

25/2/09

FOR INFORMATION

					ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12 SHEET 5 OF 20
APPVD.	REVWD.	CHKD.	REV.	DATE	WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0800 REV. _

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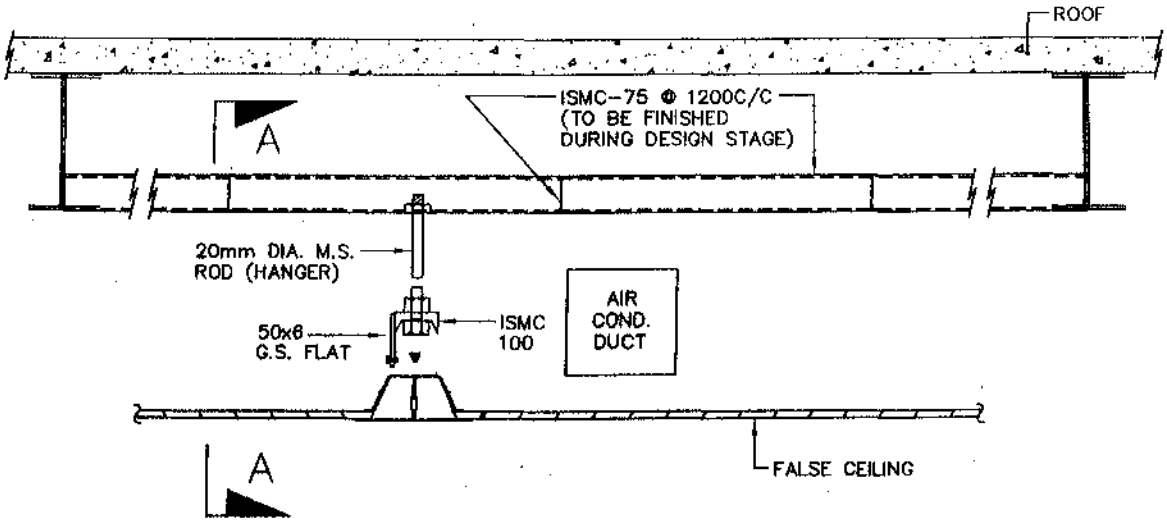
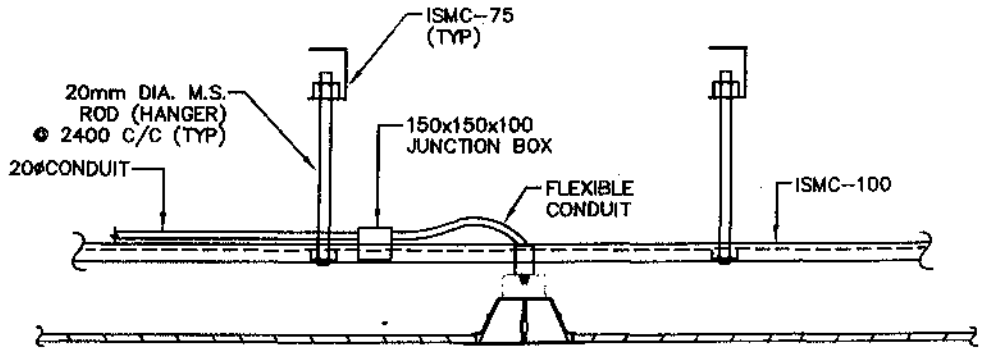




VIEW : A-A

RECESS TYPE GLS LUMINAIRE
MOUNTED IN FALSE CEILING

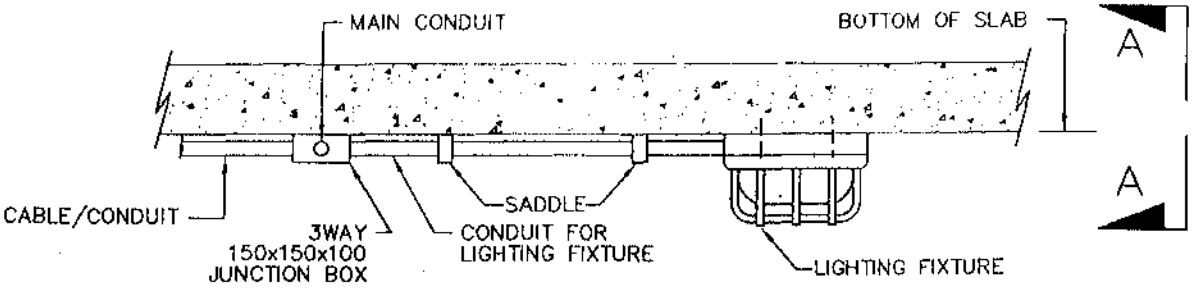
MOUNTING TYPE-5

25/3/09

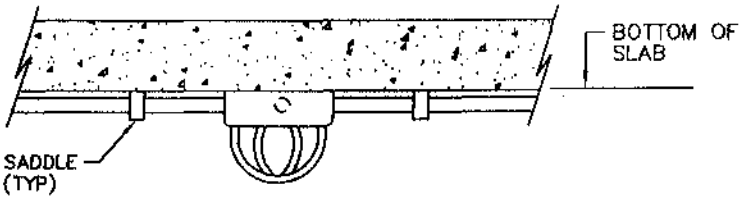
FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 6 OF 20
						DWG. NO. K7V12-000-DWG-E-0800	REV. _

A4 (SHT. SIZE 210 x 297)



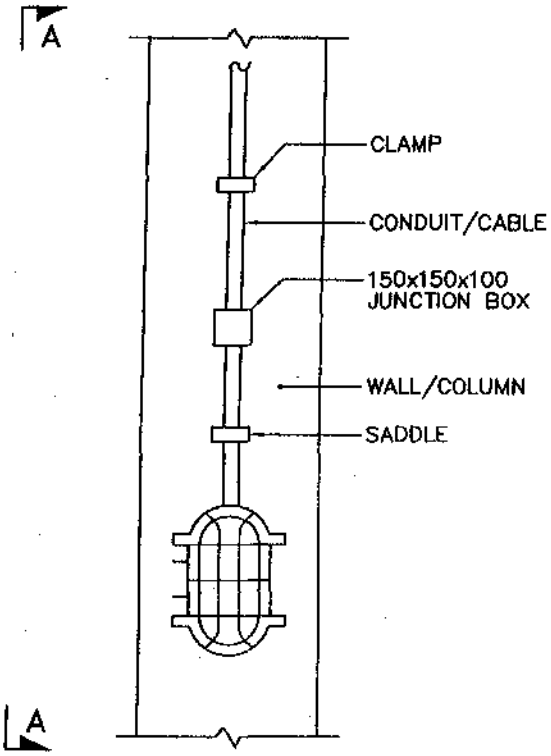
CEILING MOUNTED



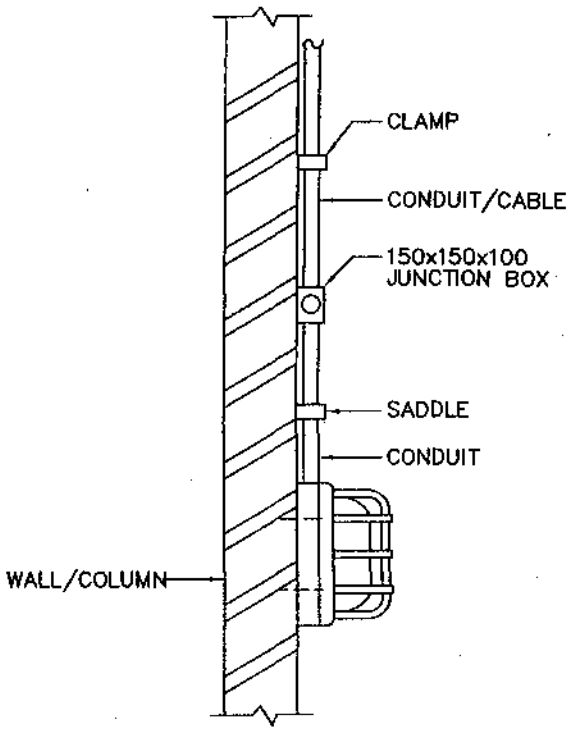
VIEW : A-A

CEILING MOUNTED BULKHEAD
LUMINAIRE WITHOUT DOWN ROD

MOUNTING TYPE-6



WALL/COLUMN MOUNTING



VIEW : A-A

WALL/COLUMN MOUNTED
BULKHEAD LUMINAIRE

MOUNTING TYPE-7

FOR INFORMATION

25/3/09

					ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 7 OF 20
APPVD.	REVWD.	CHKD.	REV.	DATE		DWG. NO. K7V12-000-DWG-E-0800 REV. –

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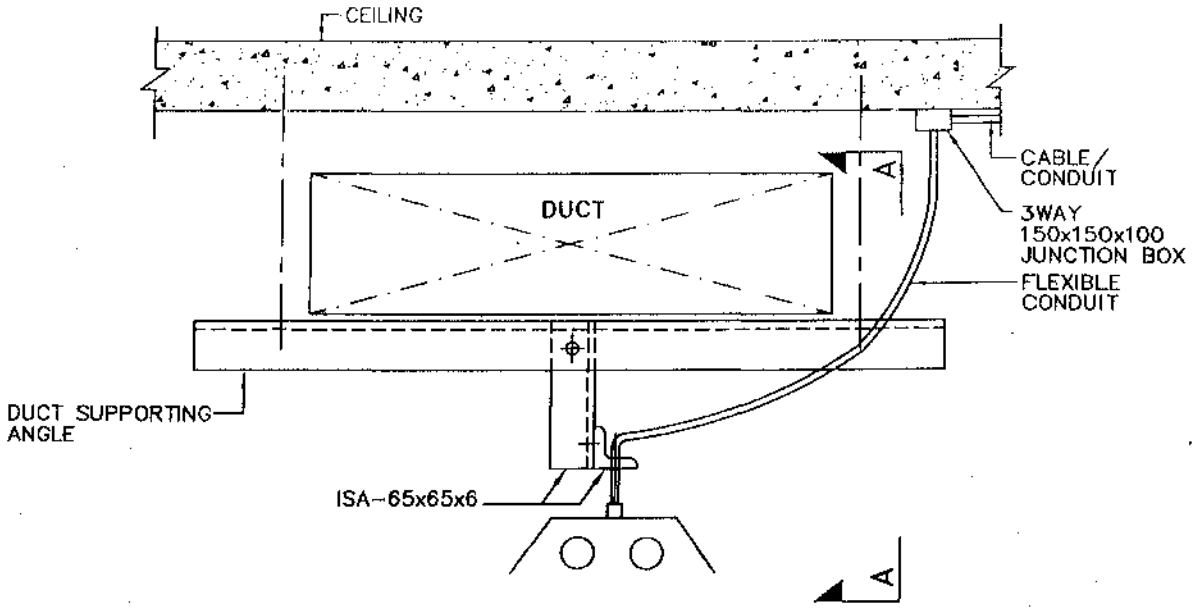
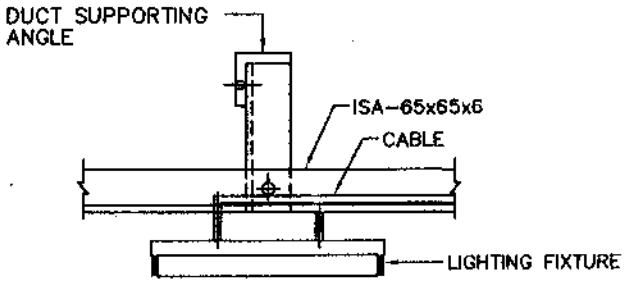
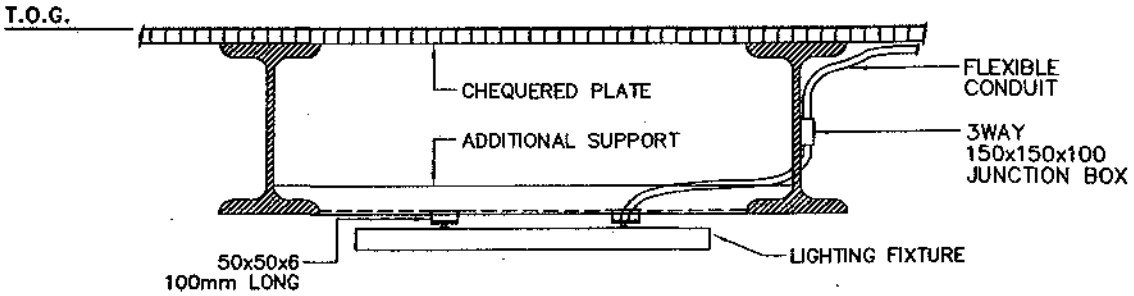




SECTION A-A
LUMINAIRE SUPPORT FROM VENTILATION DUCT
MOUNTING TYPE-8



LUMINAIRE MOUNTED FROM STRUCTURAL STEEL
MOUNTING TYPE-9

FOR INFORMATION

25/2/09

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 8 OF 20
						DWG. NO. K7V12-000-DWG-E-0800 REV. _

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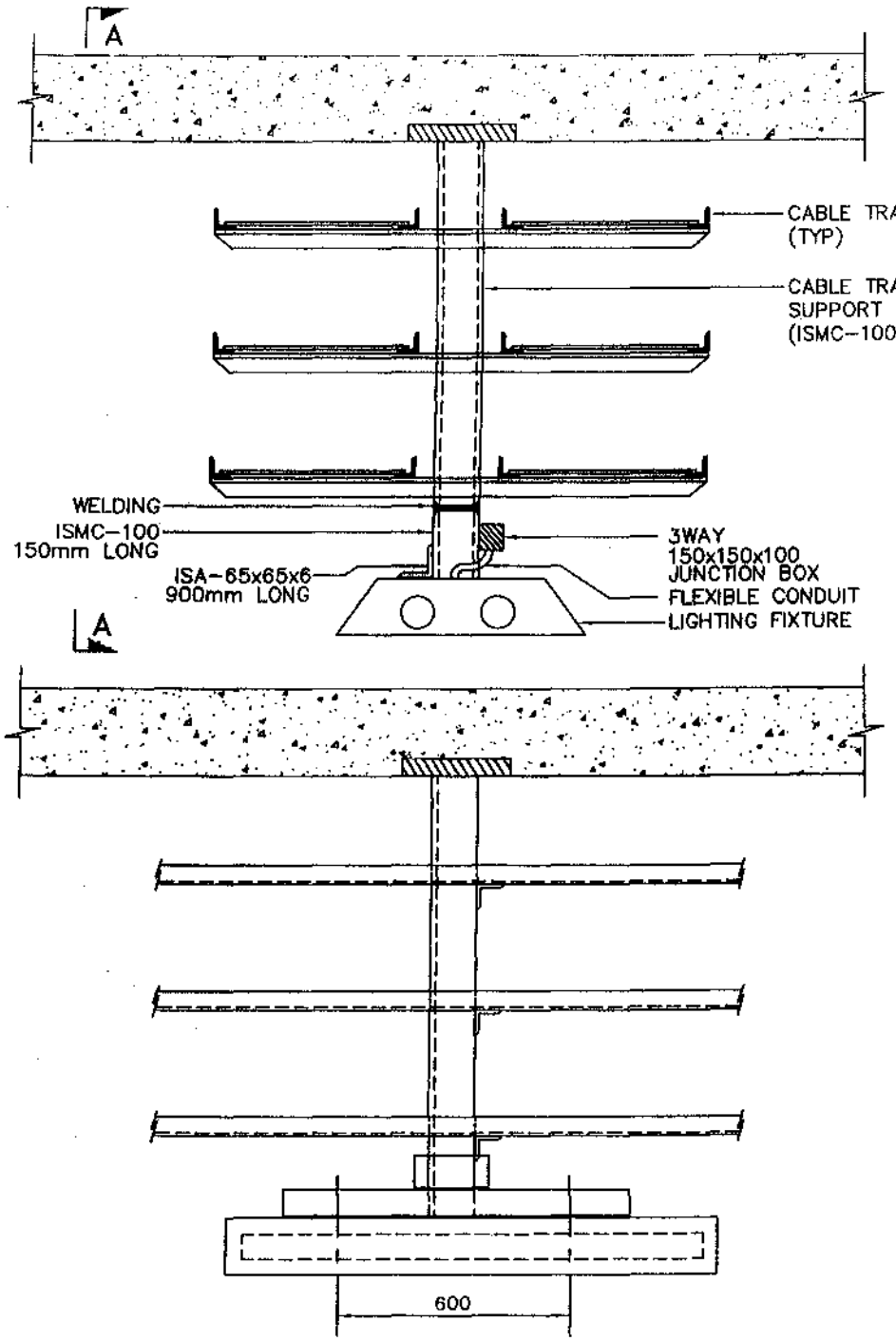

VIEW : A-A

LUMINAIRE SUPPORT FROM
CABLE TRAY SUPPORT

MOUNTING TYPE-10

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 9 OF 20
						DWG. NO. K7V12-000-DWG-E-0800	REV. _

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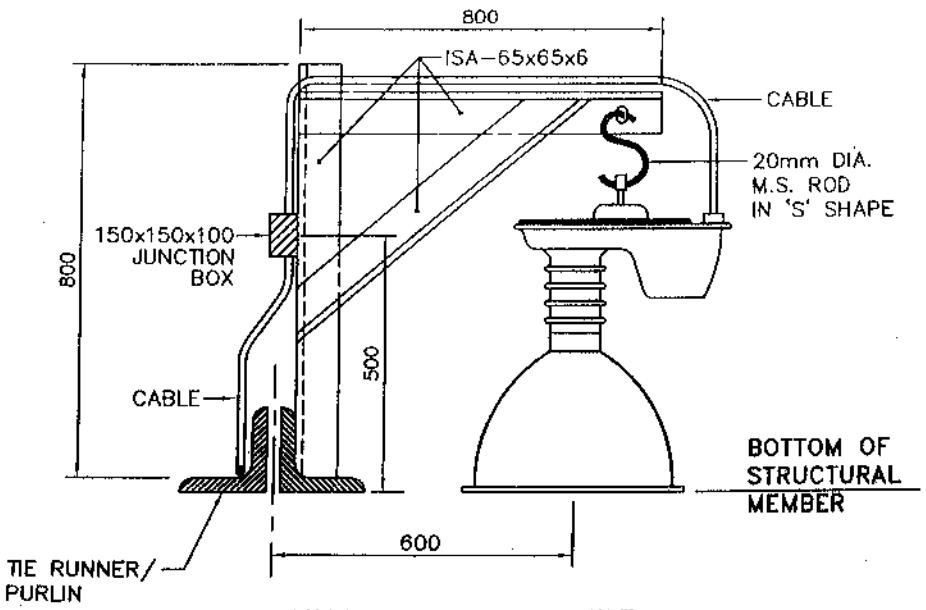
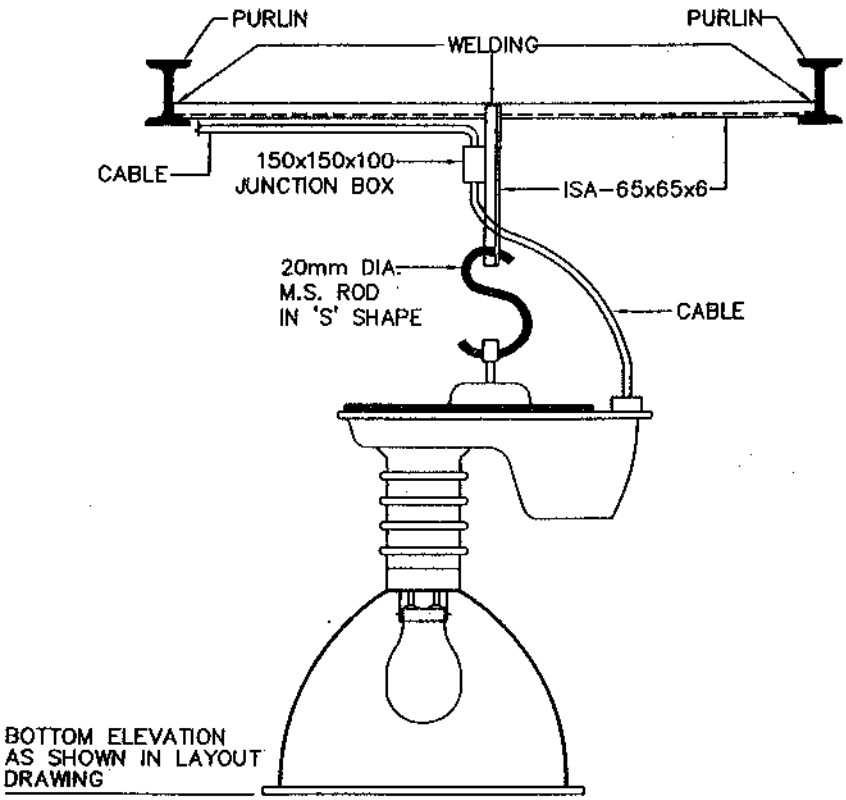


HIGH BAY LUMINAIRE
SUPPORT FROM STEEL TRUSS
MOUNTING TYPE-11



HIGH BAY LUMINAIRE
MOUNTED FROM PURLINS
MOUNTING TYPE-12

FOR INFORMATION

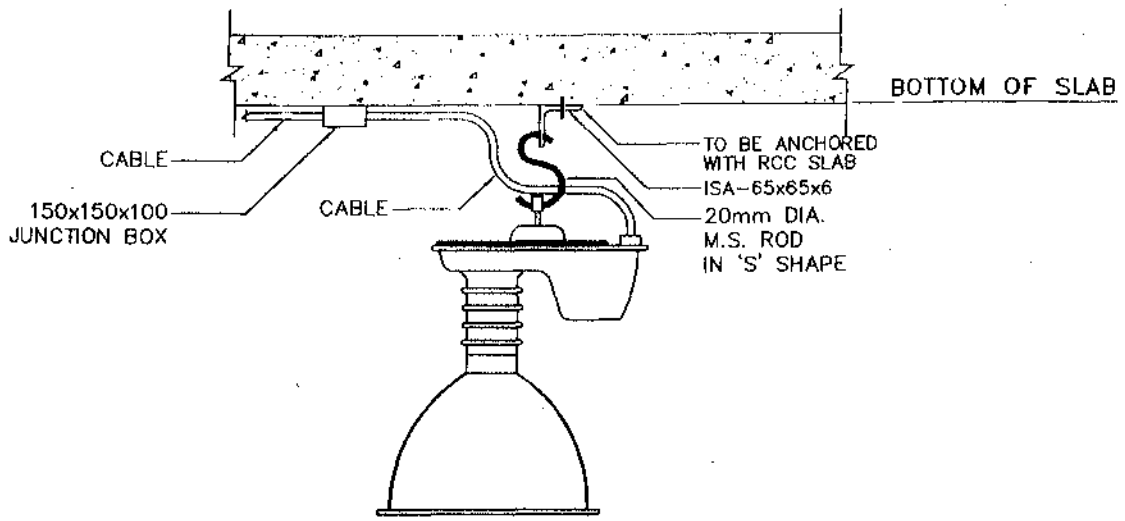
25/2/09

20.02.09

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 10 OF 20
						DWG. NO. K7V12-000-DWG-E-0800 REV. _

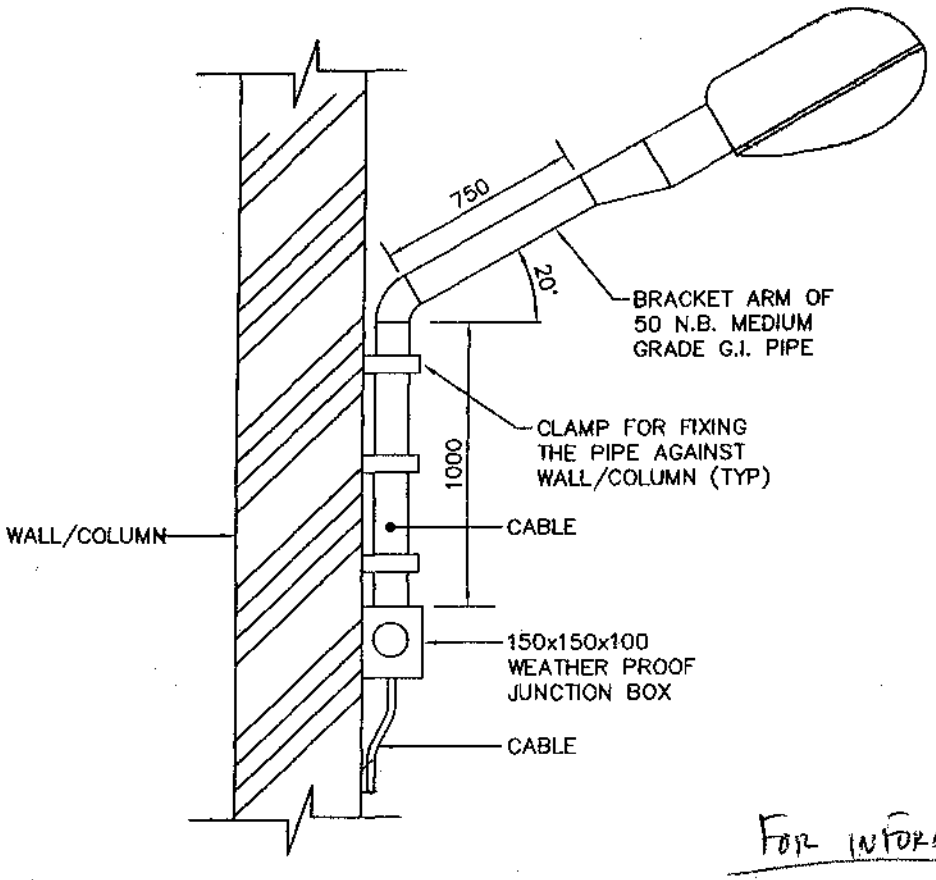
A4 (SHT. SIZE 210 x 297)

CAD FILE : K7V12-000-DWG-E-0800 NIRANJAN /09.03.09



MEDIUM BAY LUMINAIRE MOUNTED FROM CEILING

MOUNTING TYPE-13



FOR INFORMATION

25/3/09

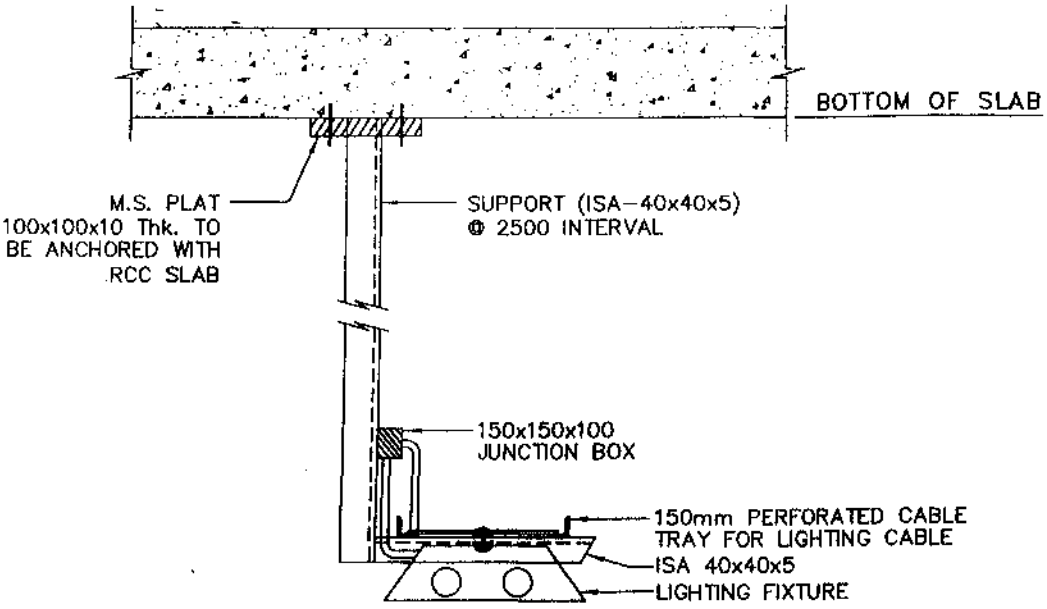
AREA LIGHTING FIXTURE MOUNTED FROM WALL/COLUMN

MOUNTING TYPE-14

2009.3.25

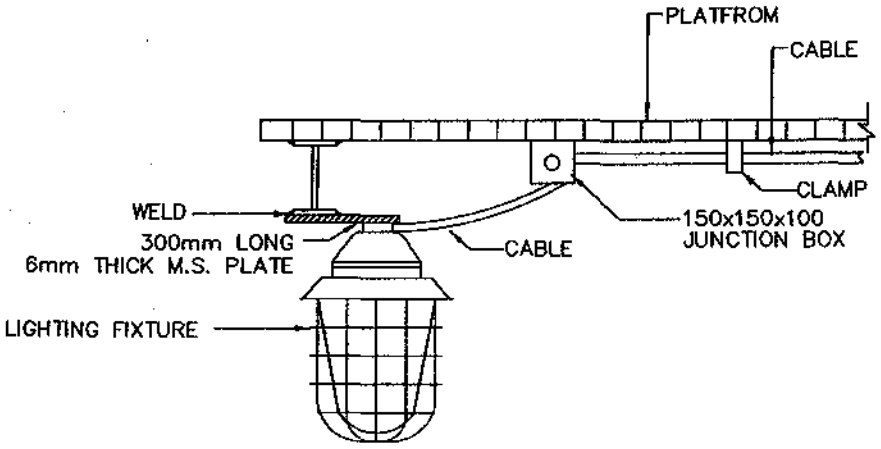
A4 (SHT. SIZE 210 x 297)

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12	SHEET 11 OF 20
						DWG. NO. K7V12-000-DWG-E-0800	REV. _



LUMINAIRE SUPPORT FOR SWGR/MCC ROOM

MOUNTING TYPE-15



WELL GLASS LUMINAIRE BELOW PLATFROM MOUNTED

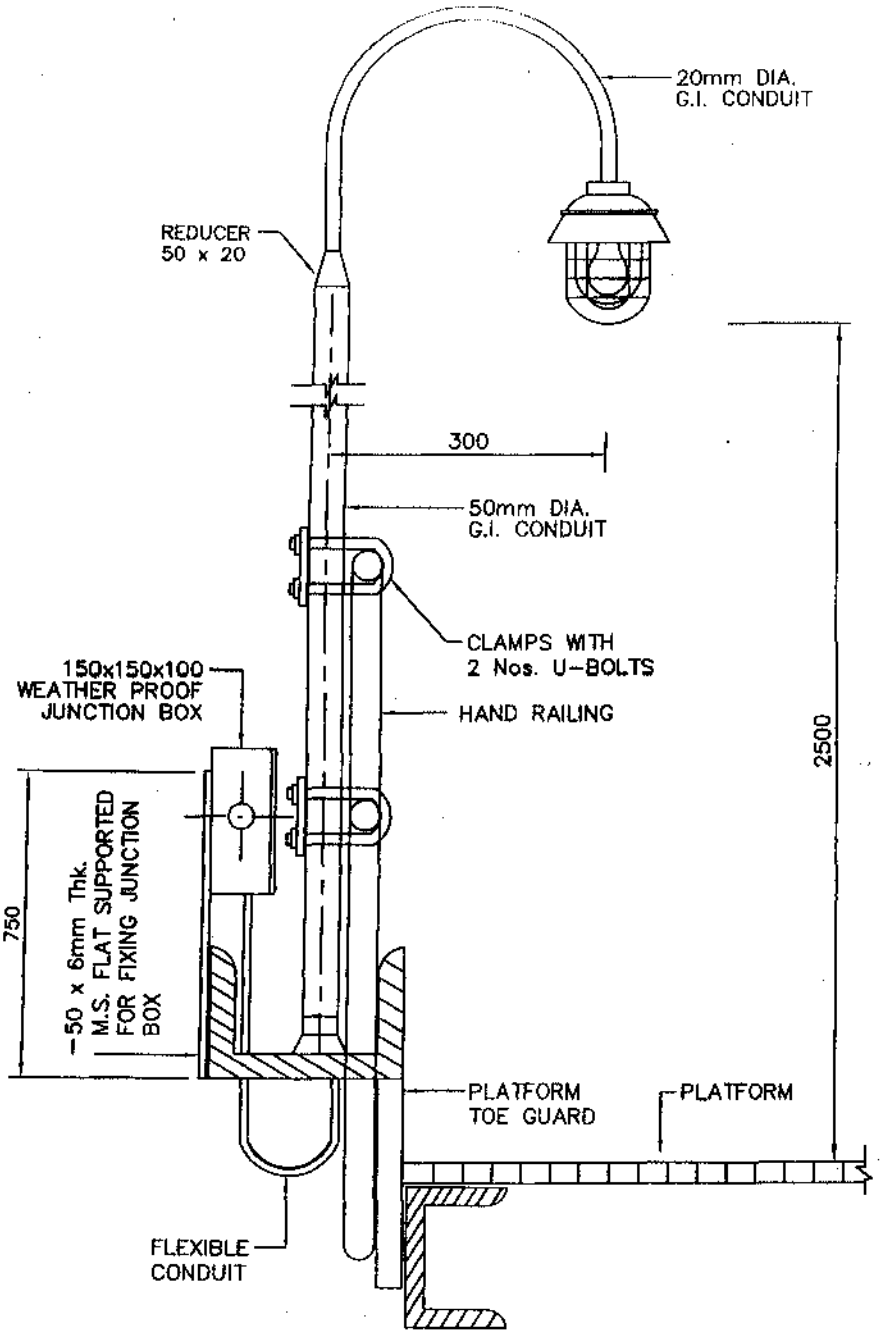
MOUNTING TYPE-16

Chy 25/3/09

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI	
					3600 MW COAL BASED POWER PROJECT	JOB NO. K7V12	SHEET 12 OF 20
					WARDHA POWER COMPANY PVT. LTD.	DWG. NO. K7V12-000-DWG-E-0800	REV. –

A4 (SHT. SIZE 210 x 297)



NOTE :- CONTROL GEAR BOX SHALL BE FIXED BY THE SIDE OF JUNCTION BOX.

FIXING ARRANGEMENT WITH HAND RAIL ON PLATFORM

MOUNTING TYPE-17

FOR INFORMATION

25/3/09

2009.3.25

APPVD.	REVWD.	CHKD.	REV.	DATE

ILLUMINATION DETAILS

3600 MW COAL BASED POWER PROJECT
WARDHA POWER COMPANY PVT. LTD.

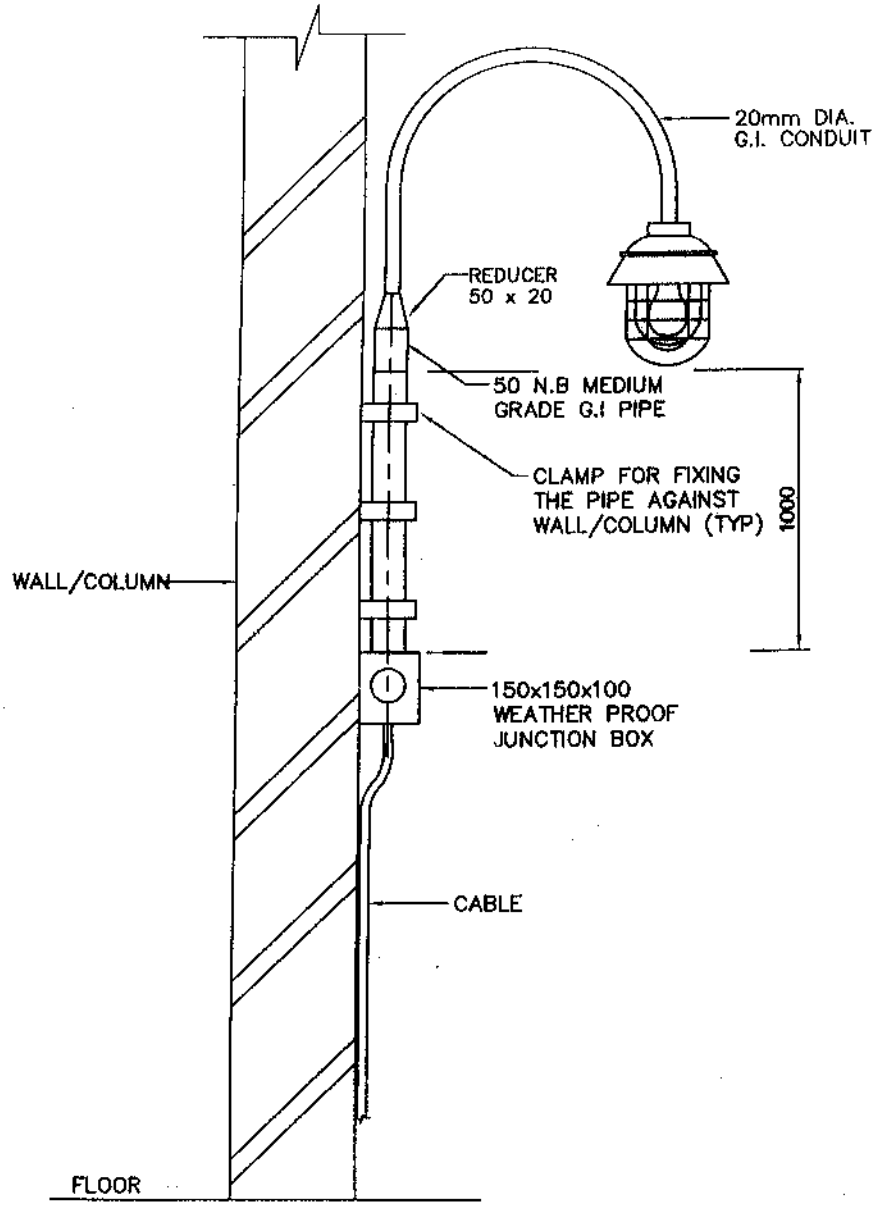
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA – MUMBAI – CHENNAI – NEW DELHI

JOB NO. K7V12 | SHEET 13 OF 20

DWG. NO. K7V12-000-DWG-E-0800 | REV. _

CAD FILE : K7V12-000-DWG-E-0800 NIRANJAN/08.03.08

A4 (SHT. SIZE 210 x 297)



AREA LIGHTING FIXTURE MOUNTED FROM WALL/COLUMN

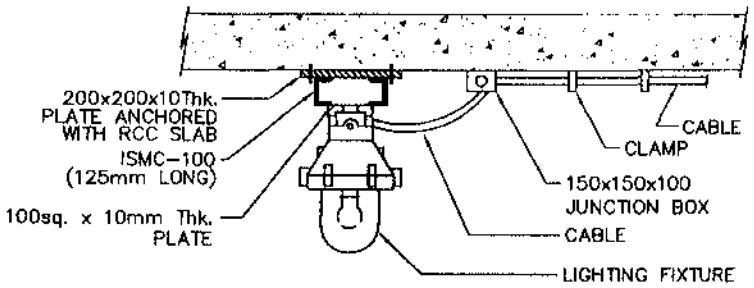
MOUNTING TYPE–18

25/3/09

FOR INFORMATION

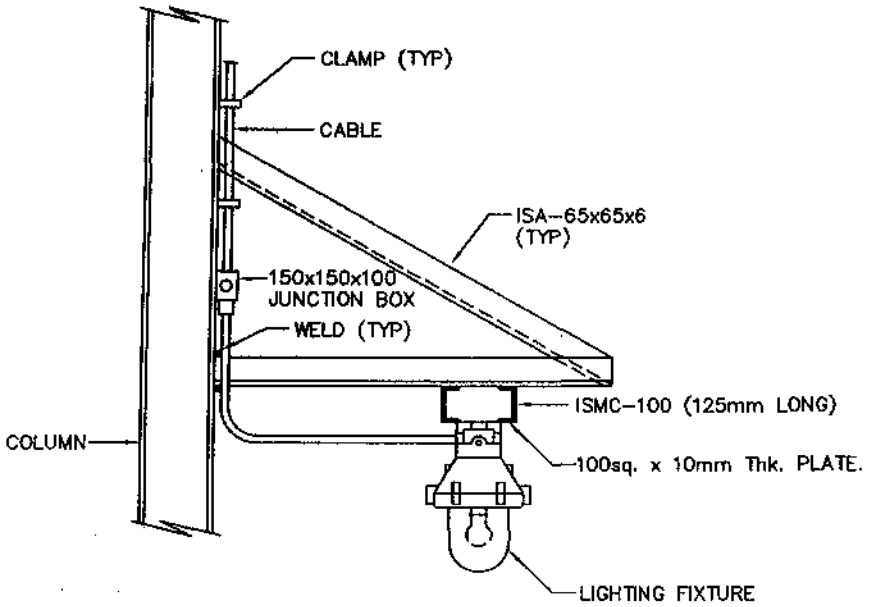
APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 14 OF 20
						DWG. NO. K7V12–000–DWG–E–0800 REV. _

A4 (SHT. SIZE 210 x 297)



WELL GLASS LUMINAIRE
CEILING MOUNTED

MOUNTING TYPE-19



WELL GLASS LUMINAIRE
COLUMN MOUNTED

MOUNTING TYPE-20

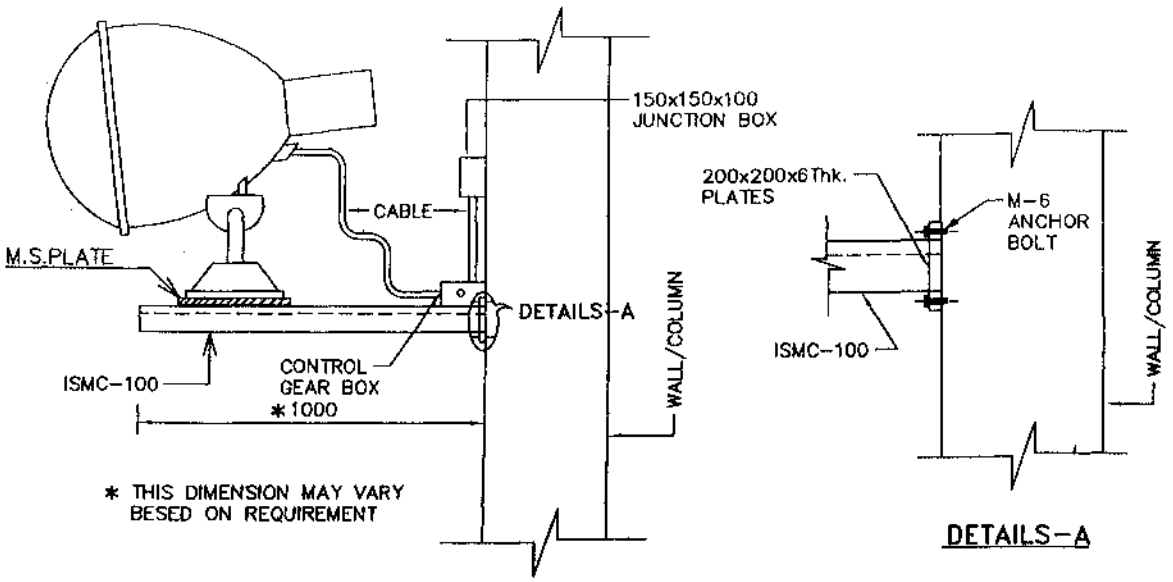
25/3/08

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 15 OF 20
						DWG. NO. K7V12-000-DWG-E-0800 REV. _

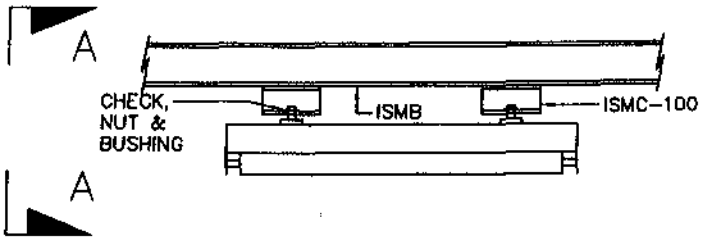
A4 (SHT. SIZE 210 x 297)

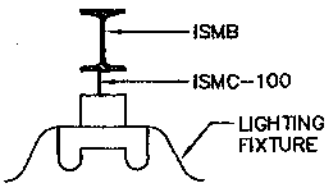
CAD FILE : K7V12-000-DWG-E-0800



FLOOD LIGHT SUPPORT FROM WALL/COLUMN

MOUNTING TYPE-21





VIEW : A-A

MOUNTING FOR STEEL STAIR CASE

MOUNTING TYPE-22

FOR INFORMATION

APPVD.	REVWD.	CHKD.	REV.	DATE	ILLUMINATION DETAILS	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA – MUMBAI – CHENNAI – NEW DELHI
					3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SHEET 16 OF 20
						DWG. NO. K7V12-000-DWG-E-0800 REV. –

A4 (SHT. SIZE 210 x 297)

SCHEDULE II

TECHNICAL SPECIFICATION

VOLUME # 5

(CONTROL & INSTRUMENTATION)

Project	6 x 600 MW THERMAL POWER PLANT PROJECT AT NARIYARA, CHATTISGARH, INDIA	
Owner	KSK Power from knowledge	**Wardha Power Company Private Limited, India**
Owner's Consultants		DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI
E P C Contractor	SEPCO	SEPCO Electric Power Construction Corporation, China

1/4/09

(XUG LI)

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	SECTION-XIXB2: PLC
	SECTION-XIXB3: FIELD INSTRUMENTS
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	SECTION-XIXB9: FIRE ALARM SYSTEM
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	SECTION-XIXB12: C&I LAB EQUIPMENT
SECTION XIXC	CONTROL AND INSDTRUMENTATION (I 2) – C&I ERECTION

辞利 1/4/09

CXOG LI)

WARDHA POWER CO. PVT. LTD.
3600 MW COAL BASED POWER PROJECT
AT NARIYANA, JANJGIR-CHAMPA DIST. CHATTISGARH

ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I0: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXA

CONTROL DESIGN CRITERIA

I0: C&I TECHNICAL SPECIFICATIONS
SEC-XIXA:CONTROL DESIGN CRITERIA

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I0: C&I TECHNICAL SPECIFICATIONS

SEC-XIXA : CONTROL DESIGN CRITERIA

1.00.00 INTRODUCTION

1.01.00 This specification is intended to cover all aspects of the design, engineering manufacture, assembly, testing & inspection at manufacturer's works, delivery at site and erection and commissioning of the complete Control & Instrumentation System for 3600 MW Coal based Power Plants being set up by Wardha Power Co. Pvt. Ltd (WPCPL) at Nariyana village, Janjgir-Champa District, Chattisgarh, India.

1.02.00 The Control & Instrumentation for the unit shall comprise equipment described and specified in this section and other part/section of this specification document. In general only the major C & I systems and conceptual guideline for the plant C & I have been indicated.

1.03.00 It is not the intent or purpose of this specification to give details of every single item that might be required for completeness and/or proper integration of the overall system. The CONTRACTOR shall be responsible for providing all materials, equipment and services, specified or otherwise which are required to fulfill the intent of ensuring functional completeness, safety of plant and personnel, operability, maintainability and reliability of the total work covered under this specification, during any stage of execution of the contract and the operating life of the plant; within the quoted price and without any further commercial implication to the Purchaser/Owner.

1.04.00 In the event of any conflict between the requirements of any two (2) clauses or documents forming a part of this contract the more stringent requirements shall supply unless otherwise confirmed by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

2.00.00 DESIGN OBJECTIVE

2.01.00 C & I System shall be provided to enable the power plant operation to be carried out in a safe, effective and reliable manner, without invoking plant or system operational limits and to provide the quality of control to support the overall performance guarantees detailed in the other sections.

The main objective of centralized control room operation for the plant is for the following actions –

a) All routine unit operations (including all normal, emergency, start-up, shut-down operations and operations when on load)

b) Any non-routine operation for which there is not ample time for plant attendant to accomplish.

2.02.00 The design of the indication, alarm and control for equipment shall be such as to employ recognized ergonomic principles leading to :

a) Minimization of incidence of operator error.
b) Maximization of efficiency of operator.

The principal design objective for the C & I System shall be of minimization of station personnel (both operation and maintenance staff).

2.03.00 The general design philosophy for the control & instrumentation system shall meet the following objectives.

- High level of automation
- High degree of overall system reliability, high MTBF & low MTTR
- Enhanced availability of plant, taking into consideration proper redundancies at various levels
- Operator friendliness and Compatibility
- Use of state-of-the-art technology but with due regard to performance provenness.
- Consideration of maintainability and accessibility.
- Consideration of long-range economy and better spares management.
- Remote monitoring and control with minimum no of local operators.

2.04.00 Application of sound maintainability principles and techniques shall be strictly adhered to. As a minimum following shall be considered:

a) Standardization of parts, instruments, hardware, actuators, primary sensors etc., which are used throughout entire plant.
b) Minimum use of special tools.
c) Modular replacement.
d) Grouping of functions.
e) Separate adjustability.
f) Malfunction identification.

g) Easy removal, replacement and repair.

h) Easy assembly and disassembly.

i) Tamper-proof design to include proper identification to prevent improper mounting and installation.

3.00.00 CONTROL & INSTRUMENTATION SYSTEM PHILOSOPHY

3.01.00 The Control & Instrumentation System shall mainly realize the following functions in order to assist the operator to perform safe start up/shutdown and normal/emergency operation of the plant.

1. Closed loop modulating control of parameters for optimized operation of turbine, boiler and balance of the plant.

2. Open loop control for automatic sequential operation, interlock and protection of various drives.

3. Continuous supervision of system parameters and equipment operating conditions

3.02.00 State-of-the-art-practices prevailing in the field of Control & Instrumentation for power plant shall be considered to ensure safe, efficient and smooth operation of the plant and equipment with minimum interference of the operating personnel during normal working of the plant.

3.03.00 The system design shall be such that no single point failure will result in total system paralysis under any operational eventuality. Redundancy shall be provided at appropriate levels for critical control system functions.

3.04.00 In the event of loss of a major plant item, activities of binary and analog controls shall be coordinated to ensure that the plant is automatically brought to a safe holding condition consistent with maintaining maximum generation permissible under reduced plant availability.

3.05.00 Local monitoring and control facilities shall be provided for operations, which demand local attention.

Local monitoring shall be provided in cases where such indications are required for maintenance like pressure gauge for pump, commissioning and tuning of equipment and where recommended by equipment manufacturers for local supervision in case of emergency.

Pressure indicators shall be provided for the following as a minimum, but not limited to:

- Suction and discharge lines of pumps/fans, including on header section if two or more pumps are employed for the same service

- Inlets and outlets of heaters, heat exchangers and de-superheaters

All input and output lines of process equipment. Incase the CONTRACTOR could not provide Pressure indicator in Input or Output line of process equipment due to technical reasons, the same shall be taken approval from OWNER during detail engineering. Differential Pressure indicators shall be provided for the following as a minimum, but not limited to:

- Across filters/strainers
- Across condenser CW line for local monitoring

Temperature indicators shall be provided for the following as a minimum, but not limited to:

- On all process lines where local indication is warranted by the system either for monitoring or testing.

- On the inlet/outlet equipment such as heaters, de-super heaters, heat exchangers & coolers for both the fluid media.

Level indicator shall be provided on all tanks. If Level gauge glass is used, the maximum length of one gauge glass shall not exceed 1 m. The gauge glasses shall be stacked to cover the complete height of the tanks including over flow level. All high pressure vessels shall be provided with level gauges on either end as per statutory requirement.

Flow gauges shall be provided on coolant line from coolers as a minimum.

3.06.00 The C & I System shall be configured to perform the following basic functions: -

a) Automatic sequencing of the start-up and shutdown of major equipment and auxiliaries including group/plant level start-up to minimize operator's intervention under normal operating conditions.

b) Regulation function for various valves and dampers to achieve guaranteed performance and to achieve the most fuel-efficient operation.

c) Protection of plant equipment and monitoring of equipment life.

d) Acquisition, display and archiving of plant data and generation of reports.

3.07.00 Centralized control for all the units of the plant has been envisaged from two Central Control Rooms. #1, #2, #3 units shall have one central control room. #4, #5, #6 shall have second central control room. The entire unit operation and monitoring under all regimes of operation i.e.,

start up, loading, normal operation, shutdown etc. shall be possible through operator's consoles located at Unit Control Desks (UCD) in the central control room.

In line with the latest trend of control & monitoring, for centralized control & monitoring of the plant, the C & I system shall be built around a Distributed Control System (DCS) with functionally distributed multifunction controllers, suitable Human Machine Interface (HMI) devices and other required peripherals and hardware.

However, control of CHP, AHP, WTP, and Compressed Air Plant(AHP) will be from respective Local Control rooms by Programmable Logic Controllers (PLC). A separate network for offsite control systems, independent of plant DCS network is preferred. Provision to link this network to the plant MIS (management information system) shall be made. However, in case it is envisaged to hook-up the offsite PLCs to the plant DCS network, for remote monitoring from the CCR, then OPC server shall be used for this purpose. Gateways shall not be used. Critical signal exchange between PLC & DCS shall be by hardwired signals. TFT based Operator/Engineering stations, printers etc shall be provided in the respective local control rooms as shown in the plant control system architecture reference drawing. PLC for the compressed Air Plant for Instrument and Service Air shall be connected to DCS for common system and Compressed Air Plant for AHP shall be connected to BOP Network. Control and monitoring for Instrument Air and service air Compressor system shall be from Local PLC as well as from DCS. Hardwired signals shall be used for control purpose.

The control implementation philosophy to be adopted for BOP systems of the plant are tabulated in Annexure-1 of this section.

The Control philosophy for interfacing of MCC/SWGR./ Actuator with PLC/DCS is are tabulated in Annexure-2 of this section.

3.08.00 A control building as an extension of the STG building is proposed to house the Central Control Room, Control Equipment Rooms, Engineering rooms etc.

The central control room (CCR) shall house operator's stations, printers, auxiliary consoles for emergency push buttons and hardwired window annunciation, proprietary operator consoles (if any) for turbine generator, generator control and protection panel, fire detection and protection panel, etc. for all the units of the plant.

The Engineering room (ER) within the CCR shall house the engineering stations and their dedicated printers.

All electronic system cabinets, interposing relay cabinets, UPS cabinets and power distribution boards, electrical interface panel if any, etc. for each unit shall be located in the respective unit Control Equipment Rooms (CER) adjacent to the CCR. Proper grouping of various

panels/cabinets shall be done in each of the control equipment room (CER).

CERs and ER shall be in the close vicinity of CCR and connected with each other by at least one entry. However there shall be more than one entry/exit point in CERs, ER and CCR for emergency escape/movement. All these rooms shall be provided with central A/C, false ceiling and cable cellar for cable laying. Cable vault/cellar will be provided for Control Equipment Rooms(CERs), Engineering rooms(ER) and Central Control Room(CCR) for cable laying.

In the CERs and CR, the width of doors shall be suitable to push inside the system panels

CR,CER & ER shall be provided with recessed lighting fixture with diffusion lenses to ensure uniform semi-direct illumination and prevent glare on the TFT screens. The illumination level in the control room and control equipment room would be designed for 400 lux, Emergency back-up illumination would be provided from D.C station battery source to take over automatically in case of A.C supply failure.

An Instrument test/calibration room and an instrument maintenance room shall be provided.

There shall be minimum one no. of Steam water analysis system (SWAS) room to accommodate dry panels with various analyzers. This room shall be air-conditioned.

Split ACs shall be provided for all utility plant local control rooms. Split ACs of adequate capacity based on Heat load calculation of respective rooms shall be provided along with one additional spare, in all local control rooms.The air conditioning in each local control room shall be adequate such that even on failure of one split AC, the room shall be fully air conditioned. A/C room /Enclosure for remote I/Os shall be provided.

Vastu requirement that operator should face east or north only, shall be followed in the central control room and local control rooms.

3.09.00 Power Cycle Plant automation will be achieved mainly using an integrated, functionally distributed, microprocessor based Distributed Control System (DCS), with redundant measurement and control functions to operate in conjunction with the Furnace safeguard supervisory system (FSSS) of the Steam Generator (SG) and the Digital Electro Hydraulic Governor (DEH), Automatic Voltage Regulator (AVR) of the Turbine Generator (TG), Sequence of Event (SOE) etc, implemented on uniform integrated DCS platform . The plant start-up, shutdown and all regimes of operation shall be automated with provision for plant cold, warm and hot start conditions. No operator intervention is envisaged during normal operation and foreseeable emergencies. Generally, prior to

a parameter reaching trip level, alarm will be generated to warn the operator about the emergency.

Also the distributed control system will monitor and record plant auxiliaries critical parameter. Data Acquisition Systems will be incorporated to carry out supervisory monitoring, data logging, event logging.

3.10.00 Separate independent microprocessor based systems are provided for Automatic Voltage Regulator (AVR), Turbine Supervisory Instrument (TSI), etc. the DCS will interact with them through remote terminal units (RTUs)/hardwired interfaces.

The primary objective of the interface will be centralized monitoring and presentation of data. Limited commands/feedback will be exchanged between the above systems and DCS to achieve complete centralized operation even if the Operator Console provided by STG Vendor fails. Minimum number of graphics for convenient monitoring & control of STG shall also have to be generated in DCS.

3.11.00 Important parameters from the independent offsite packages like Fire Protection Package, DG Package shall be monitored in plant DCS also, through hardwired signals.

3.12.00 CCW and ACW system shall be implemented in DCS. Remote I/O unit may be placed in Cooling Water Pump House. Otherwise, separate processing unit / controller with operating station shall be located in pump house.

Condensate Polishing Unit, H_2 Generation Plant, Mill reject handling system etc., shall be PLC based and interfaced to DCS through OPC server for monitoring. This shall be as per the final agreed Plant Control System Architecture drawing.

Condenser online tube cleaning system (COLTCS) shall be PLC based, Online steam leak detection system shall be PLC/Microprocessor based and both shall be hardwired to DCS.

The HP & LP dosing system controls are implemented in Condensate Water Treatment PLC. HP & LP dosing system shall be operated from OS of CPU control room in addition to the local control panel. CPU PLC shall interfaced to WTP PLC.by serial interface (RS485 MODBUS RTU) for monitoring. .

The Electro-Static-Precipitators (ESP) should have its own control system based on PLC with hardwired signals to DCS for monitoring. The ESP PLC system shall be supplied with an ES cum OS station.

Fuel oil pressurizing and supply system shall be monitored and controlled from CCR by DCS, while Fuel Oil unloading, Storage and Conditioning System shall be PLC based with local control panel and hardwired connectivity with DCS for monitoring important parameters.

Coal feeder control system shall be VFD based.

4.00.00 REDUNDANCY CRITERIA

Any single failure of instruments or control equipment shall not affect the performance of the unit in any way.

4.01.00 For hardware configuration following guide lines shall be followed.

a) For all applications excluding FSS,(MFT) and ETS, dual modular redundant control system including Input/Outputs (I/Os), processors etc. shall be used. FSS (MFT) & ETS shall be triple modular redundant.

b) For critical closed loop control system and protection of critical equipments, 2 out of 3 redundant sensor/transmitter shall be used.

c) For balance protection, close loop & open loop controls, dual redundant sensor/transmitter shall be used.

d) For measurements non-redundant sensor/transmitter may be used.

e) The DCS/PLC should have redundancy in following levels - Main processor, Network interface module, memory, communication cable, power supply and I/O modules for critical loops. The I/O redundancy criteria to be adopted for critical loops/system/equipment are tabulated in Annexure-3 of this section.

f) Sensor for protection and sensor for control/monitoring should be separate.

g) The functional segregation philosophy for the processors/controllers shall be followed in addition to worst case loading criteria while deciding the number of redundant processors/controllers required.

h) Control processor/controller used for control loops shall have hot standby redundancy, such that on failure of one control processor, the backup processor shall take over control functions automatically.

i) Redundancy criteria to be adopted for transmitters are tabulated in Annexure-4 of this section.

4.02.00 The signal distribution from sensors which are shared due to process restrictions between control loops, logics, monitoring purposes and between back-up instruments on the panel shall be as follows: -

a) Redundant components and equipment within given systems shall be distributed among processors and I/O cards to the extent practical.

b) Critical inputs shall be supplied with redundant sensors/transmitters with each input connected to different input cards. Where redundant inputs exist, the DCS shall be configured to automatically reject erroneous data. Where required, one-of-two, two-of-two, two-of-three, or median select schemes shall be utilized to ensure the integrity of critical inputs.

c) In case there is either process redundancy (Left/Right or Running/Standby) or transmitter/switched redundancy, the inputs shall be routed through independent input cards.

d) No two control loops/interlock loop shall share the inputs (either binary or analog) vide input cards if process signals are independently available. Protective inputs for two drives shall not be allotted to the same input card.

e) The use of redundant outputs driving the same final element or equipment shall generally be avoided in favor of failsafe design and redundancy of the plant equipment. The DCS output cards shall be redundant but from TB single O/P will drive the control element. At card level, one o/p will be primary driving the control element and other will be hot back up & take over as soon as primary o/p goes bad.

f) In case inputs/outputs are required from one logic to another, they can be soft wired provided, they are on same processor. For those inputs/outputs resident on other processors, the same shall be hardwired.

g) The operator stations shall be identical in capability and independently linked to the system. Although these stations shall be normally dedicated to a specific function, any station can replace the function of any other station at any time.

h) All power source and power conditioning equipment in the system shall be redundant.

i) While allocating control tasks for Interlock Protection, following criteria are also to be satisfied.

- Left and right air-flue gas paths do not share redundant processors.

- Left and right water paths do not share redundant processors.

- Those auxiliaries which are common to both paths (BFP-C) will be resident in the processors of the left/right paths so that both paths will not be lost due to the failure of a processor.

- The Air and Water paths do not share processors.

5.00.00 GENERAL TECHNICAL REQUIREMENTS

5.01.00 All equipment, system and associated accessories shall be from the latest proven product range of qualified manufacturers. All materials and equipment furnished for permanent installation shall conform to applicable local and international codes and standards Specifications and shall be new, unused and undamaged.

5.02.00 The equipment and systems shall be designed and constructed to meet specification requirements, and shall perform accurately and safety under the environmental and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion or other operating troubles during the continuous service life of the plant. It will be the responsibility of CONTRACTOR to fully acquaint himself with the functional requirements and operating conditions for equipment, system/sub-system/ assemblies and accessories offered for this project. Additional features shall be provided where required to meet service conditions, functional/descriptive or parametric requirements for equipments/systems/assemblies/ accessories.

5.03.00 Unless otherwise specified, all equipment/systems/sub-systems etc. shall be fully tropicalised. The outdoor equipment shall also be designed to operate in dust-laden atmosphere and under tropical rain. Wherever necessary, space heater, dust and water proof cabinets and explosion proof enclosures shall be supplied. It shall be ensured by the CONTRACTOR that all components are operated below their electrical and thermal rated values and the CONTRACTOR shall take into account all possible combinations of operating environments, power supply variations and transient conditions.

5.04.00 The design of the Control & Instrumentation system shall be such that isolation of any piece of defective equipment/accessories should be possible without shutting down the main equipment and should result in minimum disturbance to the process.

5.05.00 The design of control systems and related equipment shall adhere to the principle of "fail safe" operation at all system levels. "Fail-safe Operation" means that loss of signal, loss of power supply/air supply or failure of any component shall not cause a hazardous condition while at the same time prevent occurrence of false trips.

The following types of failure as a minimum shall be taken into account:

a) Failure of sensors or transmitters, producing high or low signal.

b) Failure of controller during automatic operation.

c) Loss of motive power to final control element actuators.

d) Loss of control power.

e) Loss of instrument air supply.

5.06.00 The instrument material specifications shall be consistent with the operating parameters like temperature, pressure, corrosion conditions and other process conditions. The instruments shall meet the brief technical requirements as specified elsewhere.

5.07.00 To ensure safe operation of C & I equipments located in hazardous areas, based on area classification requirement, transmitters shall be intrinsically safe and JB/Switch shall have ex-proof enclosures.

5.08.00 Safety earthing and C & I system earthing shall be separate. Safety earthing bus shall be connected to main plant earthing pit. Separate earth pit/s shall be provided for system earthing bus (electronic earth). Electronic earth shall be cabled directly to the corresponding earth bar. Separate earthing shall be provided for intrinsically safe system.

5.09.00 All outdoor field mounted instruments shall have waterproof enclosures conforming to IP-65. All panels/cabinets shall have protection class IP-54 in ventilated areas and IP-41 in Air-conditioned area.

5.10.0 All field instruments shall be located in accessible/vibration free locations and clearly visible range for all readable instruments. Access platforms with ladders shall be provided for measuring instruments located at high or difficult places.

All temperature gauges, pressure gauges, transmitters shall be geographically grouped and located in racks or local panel.

All the temperature transmitters(if used) shall be mounted in separate enclosed racks.

5.11.00 Junction boxes/field termination cabinets shall be provided for the following, as a minimum, but not limited to:

- Termination of all sensors and transmitters located area wise
- Termination of transmitters to JBs which are mounted on the transmitter racks

5.12.00 Separate cable trays shall be provided for control cables and instrumentation (signal) cables and separated from power cable trays by minimum distances specified in VOL-II-SEC-XIXC of this specifications. Only top cable tray shall be covered. Instrumentation cable tray shall be perforated type. Control cable tray shall be ladder type.. All cable entry points to instruments, junction boxes of panel shall be provided with suitable dust and watertight double compression type glands. All cables

from field to junction box shall be through flexible conduit upto main tray/sub-tray.

5.13.00 PLC based systems shall be used for Ash handling, Coal handling, Water treatment, Condensate polishing unit, Air compressor. PLC shall have redundancy of CPU/memory/power supply. All PLCs should be compatible with DCS so that monitoring can be done through DCS. OPC server shall be provided for interfacing PLC based systems for monitoring at CCR. These should be redundant and have redundant link with DCS. This shall be as per final Plant Control System Architecture drawing.

5.14.00 All trips shall have an alarm to indicate trip condition, and pre-alarm to alert the operator.

5.15.00 The equipment supplied shall have provision for protection against electrostatic discharge and radio frequency interference. Power conditioning shall be provided for DCS/PLC so that system is unaffected by interference.

5.16.00 Hardwired back-up panel shall be provided to mount Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator.

5.17.00 Auxiliary console shall house PA system station and direct hardwired push buttons and respective status indication lamps to ensure emergency trip of Boiler, Turbine.

5.18.00 Hard-wired annunciation system shall be provided for important parameters crossing alarm set points, equipment trippings. The annunciator system shall be audio-visual type with 'First-up' facility. The selection of individual alarm and grouping of alarms shall be done judiciously so that all important alarms essentially required for unit operations are taken care of without increasing the number of windows beyond a certain reasonable figure (64 no.s)

5.19.00 All the monitors pertaining to DCS/PLC/TDM(Turbine Diagnostic Monitoring for STG and Turbine driven BFPs)/I&C systems shall be LCD type having 21" inch screen size.

5.20.00 Sequence of event recording system(SOE) shall be implemented in DCS and provided with required input capacity to log trips, cause of trips and other important faults to diagnose the cause of plant trip with a resolution of one millisecond. The system shall include a dedicated dot matrix type printer.

5.21.00 A master clock system, capable of receiving time signal broadcasted by National Physical Laboratory/GPS signal and processing it and then transmitting and synchronizing this time with DCS and PLC systems shall be provided by CONTRACTOR. This Master clock facility shall be used for time synchronization of the DCS & PLC and all other systems to be networked with DCS/PLC.

- Furnace Draft Control
- Drum Level Control (three element)
- Superheated Steam Temperature Control
- Reheat steam temperature control
- Deaerator Pressure Control
- Deaerator Level Control
- Turbine Governing Control
- Turbine gland steam pressure & temperature controls.
- Condenser Hot Well Level Control
- Pressure Reducing & De-superheating temp. control.
- CBD/IBD Level Control
- HP/LP Heater Level Control
- HP/LP bypass control
- BFP minimum re-circulation control
- CEP minimum re-circulation control
- Make-up water flow/tank level control
- Mill outlet temperature Control
- Mill inlet air flow control
- Windbox damper/ secondary air damper control
- Air heater cold average temperature control
- Soot blower pressure/temperature control

6.02.00 CO-ORDINATED MASTER CONTROL

Co-ordinated master control system shall control the operation of boiler and turbine as an integrated system consistent with the generation requirements but constrained by the unit capability. The system shall enable the operator to select either of the three modes – coordinated mode, boiler follow mode, turbine follow mode.

In coordinated mode, the unit master may be in auto receiving the load demand signal from Load Dispatch Centre or in manual, when the operator manually generates the load demand signal. In boiler follow mode, the boiler master station will be controlling the throttle pressure. In turbine follow mode, the turbine master station will be controlling the throttle pressure with steam flow as feed forward signal.

6.03.00 COMBUSTION (AIR AND FUEL FLOW) CONTROL

The output of boiler master station shall be used in fuel and airflow control system to regulate the firing rate. The output of turbine master station shall provide the set point for the output controller of electro hydraulic governing system, which in turn acts on valve lift controller for positioning the turbine throttle valves.

Fuel flow to the boiler shall be controlled by modulating coal feeder drive and air flow by controlling the dampers in air duct and FD fan dampers.

The control loop shall ensure that the fuel flow to the boiler is always limited to the extent of air availability, thereby ensuring air rich conditions and combustion safety at all times. The fuel air cross limiting programme shall ensure that air flow shall increase before fuel flow on load increase and that fuel flow shall decrease before air flow on load decrease. Online O_2 analyser shall be used for combustion control

6.04.00 FURNACE DRAFT CONTROL

The furnace draft shall be controlled by modulating the IGV/VFD of ID fans. The system shall incorporate all safety provisions to protect the furnace from excessive negative or over-pressure due to master fuel trip or improper fan operation. Provision shall be made for automatic tripping of one F.D. fan when furnace draft exceeds a preset (+ve) limit and for tripping of one ID fan if furnace draft exceeds preset (-ve) limit.

6.05.00 FEED WATER CONTROL

Feed water control system shall include single element and three-element drum level control.

Three elements of the control system are steam flow, feed flow and drum level. Feed flow shall be measured by nozzle. Steam flow shall be computed from Turbine first stage pressure. The feed water flow after being linearised by square root extractors shall be compared with computed steam flow and this compared value is fed to a P+I controller where it is again compared with the preset drum level transmitter and compensated for density variation at high pressure. The output of the controller is constantly modified to control the feed water control valve/feed water pump drive speed through an auto/manual station until the preset drum level is reached. For upto 30% load low-load control valve in single element mode and between 25% and 100% three element

modes shall be operative. CONTRACTOR shall furnish Feed Water Control philosophy for OWNER's approval during detail engineering.

6.06.00 STEAM TEMPERATURE CONTROL

For controlling the final steam temperature from 100% MCR to 60% MCR, an inter-stage spray type at temperature shall be provided.

The measurement of final steam temperature shall be done by thermocouples, output of which shall be transmitted to a P + I controller. The output signal of controller shall be constantly modified to control the spray water control valve to attain the preset temperature. This control loop also receives an anticipatory signal from the steam temperature transmitter measuring the steam temperature at the super heater outlet. In fact, this control loop shall be in cascade mode.

6.07.00 DEAERATOR PRESSURE CONTROL

The deaerator pressure shall be maintained at a constant set pressure by regulating the supply of heating and deaerating steam flow to the Deaerator. The deaerator pressure control should be effective in the initial start-up when auxiliary steam is utilised as well as during normal operation when extraction steam is utilised.

6.08.00 DEAERATOR LEVEL CONTROL

Deaerator level shall be controlled by controlling condensate flow to the deaerator. Deaerator level control shall be three element type, three elements being condensate flow, feed water flow & deaerator level.

6.09.00 BLOW DOWN TANK LEVEL CONTROL

The blow down tank level shall be controlled by throttling the drain valve within an adjustable band.

6.10.00 STEAM TURBINE CONTROL

The steam turbine control system shall have and not limited to the following :

Speed control, load control, condenser vacuum control, lube oil pressure control, inlet steam pressure control and exhaust hood temperature control.

The Turbine shall be equipped with Digital Electro-Hydraulic Governing (DEH) system to facilitate the operation of the Turbo-set in an integrated grid system DEH will consist of distributed processing unit, data communication and man machine interface. OPC protection shall also be implemented in DEH.

The components of the governing system shall be selected on the basis of reliability over a wide range of operating conditions and shall be well proven to ensure overall system reliability. The governing system shall be designed for turbine operation under constant pressure mode as well as sliding pressure mode. The system shall be designed for continuous operation on the entire load range in all regimes of operation. The governing system shall work in conjunction with Turbine Automation System, Turbine Stress Control System. Turbine supervisory equipment, LP bypass system for the safe operation of the Turbo-set. The governing system processor shall be redundant, irrespective of whether it is a separate system or integral with the DCS.

The controls covered in this system shall basically consist of valve-lift controller, speed-controller, power controller, inlet steam pressure controller and output frequency drop characteristic controller. The speed controller shall ensure controlled acceleration of the turbine generator and shall prevent over speed without tripping of the unit under any operating conditions or in the event of full load throw-off.

The speed controller shall limit the over speed of the turbine on loss of full load to a value below the trip point or safe limit. The governing system shall be equipped with speed/load changer to control the speed or power output of the steam turbine within the limits, locally and remotely from the console panel insert. The speed/load changer provided shall be capable of adjusting the speed of the turbo set to the desired value of rated speed for (manual/auto) synchronization of the generator with the bus. It shall also be capable of varying the load on the machine from no load to full load. The speed/load changer shall be capable of accepting analog/pulse/digital signal from coordinated control system.

The governing system shall be equipped with a load limiting device capable of being operated both locally as well as remotely from unit control room for the purpose of limiting the amount of opening of the governor controlled valves to set the load at a pre-determined limit, while the turbine is in operation. All types of remote indications shall be provided on operator's console for monitoring and safe operation of the TG.

6.11.00 CONDENSER HOTWELL LEVEL CONTROL

The condensate pump discharges condensate from the condenser hotwell to the Deaerator Storage Tank after passing through the steam ejector, gland steam condenser and series of LP heaters. The Condenser hotwell level shall be maintained by controlling make-up water flow to the condenser and by controlling condensate spills to surge tank.

It is to be ensured that the necessary minimum flow through the condensate extraction pump would always be guaranteed.

Level measurement for Hot well is to be done through displacement type 'transmitter' instead of 'capacitance' type to avoid problems associated with vacuum service.

6.12.00 PLANT INTERLOCK AND PROTECTION

The interlock and protection system for the plant and equipment shall ensure :

a) Safe start-up or shutdown of major auxiliaries by automatic operation of the associated facilities including steam turbine and steam generator.

b) Smooth, continuous, safe and efficient operation of the plant, equipment and auxiliaries, by automatic interlock starting of back-up facilities in case of failure of the running facility.

The Unit Protection System shall sense abnormal or hazardous operating conditions and shall automatically initiate shutdown, isolation, or runback of major equipment as required to protect personnel and equipment.

The Unit Protection System shall be implemented at two levels. Individual equipment shall be protected by logic contained within its distributed processors. Examples of this type of protection shall be abnormal temperature, pressure, level, flow, and other process interlocks such as pump minimum flow requirements, minimum NPSH requirements, low lube oil pressure, high vibration, and the like. The steam turbine proprietary control system contains the protective logic necessary to guard against potentially dangerous conditions such as high vibration, abnormal oil temperature, low oil pressure, high condenser pressure, over speed, and other potentially damaging conditions.

In addition to the individual equipment protection logic described above, unit protection logic shall be provided in a dedicated pair of microprocessors. The unit protection logic coordinates the tripping of major plant components to prevent dangerous or potentially damaging plan t-operating modes. The unit protection logic shall also run back or trip major components as required in response to loss of plant support systems and systems, which are common between major components with in a unit.

Interlock and runback logic shall be provided to coordinate the unit response to auxiliary equipment upsets. The logic shall attempt to maintain a balance between steam production and steam consumption within the operable ranges of the equipment in service.

Equipment to be considered in the development of interlock and runback logic shall include the following groups, but not limited to :-

a) Condensate pumps & condenser vacuum.
b) Feed water pumps
c) Circulating water pumps.
d) Coal Pulverizerizing system
e) Steam turbine (load rejections)
f) Induced Draft Fan
g) Forced Draft Fan
h) Primary Air Fan
i) Air pre-heater system
j) HP heater
k) LP heater
l) Turbine drain system
m) Boiler drain and vents
n) Turbine oil
o) Auxiliary cooling water
p) FSSS/BMS

Unit trip logic shall also be provided to allow the simultaneous tripping of the steam generator and steam turbine within a unit. The interlock and runback logic shall be implemented in the unit protection processors.

6.13.00 BOILER PROTECTION

Boiler protection system shall be provided to achieve the following functional requirements.

- Boiler Protection actions including Master Fuel Trip (MFT). MFT shall be implemented by Triple Modular Redundant system with triple redundancy in field inputs.
- Purging.
- Sequence control, interlock and protection during unit start up, shutdown and under emergency conditions.

The boiler shall be protected against abnormal conditions such as the following :-

a) Both emergency trip buttons pushed
b) Loss of all fuels.
c) Reheater protection acted.
d) Air flow less than 30 %
e) Loss of flame
f) Furnace pressure very high
g) Furnace pressure very low
h) Loss of both FD fans
i) Loss of both ID fans
j) Drum level very high
k) Drum level very low
l) Loss of AC at any elevation in service
m) Loss of DC
n) Circulating water not adequate

6.14.00 FURNACE SAFEGUARD SUPERVISORY SYSTEM (FSSS) / BURNER MANAGEMENT SYSTEM (BMS) :

FSSS/BMS shall be designed in accordance with boiler manufacturer" recommendation and meet NFPA requirements. The FSSS/BMS shall include Burner Control System (BCS) and Furnace Safeguard System (FSS). The FSS will be implemented by triple modular redundant system. Fully proven microprocessor based FSS redundant in CPU, Power Supply, I/O's shall be provided.

The FSSS will interface with the operator by providing message and graphic display to enable the operator to follow the progress of the automatic steps of the BCS and FSS during start-up, shutdown or normal on-line operation.

The operation will be provided with sufficient information from the VDU with graphic displays to enable the operator to ascertain at all time the status of each piece of equipment to allow him to use the sequencing action or take over manual control when necessary. Status of equipment will reflect by its color change on VDU, Interlocks will provide maximum safety to prevent control action from creating unsafe conditions upon component malfunction or incipient hazard due to the failure of related equipment.

a) BCS will perform the following major functions :-

i. Provide safe light-up, continuous supervision of operation and shut down of the oil guns and coal burners.
ii. Position of wind box dampers for proper secondary air distribution during purge, burner light-up and load-up operation.
iii. During all modes of operation provide full supervision and interlock features including the monitoring of burner flames.
iv. Provide control of the scanner air fans.

b) FSS functions include MFT, fuel oil leakage test and furnace purge. The FSS acts to prevent the development of unsafe fuel and air mixtures within the boiler furnace, trip the fuel system when necessary and avoid the overheating of the boiler pressure parts. It will accomplish the preventive actions through the following monitoring and protection functions :

i. Monitor boiler and turbine-generator operating conditions and upon detection of a condition hazardous to personnel or to equipment, generate a Master Fuel Trip (MFT) signal.
ii. Rapidly shut off fuel input to the boiler by removing the minimum amount of boiler fuel firing equipment

and related plant auxiliaries from service upon recognition of a hazardous condition.

iii. Maintain boiler input air flow conditions following an MFT to allow a post firing purge of combustible gases from the boiler and flue gas ducting.

iv. Prevent the readmission of fuel to the furnace until completion of a five-minute purge cycle with its associated permissive.

Local panels as required to be provided. All the necessary operator controls required for start-ups/commissioning/maintenance are to be provided in the local panel.

If the system is not implemented in DCS, two-way redundant, proven data highway link to be provided with the DCS. All remote operations are to be performed from DCS VDU/KBD. All the necessary hardware, software required for this are to be supplied as part of FSS package. Irrespective of implementation platform FSS system shall be (Triple redundant).

6.15.00 SOOT BLOWER CONTROL(SBC):

Soot Blower system shall be provided to ensure automatic sequential operation of soot blowers. The minimum functional requirements of Soot Blower System are as follows :-

a) Automatic sequential starting of each soot blower.
b) Selection facility for individual soot blower for automatic sequential operation/manual over-riding of automatic operation.
c) Capability of disable the operation of any soot blower, if required.
d) Indication of the soot blowers in operation.
e) Monitoring all essential parameters of the soot blowing system.
f) Indication of any malfunctioning of soot blower.
g) Pressure and Temperature interlock with automatic retraction of the soot blower.
h) Steam pressure control.

Control circuits of the retractable soot blower shall be designed so as to prevent insertion of blower nozzles in the combustion chamber unless soot-blowing steam is available.

6.16.00 STEAM TURBINE PROTECTION(TPS/ETS)

The Turbine Protection System (TPS) shall be implemented in fault tolerant voting logic. Turbine Protection System shall be implemented in Triple Modular Redundant system. Three independent channels each having its own and dedicated processing modules, controllers, I/O modules shall be provided. All the three channels shall continuously track each other all the time.

The Turbine protection system shall be a fail safe, triple redundant system, approved by TUV SIL3 certification.

CONTRACTOR shall provide all the required primary sensors and system hardware for the Protection System as per his standard and proven practice. Minimum Primary sensor redundancy shall be as follows:-

a.	Lube oil pressure low	:	2 out of 3
b.	Axial shift high	:	2 out of 3
c.	Over speed	:	2 out of 3
d.	Condenser vacuum low	:	2 out of 3

The redundancy in the other inputs as follows required for the safety of the turbine shall be based on CONTRACTOR's experience and proven practice

a. Lube oil temperature high

b. Steam inlet pressure low

c. Loss of Governor fluid pressure

d. Exhaust hood temperature high

e. Hot well level high

f. High vibration

The System shall include turbine lock-out relays, turbine trip solenoid and the hardware for testing the protections.

The turbine generator shall be provided with redundant solenoid tripping device. The tripping device shall be designed to operate on DC supply. The trip coils shall be monitored continuously for healthiness and the failure shall be alarmed.

The Turbine Generators shall also be protected against excessive over-speed by separately actuated over-speed devices/emergency over-speed governors. Two over-speed settings have been envisaged.

In addition to the emergency over-speed governors, an emergency hand trip device shall be provided on the governor pedestal to facilitate manual tripping of the unit. It shall also be possible to trip the turbine from the Control Room as well as from local governing rack.

6.17.00 <u>AUTOMATIC TURBINE RUN-UP SYSTEM (ATRS):</u>

The Automation System shall run up the turbine automatically from zero speed to synchronizing speed then load the machine upto block loading and continuously check the operation upto 100% MCR without impairing the life of the turbine; inclusive of Auto-synchronizer.

The system shall be designed to provide the following functions:

a) Automatic start up/shut down sequence.
b) Stress/temperature margin controlled acceleration as per the pre-selected mode i.e. slow, normal and fast.
c) Stress/temperature margin controlled speed holds and monitoring of excitation control.
d) Automatic synchronization and MIN block loading.
e) Stress/temperature margin controlled loading/unloading upto 100% MCR.
f) Unloading and shut down of the machine.

The System shall essentially control the following functional groups, but not be limited to :

a) Turbine run -up/shut down
b) Lube oil supply system
c) Control fluid system
d) Turning gear system
e) Gland steam supply system
f) Turbine drains system
g) Evacuation System

In order to achieve the automatic sequential control, structure generally consisting of group level, sub-group level and individual drive level as mentioned above shall be provided.

The group-level shall control a set of sub -groups or drives for the purpose of setting a physical parameter. Appropriate start-up and shut down commands shall be issued to the sub - group control and various check backs shall be received from subgroups or drives. Each sub-group shall execute the sequential start-up and shutdown programs of a set of inter-related drives along with system interlocks and protections associated with that sub-group as well as basic interlocks and protections related to individual drive falling under the sub-group. The drive level shall accept commands from the sub-groups, etc. and transmit them to the respective drive after taking into account various interlocks and protections and the safety of that particular drive.

Group and sub -group control shall be set up by means of sequence progressing. A sequence shall be used to move a group, sub-group from an initial state to a final state.

A sequence made of steps shall be executed in predetermined order according to logic criteria. For each step there shall be a provision for

"waiting time" and "monitoring time" and it shall output an action on the process.

Desired number of criteria shall act as pre-conditions before the sequence control can take off to execute its defined program the program shall comprise different number of criteria required to be fulfilled :

a) "Waiting time" implies that the subsequent step would not be executed unless the specified time elapses. If no value is specified as waiting time, the next step gets serviced as soon as back criteria are fulfilled for the previous step.

b) The time required in executing the command of any step as well as the time required for appearance of check back signals of the steps is indicated as "monitoring time".

Under normal condition of the equipment each step shall be completed within specified time, otherwise a signal shall be generated indicating that specified monitoring time is getting exceeded and program is not proceeding further.

All the necessary interlocking and protection requirements of the process and equipments involved shall act as starting/stopping criteria in all modes of operations. All inputs required for protection system shall be on high priority basis.

Manual intervention shall be possible at any stage of operation and the Sequence control shall be able to continue at the correct point on return to automatic control.

Protection commands shall have priority over manual commands, and manual commands shall prevail over auto commands. Open or close priority shall be selectable for each drive.

The system shall be designed such that no upset occurs either to process or to the drive when the power is restored. Any action required during control power failure or after its restoration shall e initiated by the operator only.

The sequence start up modes shall be of the following types:

a) AUTOMATIC MODE

In this mode of operation, once the sequence is initiated the sequence shall progress without involving any action from the operator. The auto -sequence start/stop command shall be given from VDU based operator's console.

b) SEMI-AUTOMATIC MODE

In this mode of operation, once the sequence is initialized, the step progressing shall be flagged on the operator's console. But the step execution command shall be inter-locked and shall be sent by the operator.

It shall be possible to bypass and/or simulate one or more criteria to enable the program to proceed. This facility shall allow the program to be executed even if some criteria are not fulfilled because of defective switching device etc., while the plant condition is satisfactory. Since, this mode of operation necessitates a detailed understanding of the plant process, it is essential for the operating controls to be locked by three levels of password.

All the criteria bypassed shall be displayed and logged in plant DCS. It shall be possible to put the system on Auto-mode after operating it on semi-automatic mode for some steps or vice-versa, without disturbance to the operation.

c) OPERATOR GUIDE MODE

It shall be possible to use the sequential control in operator guide mode/test mode, i.e., the complete system runs and receives input from the plant and required commands from operator's station. This mode shall allow the operator to practice manual operation using step and criteria indications.

6.18.00 AUTOMATIC TURBINE TESTING (ATT) SYSTEM

CONTRACTOR shall provide ATT system for on-load testing of turbine protective equipment automatically in a sequential manner without disturbing normal operation and keeping all protective functions operative during the test. The ATT facility shall include but not limited to the following :

a) Opening and closing action of Emergency stop valves and control valves, reheat stop and interceptor valves.
b) Over speed trips.
c) Low vacuum trip
d) Thrust bearing trip
e) Electrical remote trip
f) Main trip valve

Automatic turbine testing mentioned under item (b), (c), (d) and (f) above shall be possible to be carried out on 100% load.

The CONTRACTOR shall include in his proposal all components for the above testing system like actuators, solenoid valves, pressure switches, limit switches etc.

The system should have the facility of selecting individual tests and detailed fault indications to identify malfunctions. The CONTRACTOR

shall clearly bring out all the features of the offered system in the proposal.

6.19.00 TURBINE SUPERVISORY INSTRUMENTATION (TSI)

Turbine supervisory instruments shall monitor the behavior of the turbine under various operating conditions and provide adequate information on the operational aspects of the turbine. The turbine supervisory equipment shall be complete including sensors, transmitters, converters, limit value monitors, measuring and amplifier modules, power supplies, etc. with the required accessories including special cables, compensating cables, junction boxes, etc. for all measurements but not limited to the following: -

a) Shaft eccentricity detection.

b) Absolute shaft vibration measurement at every bearing.

c) Absolute vibration in the bearing pedestals (both horizontal and vertical).

d) Differential expansion of rotor and cylinder.

e) Overall expansion.

f) Axial shift of the rotor.

g) Turbine speed.

h) Phase reference (key phasor)

i) Bearing metal and drain oil temperature and Turbine metal temperature shall be monitored from DEH.

Vibration measurements shall be carried out both for horizontal & vertical planes (X & Y) for any measurement. Vibration transducer shall be either seismic velocity type or piezo electric accelerometer type or proximity type, depending upon application. The vibration transducer shall be furnished in weather proof IP-55 housings.

The vibration monitoring system shall be furnished complete including vibration transducers with low noise flexible cable in flexible conduit, terminated at local junction boxes, all inter-connecting cables, mounting racks/cabinets, power supplies, calibration equipment, indicators, integrating units, signal conditioning devices and all other accessories required for monitoring of vibration at each point in velocity units and for completeness of the system.

All critical parameters of turbine like speed, frequency, vibrations, axial shift, differential expansion recorded in DCS. Power lubricating oil pressure shall be recorded in DEH.

Total six turbine speed sensors shall be provided, out of which three shall be used in DEH and three shall be used in ETS.

6.20.00 TURBINE STRESS CONTROL

Turbine Stress Control (TSC) System shall be so designed that the system shall work in conjunction with Turbine Automation System and DEH system to achieve the following functional requirements.

a) Continuous on-line monitoring of thermal stress levels in all critical parts of the turbine such as main stop valves, control valves, HP casing, HP shaft and IP shaft.

b) Continuous online computation of stress margins available for the above mentioned critical components of the turbine during various regimes of operation.

c) Computation of the limits of speed and load changes allowable at any particular instant before synchronization and after synchronization respectively.

d) Achieving turbine operation in conjunction with Turbine Automation System & DEH in various regimes of unit operation as per the mode (i.e. slow, normal, and fast) selected by the operator from operator station.

e) Analysis of fatigue for all major components of the turbine and also to compute the percentage service life consumption of the turbine.

f) Display the stress margins etc. for operator guidance and storage of necessary data such as percentage service life consumption etc.

CONTRACTOR shall provide all measuring transducers for generator load, temperature measuring sensors and transducers along with cold junction compensation for turbine casing wall, emergency stop valve, HP Turbine control valve, Turbine shaft temperature and any other special devices for stress calculations and turbine life calculations etc. All measuring transducers shall be terminated in local junction boxes.

The TSC System shall continuously display the free stress margins for the turbine critical parts. These margins shall be divided into two parts namely upper (heat-up) margin and lower (cool down) margin. The allowable load or speed gradient whichever is applicable shall also be displayed in a similar way. CONTRACTOR may display any other type of display as per the manufacturer standard.

The stress margin and speed/load gradients displays shall attract the operator's attention whenever the permissible limits are exceeded.

The TSC System shall provide at least three modes of turbine operation i.e. slow, normal and fast. Depending upon the urgency of unit start-up etc., the operator shall be able to select any of the three modes for turbine run-up and loading, for example when there is great urgency to start-up the unit, operator shall select the fast run-up mode whereas when there is not so much of urgency, the operator may select the normal or slow mode whichever suits best so that the turbine is not unnecessarily stressed. This will increase the overall turbine life.

6.21.00 TURBINE WATER INDUCTION PREVENTION (TWIP):

The turbine water induction prevention logic detects the presence of potential water admission sources, disposes of accumulated water, and isolates the turbine from the water source as required. The turbine water induction prevention logic shall be designed in accordance with ASME Standard TDP-1 and implemented in DCS.

The TWIP logic serves three major functions :

a) Prevents water accumulations by inhibiting the use of attemperating sprays at low loads.

b) Prevents the carry-over of water from sources such as the boiler and deaerators.

c) Disposes of accumulations of water in low point drains by forcing drain valves open during low load operations and prior to turbine startup.

d) High level in heaters resulting water ingress inclusion of gland seal condenser.

6.22.00 BY-PASS CONTROL SYSTEM (BPC)

HP & LP Bypass Control Systems should permit faster start up of the BTG unit, establish reheater flow during starting & low load operation and also should act as a pressure relief device in case of sudden load throw off or turbine trip by bypassing the active steam to condenser via reheater.

HP & LP Bypass systems' control functions shall be implemented in the DCS system. The by-pass systems shall incorporate pressure and temperature control valves to allow de-superheating of the steam prior to application to the condenser. After fast opening on auto, bypass system should comeback automatically to pressure control mode to maintain the set pressure without any operator intervention.

HP/LP bypass shall be hydraulically operated to get fast response.

The DCS CPU response time, scan time of I/O cards, control loop execution time, EHG response time, bypass valve response time etc.

should be suitably selected to ensure achievement of the house load operation.

6.23.00 FLAME MONITORING SYSTEM

The Flame Monitoring System (FMS) shall include suitable IR/UV flame detectors of proven type, conforming to NFPA recommendations with solid-state logic circuits for each burner element. FMS be capable of discriminating between oil and coal flames. The flame-monitoring amplifier shall generate 4-20mA DC signals corresponding to flame intensity and flicker and also digital outputs. Outputs of FMS shall be fed to DCS for control and monitoring. The FMS shall have following monitoring features:

a) 100% self-checking for electronics.
b) Flame conditions shall be clearly indicated by means of bar graph, flame icon, and digital display on screen of monitor.
c) Early warning of flame instability, flame-out condition and diagnosis of Burner Malfunction.
d) Pre-selectable "Flame Off" response time.
e) The system shall provide potential free contacts (Dry contacts).

Complete cooling air system for the flame scanners shall be provided with main and DC stand -by fans with associated instruments to provide uninterrupted cooling air supply.

6.24.00 ELECTRONIC DRUM WATER LEVEL INDICATOR (EWLI)

CONTRACTOR shall supply conductivity type boiler drum level indicator based on conductivity discrimination principle between water and steam.

Instrument shall be complete with its local and remote indicators, isolation valves, drain & vent vales, special cable, probes etc. Remote indicator shall be installed on BTG panel in central control room. The signals shall be given to DCS for displaying on operator workstation also.

6.25.00 FIELD INSTRUMENTS & ANALYZERS

6.25.01 Field instruments shall be suitable for area in which these are located. In general field instruments shall be weatherproof, dust tight and corrosion resistant with protection class IP-65 for outdoor applications and IP-56 for indoor applications.. Field instruments shall be suitably grouped or clustered area-wise and shall be terminated in local junction boxes.

6.25.02 PROCESS TRANSMITTERS

All the Process Transmitters shall be 2-wire smart (HART) type with integral LCD indicator and with facility for remote calibration. These shall support international field bus. Transmitters shall also have 4-20 mA DC output with driving capacity upto 500 ohms. Transmitters shall be properly

grouped and mounted in transmitter enclosure to be placed at suitable locations.

Dedicated HART management system for configuration, maintenance, diagnostics and record keeping facility for electronic transmitters required to be provided.

Pressure transmitters shall be provided for the following as a minimum, but not limited to:

- At suction and discharge of all major pumps/fans
- For all control applications as demanded by the process. It shall be noted that for all critical control applications as defined in Annexure-4 of this section , redundant transmitters shall be provided.
- Pressure conditions of all major vessels/tanks like deaerator, hotwell, boiler drum etc.

Differential Pressure transmitters shall be provided for the following as a minimum, but not limited to:

- - For all the requirements of differential pressure, flow and level measurements. It shall be noted that for all critical control applications as defined in Annexure-4 of this section , redundant transmitters shall be provided.
- .

Temperature transmitters shall be provided for the following as a minimum, but not limited to:

- - Where the RTD/thermocouple are used for control/protection application. It shall be noted that for all critical control applications as defined in Annexure-4 of this section , redundant transmitters shall be provided.

Level transmitters shall be provided for the following as a minimum, but not limited to:

- On process equipment where continuous remote monitoring and/or control of level is envisaged

6.25.03 PROCESS GAUGES

Process gauges shall be provided for local indication, trial run and testing of various equipment. Local Gauge boards shall be provided for operator convenience. Each vessel shall be provided with direct level gauges to monitor the level locally. All pump pressure gauges at discharge and suction line, where pressure variation is more, the pressure gauges shall be oil or glycerin filled type.

6.25.04 TEMPERATURE SENSORS

All temperature elements shall be of duplex type with thermowell. Depending on temperature ranges, 3 wire Pt-100 Resistance Temperature Detector (RTD) and thermocouple of type J, K and T(ISA

standard) shall be used. For low temperature zone having vibration, J-type thermocouples shall be used where as in other low temperature application upto 400 deg. C, RTD shall be used. T type shall be only for Generator stator winding temperature if used. For higher temperature K-type thermocouples shall be used. Metal temperature thermocouples shall be used for drum and super heater and re-heater. Cold junction compensation should be applied for thermocouple measurements.

6.25.05 PROCESS SWITCHES: PROCESS TRANSMITTERS GENERALLY SHALL BE USED INSTEAD OF PROCESS SWITCHES. PROCESS SWITCHES SHALL BE USED ONLY AT SOME PLACES PER RECOMMENDATION OF EQUIPMENT MANUFACTURERS. IF SWITCHES ARE USED, MAKE SHALL BE SOR OR UE.

For critical alarm and protection/interlock functions, direct process switches (pressure, level) contacts shall be used. Transmitter also may be used if dedicated for protection function and separate from that of control.

Temperature switch and Flow switch shall not be used for protection function.

Pressure switches/transmitters shall be provided for the following as a minimum, but not limited to:

- On all process lines/equipment where parameter abnormality/status including pre trips alarms to be communicated to the operator in control room.
- For all permissive conditions governed by safety operation of the equipment, eg. pressure adequate condition
- For all protection conditions, eg. pressure very high/very low conditions
- For all interlock conditions which governs starting of standby equipment or subsequent equipment for safety operation of the system
- Redundant switches shall be employed for protection in case of critical applications

Differential Pressure switches/transmitters shall be provided for the following as a minimum, but not limited to:

- Across filters/strainers for remote monitoring

Temperature switches shall be provided where parameter abnormality to be communicated to the operator in the central control room.

Level switches shall be provided for the following as a minimum, but not limited to:

- On all equipment (storage vessel) where level variations/ abnormality/status to be communicated to the operator in the control room

- All permissive and interlock conditions governed by the safety operation of the equipment and for protection conditions. For all critical services, redundant switches shall be provided for protection application.

Flow switches shall be provided for the following as a minimum, but not limited to:
- Genarlly at different outlet header of identical equipment to alarm in the event of inadequate coolant circulation or lube oil circulation.

6.25.06 FLOW ELEMENTS

For the measurement of flow for clean fluids, concentric square edge orifice plates shall be provided. For high pressure fluid lines having nominal size 100 mm and above flow nozzles shall be used except for main steam flow. For oil service, positive displacement or coriolis type flow meters shall be used. Aerofoils/annubars/venturis shall be used for air flow measurement. All flow element calculation, design and construction shall be based on BS/ASME Standard. Wherever required, flow signals shall be pressure and temp. compensated.

6.25.07 LEVEL MEASUREMENT

Tank Level measurement shall be electronic top mounted capacitance/ Piezo electric/ Buoyancy type or DPT type for local and remote indications.

Complete Coal Bunker Level and Fly Ash Silo Level Monitoring System consisting of Radar type of measurement shall be provided. The signal/alarm may be interfaced with main DCS for information purpose.

6.25.08 FINAL CONTROL ELEMENT

Response time of the final control elements shall be carefully considered vis-a-vis the process dynamic requirement during selection of the type of final control element.

a) In general, Pneumatic Power Cylinders for control dampers and diaphragm operated Control Valves shall be envisaged for control purpose.

b) For system like Governing Control, Steam Bypass Control etc. hydraulically controlled final control element shall be used to match the dynamic response of the plant.

c) For isolating and inching services, electric actuators shall be provided unless fast response is required.

d) For fast trip applications like fuel oil shut off valve etc. solenoid operated pneumatic trip valve shall be used.

All the final control elements shall be complete with suitable smart positioners, Air lock Valve, end position (open/close) limit switches, local position indicator, Position transmitters, I/P Converters, Limit Switches, and hand wheel with lock , air filter regulator etc., as required for the operation of the plant.

The control valves shall, in general, be globe body single or double seated type. They shall be in manifold form with isolation, bypass and drain valves except where redundant valves are provide.

The final control element shall be designed for stay put/open position as per the plant requirement upon failure of power/air supply.

Where a single control valve cannot meet the turn down ratio as dictated by the process, control valves with split range application shall be provided.

a) Solenoid valves shall be provided with pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below, as a minimum, but not limited to:Two(2) way solenoid valves shall be provided, where process line of less than 2 inch with low pressure & temperature application eg ACW overhead tank makeup line
b) Three(3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder. Eg:pneumatic operated spray water block valve.
c) Four (4) solenoid valve shall be provided for operating double acting cylinders eg.pneumatically operated on-off type dampers
d) Two trip solenoid valves (single coil) normally energized type shall be supplied for protection application and single coil for open/close application.

6.26.00 STEAM AND WATER ANALYSIS SYSTEM (SWAS)

SWAS shall be designed for continuous monitoring of Steam and Water quality at strategic points of the plant cycle.
Sampling points and measurements as below should be included :-

Make-up DM Water	- Conductivity, silica
Hotwell condensate	- Conductivity
CEP discharge	- Conductivity, pH, Dissolved Oxygen
CPU outlet	- Conductivity, sodium
LP Heater outlet	- Conductivity
Deaerator outlet	- Dissolved Oxygen
Economiser inlet	- Conductivity, pH, Hydrazine
Boiler drum water	- Conductivity, pH, Phosphate
Main Steam	- Conductivity, silica, Degassed cation conductivity
Reheat steam	- Conductivity

SWAS shall comprise of mainly :

a) Sample Handling / Conditioning System having filters, pressure reducing elements, secondary coolers, grab sample valve etc. to perform initial pressure and temperature conditioning of the sample and the wet part of the analyzers.

b) Dry section (separate from wet section) shall house the electronic components of the Analyzers, indicators, Push Buttons etc. Annunciator will be provided at the panel.

c) Conductivity, pH, Silica and Dissolved Oxygen etc. shall be measured on line and at appropriate points of the cycle. All the monitoring instruments shall have standard 4-20 mA output for monitoring at DCS.

d) SWAS shall be complete with sampling points, root valves, isolation valves, impulse pipe, cables, special cables and all accessories. Interface of SWAS parameters with DCS shall be provided.

e) Automatic hydrazine feed control system and ammonia feed control system shall be provided with chemical feed system.

f) The SWAS analyzers shall be placed in air conditioned environment. The SWAS sampling rack/wet panels shall be placed in the separate non AC room adjacent to SWAS analyzers room.

6.27.00 GAS ANALYZERS:

a) To monitor the quality of combustion and to control optimum combustion signals from various flue gas analyzers like Oxygen (Zirconia type), Carbon Monoxide etc. shall be deployed.
b) For detection of air heater air leakage Oxygen Analyzers shall be used.
c) The construction and material of the probe and shield shall be suitable for use in flue gas temperature upto 1600°C and abrasion due to high ash coal.
d) O_2 analyser shall be non-sampling type using zirconia probe. Zirconia probe analyzer should have facility of in-situ calibration. Calibration should be done using standard test gases. Analyzer shall have built in auto calibration facility.

OXYGEN ANALYZER

01.	Type	:	Zirconium sensor, micro-processor-based transmitter, field repairable.
02.	Range	:	0.1-10% / 0.25-25% by volume
03.	Output	:	4-20 mA DC linear
04.	Probe Length	:	1800mm (approximate depending on duct size)
05.	Process Temperature	:	850 ^{O} C approx.
06.	Measurement Reference	:	Instrument Air
07.	Accuracy	:	± 1% of F.S.
08.	Response Time	:	Less than 5 (five) seconds
09.	Amplifier Housing	:	IP-65
10.	Calibration	:	Automatic periodic
11.	Calibration Frequency	:	Once every 24 hours
12.	Power Supply	:	110V, 50 Hz, 1 Phase
13.	Material for Gas Carrying Components		Stainless Steel
14.	Read Out	:	Local indicating Meter
15.	Protection	:	Automatic cell protection against reducing atmosphere
16.	Alarm Facility	:	1 HI and 1 LO independently adjustable over span. Contact rating 500 mA at 220 V DC (minimum).
17.	Preferred Features	:	i) HI and LO alarm LED visible from front. ii) Power Supply On/Failure LED visible from front
18.	Accessories	:	i) Mounting flanges, adaptor plate and protection shield ii) Probe filter flame arrestor iii) Cable with conduit from cell to amplifier (as required) and other special cables (if any)

iv) Automatic calibration kit (complete with all accessories and standard Gas Cylinders)

6.28.00 EMISSION MONITORING SYSTEM

In conformity with the local and national pollution control norm, online continuous Emission Monitoring System shall be provided for monitoring SOx, NOx, CO and particulates on Flue Gas Stack. The system shall comprise of isokinetic sampler/s to draw representative samples, coarse and fine filter, line heater, manifolds etc for drawing the sample from specified elevation recommended by EPA. Particulate analyzer, measuring dust content in mg/m^3, shall be located at specific chimney elevation for across the stack measurement. Opacity monitor shall be installed at the outlet of ESP on each pass. Oxygen analyzer shall be envisaged to convert ppm into lbs/MBTU for Sox/Nox measurements.

An analyzer shelter, located near chimney, shall house the SOx, NOx, CO, SPM analyzers, reference gas cylinders, sample processing system and an operator's console for display and report generation. The system shall be hooked-up with the plant DCS through hardwired interconnection for diagnosis, calibration and on demand report generation to meet the requirements laid down by appropriate regulatory authorities. The system shall have facility of local display / indication on the analyser cubicle of all measuring parameters along with display facility in DCS. Link shall be established between CEMS and DCS for data reporting and central monitoring.

6.29.0 AMBIENT AIR MONITORING SYSTEM:

The Ambient Air Monitoring System shall meet the following requirements: To demonstrate compliance with ambient air quality standards, and as required by the State Pollution Control Board, four (4) ambient air quality monitoring stations shall be installed in and around the project area at approved locations. (For details refer Cl.4.00.00, sec-XIXB7)

6.30.00 MACHINERY MONITORING SYSTEM

In order to monitor the health of large drives, adequate number of vibration measuring instruments shall be deployed in important drives and equipment like ID/FD/PA fans, Boiler Feed Pumps, Condensate Extraction Pumps, Cooling Water pumps, Coal mill, Steam turbine, BFP turbine/motor, turbine generator. For turbines, complete turbine supervisory instruments like eccentricity, axial shift, differential expansion etc. shall be deployed in addition to vibration measurement. All these monitoring instruments shall have standard 4-20 mA output for connecting them to DCS and other secondary instruments as applicable.

In addition, all the vibration measurement of main turbine & BFP turbine shall be connected to a Centralized PC based vibration analysis system.

Machine monitoring system for Main Turbine and BFP turbine/Motorized BFP monitoring shall be Bently Nevada BNC 3500.

Vibration analysis system shall be System 1 by Bently Nevada which will be integrated with BNC 3500 for main turbine, and BFP turbine.

While selecting the vibration monitoring system for HT motors like CEP, ID/FD/PA, CWP, Mills etc., and CONTRACTOR shall keep in mind that the vibration data of these HT motors shall be available in DCS for monitoring.

6.31.00 BOILER TUBE LEAKAGE DETECTION SYSTEM

A computer based boiler tube leak detection system using acoustic and vibration transducers shall be supplied. The system shall be capable of identifying small steam leaks inside the boiler against high levels of background noise and by continuously monitoring the growth of a steam leak from its inception, provide information about the severity and position of leaks to enable them repaired quickly. The system shall provide the information about the steam leak in the form of potential free contact for alarm in addition to alarm display for sensed transducers in bar-graph and boiler mimic (for location of leak) display on PC colour monitor. The system should also provide information from the field transducer in the form of trend displays, frequency spectrum and unfiltered sound at each transducer in loudspeaker/headphone.

The system should also provide optional facility for inhibiting the unwanted sound signals in display information from the soot blowers in operation. The system shall include automatic and manual purging facility for keeping the wave-guides of acoustic transducer clean. Data storage of transducer signals information for a min. of previous 60 days should be available on the computer hard disc for analysis in trend / bar graph/ frequency spectrum displays. The system should test field transducers and its associated electronics for healthiness automatically and on manual demand. The system should have facility for calibrating the field transducers and its electronics for sensitivity adjustment with a portable calibrator.

6.32.00 ONLINE CONDENSER TUBE CLEANING SYSTEM

For maintenance of cleanliness of condenser tubes, this system based on ball re-circulation type shall be employed. The system shall be PLC based with One no. Ball recirculation monitor.

6.33.00 ELECTRICAL CONTROL SYSTEM

Complete control, monitoring / status indication of electrical system (including HT/LT boards, distribution boards etc.) shall be provided through DCS.

The status input of all relevant electrical equipment and sub-systems and electrical parameter shall be considered as input for display of complete electrical status of the system.

Energy management system shall be implemented in DCS.

Numerical relays and Load managers of MCCs (may be Daisy chained) shall be connected to OPC server for interfacing to DCS. Gateways shall not be used.

One ES cum OS shall be located in the switchyard control room for Electrical SCADA system. One Engineering Station (ES) with dedicated B/W laser printer and One Operator station (OS) shall be provided for switchyard SCADA system in CCR and also interfaced to DCS for monitoring. Details shall be worked out during detail engineering.

6.34.03 Deleted

6.35.0 MAINTENANCE AND CALIBRATION EQUIPMENT:

Maintenance and calibration equipment shall be of proven type. One Electronic Test Bench and one Pneumatic test bench, DCS Module Testing kit along with tools and equipment required for proper maintenance and calibration of the installed C&I devices and systems shall be supplied by the contractor. A list of maintenance and calibration equipment is mentioned in VOL-II-SEC-XIXB12 of this tender specifications.

6.36.0 Deleted

7.00.00 UTILITIES

7.01.00 ELECTRIC POWER SUPPLY

The power supply shall be designed to meet the electric power requirements of various C & I systems including DCS. The power supply to the Control & Instrumentation System shall be 240VAC 50 Hz from completely redundant UPS at one point through 2nos. feeders. Necessary derivation and distribution to make the system complete and reliable shall be done.

Each off site plant control system and remote pump house control systems shall be powered from their own packaged completely redundant UPS units.The rating shall be suitable designed.

Separate UPS shall be provided for administrative office.

UPS for communication system shall be separate from plant UPS.

All power supply systems would be sized for 30 Min. battery back up to take up the entire load in case of total power blackout and with 25 % spare capacity for additional load augmentation in future.

24VDC power supply shall be used for contact interrogation.

220VDC Power supply shall be used for protection circuits and Turbine trip solenoids. 24VDC shall be used for other solenoids.

7.02.00 AIR SUPPLY

Air Supply system shall be designed for dry instrument quality air at 6.0 Kg/sq.cm (max.) terminated with an isolating valve and distribution network to cater to various instruments. The instrument air supply system for various pneumatic C & I devices shall be complete in all respects with necessary filter regulators, valves, piping/tubing etc.

There shall be an instrument air buffer vessel which can cater to complete instrumentation requirement for at least the time period required for safe shutdown of the plant, in case instrument air fails.

Each pneumatic instrument shall have an individual air shut-off valve. The pressure regulating valves shall be equipped with internal filters, pressure gauges and built-in filter. All pneumatic actuators for control valves/dampers etc. shall be designed to operate at minimum of 4.0 Kg/sq.cm supply air pressure.

8.00.00 METERING BASES OF CHART UNITS

Metering bases of chart units shall be SI(international standard) units. The following system of units shall be followed throughout the specification unless otherwise mentioned :

a)	Pressure	:	KG/Sq.cm or Bar
b)	Differential Pressure	:	mm of water column or Kg/Sq.cm.
c)	Draught	:	mm of water column
d)	Vacuum	:	mm of water/Hg column
e)	Temperature	:	Degree Celsius
f)	Flow (steam, condensate, feed water)	:	Tonnes/Hr.

g)	Flow (furnace oil)	:	Kg/hr.
h)	Flow (Air/Gas)	:	N Cu.m/hr.
i)	Flow Base	:	760 mm of Hg at 16 Deg. C
j)	Density	:	gm/cc
k)	Level	:	mm
l)	Conductivity	:	Micro-mho/cm.
m)	Gas Analyser	:	Percentage by Volume.

9.00.00 CODES & STANDARDS

9.01.00 GENERAL

9.02.00 All equipment, systems and works covered under the CONTRACTOR's scope shall comply with all statutory regulations and safety codes as applicable internationally and in locality where the equipment will be installed.

9.03.00 The CONTRACTOR's scope of supply shall include some items such as thermowells, control valves and other in-line devices for main steam, feedwater system, falling under the purview of Indian Boiler Regulation (IBR) Act. It shall be the responsibility of the CONTRACTOR to obtain the necessary approval of the concerned Inspecting Authority/Chief Inspector of Boilers for the design and design calculations, manufacturing and erection procedures as called for under the Indian Boiler Regulations Act.

9.04.00 The design, manufacture, inspection, testing and erection of the equipment covered under this Specification shall conform to the standards and codes (latest editions) including but not be limited to those mentioned below. Contractor shall refer to the latest revision of all codes and standards.

CONTRACTOR shall however, follow sound Engg. practice throughout.

Temperature Measurement	-ASME PTC 19.3 ANSI MC 96.1 IEC 751 BS 1401 IS 2806 DIN 43760
Pressure Measurement	-ASME PTC 19.2 IEC 381 IS 3624
Flow Measurement	-ASME PTC 19.5 BS 1042/ ISO 5167

Control Valves	ISA S 75.01-75.05 ANSI B16.34 ANSI B16.10
Sampling System	-ASME PTC 19.11 ASTM D1198 ASTM A 269
Enclosures	-IEC 529 IEC 79 (Hazardous) IS 2147/IS 13947
Annunciator	- ISA S 19.1
Boiler Safety Interlocks	- NFPA Section 85B/D/E/F/G
Instrument Tubing, Fitting	- ANSI B 16.11/B 31.1
Cables	- IEEE 383 BS 6746 IS 5831 BS 5308 BS 6346 IS 10810 IS 1554 BS 6360 IS 694 IS 8130 BS 6500

10.00.00 SCOPE OF WORK

10.01.00 The scope of supply covers complete Control & Instrumentation of boiler, turbine, all auxiliaries and common facilities for the Power Plant .

10.02.00 The supply for the complete Control & Instrumentation system shall include Distributed Control System (DCS)/Programmable logic control system (PLC) with complete set of Hardware & Software, Primary/Secondary instruments, Steam and Water Analysis System (SWAS), Continuous Emission Monitoring System (CEMS), Electronic Drum Level Indicators, Furnace safeguard supervision system (FSSS), Automatic Turbine Run-up System (ATRS), Automatic Turbine testing system (ATT), Turbine Governing system (DEH) & Turbine Supervisory system (TSI), Machinery monitoring system, TDM for TG and BFP Turbine. Back up panels, , Master & slave clock system, Automatic steam leak detection system, Condenser online tube cleaning system, C&I Lab instruments, Intercommunication System, Fire Alarm system, Ambient Air Quality Monitoring System,,Panels/Cabinets/Desks/Gauge Boards(completely tubed/wired), Junction Boxes, Control Valves & Actuators, Instrumentation Cables along with cable-trays, supports and Process Connection/Tubing, etc. for the Power Plant covering the total functional requirements of monitoring, controlling, alarming, sequence interlocks and equipment protection, etc. for boiler, turbine, auxiliaries and common facilities.

10.03.00 Commissioning and erection including supply of erection hardware for the entire plant.

10.04.00 Spares needed for commissioning and recommended spares for two years trouble-free operation as per the commercial contract.

10.05.00 Special tools & tackle as needed for proper maintenance.

11.00.00 TESTING AND INSPECTION

11.01.00 TESTING AND INSPECTION AT WORKS

Shop test shall be performed to ensure that all equipment / subsystems / systems furnished are manufactured and tested from component inspection stage to the Acceptance Test at shop conforming to the requirements of the specification and approved Quality Assurance Programme.

Typical tests are as follows :-

11.01.01 MICROPROCESSOR BASED CONTROL SYSTEMS

a) Demonstration of proper function of critical hardware.

b) Demonstration of all human/machine function.

c) Checking of proper functioning of software/application software packages.

d) Demonstration of diagnostic features and auto switchover from main to standby system/hardware.

e) Thorough exercising of each device including processor.

f) Simulation of all major closed loop control and open loop control with mathematical mode/simulator.

g) Checking spare system capacity and various scan time/response time.

h) Burn-in and elevated temperature test, surge protection test.

i) Power consumption and Power failure protection checking.

j) Checking of all print out and display formats.

k) Environmental test.

11.01.02 All non-destructive examinations shall be performed in accordance with ASME code requirements.

11.01.03 Various performance tests like hydrostatic test, leakage test, Cv test of Control Valves. calibration checking of field instruments, etc.

11.01.04 Calibration checking of field instruments.

11.01.05 Sample checking for various erection hardwares.

11.02.00 TESTING AT SITE

A few typical tests have been indicated below :

a) Complete Loop Checking with transmitters, actuators and other accessories connected.

b) Checking of sequence and interlocks.

c) Compatibility test for testing communication between subsystems, PLCs and DCS.

d) Pre-commissioning trials and start-up tests.

e) Hydrostatic testing, air testing of different instrument piping at 1.5 times of design pressure..

f) Continuity, identification and short circuit tests, insulation tests.

g) Performance Guarantee Tests

i) Test for Steady State Operation

ii) Dynamic Load Test

12.00.00 DATA AND DOCUMENTS

12.01.00 DATA AND DOCUMENTS TO BE FURNISHED BY THE CONTRACTOR

a) Plant Operational Philosophy.

b) Description and write-up of control and interlocking system.

c) Complete layout diagrams with foundations details of all panels, desks and consoles.

d) Interconnection blocks schematics and architecture drawing for complete C & I equipment and systems.

e) Interconnection & wiring schematics between various instruments and sub-assemblies.

f) Detail wiring diagrams of all panel desk, control consoles, system cabinets etc.

g) Proposed displays and logs with menu and format.

h) Flow chart for auto control loops. Logic flow sheets/Boolean diagram for open loop controls.

i) Flow element and Control valve sizing calculations and dimensional drawings.

j) Scheme for steam and water analysis system.

k) Scheme for Machinery Monitoring System.

l) P&IDs for all systems.

m) Interconnection Diagram of different PLC's / C & I systems of BOP plants and the DCS showing all hardware details.

n) Complete Instrument Schedule.

o) Calibration test & quality assurance test procedure and test certificates.

p) Shop and site Test Records.

q) DCS documentation.

r) Manuals & technical literature for DCS and other instruments/ equipments.

s) Software documentation including as built database listing, loop schematics, diagrams, autocad drawings, manuals, backup of data base and graphics on CD etc.

t) Instrument installation diagram showing all erection hardware.

u) Cable Schedule and interconnection diagram.

v) Power supply arrangement for field mounted instruments/panels/sub systems.

w) 'As built' status drawings.

x) Plant operation philosophy with listing of control centers.

y) Plant control system architecture diagram indicating the DCS

z) configuration alongwith the interconnections with various C&I subsystem

aa) Filled up Technical Particular Sheets/Schedules.

bb) Control Room ,Control equipment room Layout.

cc) Closed Loop and Open Loop Control Schemes along with write-up.

dd) Details of C & I and PLC System offered for BOP plants and subsystems.

ee) Lists of spares (erection/ commissioning & recommended), special tools and tackle.

ff) Vendor list of instrumentation items.

I0: C&I TECHNICAL SPECIFICATIONS

SEC-XIXA : CONTROL DESIGN CRITERIA

ANNEXURE-1

Control implementation philosophy for BOP systems

Sr. No.	BOP Packages	Control From
1	Fuel Oil Storage, Handling and Conditioning System	PLC based with LCP
2A	Pre-treatment Plant including the Chlorination system	DM Plant PLC with LCP (if applicable)
2B	Raw Water Pump, fire water pump	PLC with LCP
3	Auxiliary Water System (potable, service, CW make up water, DM makeup etc)	DM Plant PLC with LCP (if applicable)
4	Demineralized Water Treatment Plant	PLC Based with OS & OS/ES
5	Circulating Water System & Auxiliary Cooling Water System	DCS based; controlled from Central control room
6	CCW side treatment	DM Plant PLC with LCP (if applicable)
7	Cooling Towers & Accessories for the CW & ACW system	DCS based; controlled from Central control room
8	Effluent Treatment Plant	Separate PLC with LCP (if applicable) interfaced to DM plant PLC through soft link
9	RO plant	DM plant PLC with LCP (if applicable)
10	Fire Protection and Detection System	PLC/Microprocessor based system with LCD display/OS

11	Compressed Air System	PLC based for Plant Compressed Air System(Instrument Air and Service Air) and hardwired to DCS for controls and monitoring. For AHP compressed Air System shall be PLC based monitoring and control from AHP OS.
12	Air Conditioning & Ventilation System	PLC based with LCP (if applicable)
13	Chlorination and Acid dosing for CW system	PLC/Microprocessor based system with LCD display/OS
14	Coal handling system	PLC Based with OS & OS/ES
15	Ash handling system	PLC Based with OS & OS/ES

I0: C&I TECHNICAL SPECIFICATIONS
SEC-XIXA : CONTROL DESIGN CRITERIA

ANNEXURE-2

Drive Control Interface: Control philosophy for interfacing of MCC/SWGR./ Actuator with PLC/DCS

Drive Control philosophy: Control philosophy for interfacing of MCC/SWGR./Actuator with PLC/DCS						
Type of Drive	**Local (LCS)**		**MCC / SWGR**		**Control room / PLC**	
	Control	**Indication**	**Control**	**Indication**	**Control**	**Indication**
LT Unidirectional motor	Stop(Locked), Start		Stop PB(Locked), L/R selection.	ON/OFF, Motor Overload, Ammeter for Motor Above 30KW	A/M Selection, Start, Stop	Bkr. Close, Bkr. Trip, Current >= 30KW, Current < 30KW – Critical Motors, Local/Remote, Local Start, Integrated Alarm – Device Fault, Protection Trip, Control Ckt. Unhealthy
HT Unidirectional Motor	Stop(Locked), Start		Stop PB(Locked), L/R selection.	ON/OFF, Trip Ckt. Healthy, Trip relay operated, KW Meter, Ammeter	A/M Selection, Start, Stop	Bkr. Close, Bkr. Trip, Current, Local/Remote, Local Start, Protection Device Fault, Protection Trip, Bkr. In service, Bkr. In test, Integrated Alarm – Device Fault, Control Ckt. Unhealthy, WDG/BRG Temp

LT Bidirectional Motor (Non Inching type) integral Starter	Start Fw/Open, Start Rev./ Close, L/R Selection	Fw/ Open, Rev./ Close, Open/ Close Limit Sw., Open/ Close Torque Sw, Fault	--	--	Open, Close	Open LS, Close LS, Fault & L/R Selection
LT Bidirectional Motor (Inching type) integral Starter	Start Fw/ Open, Start Rev./ Close, Stop P.B, L/R Selection	Fw/ Open, Rev./ Close, Open/ Close Limit Sw., Open/ Close Torque Sw, Fault	--	--	Open, Close, Stop PB.	Open LS, Close LS, Fault, L/R Selection & Position feedback
Solenoid Operated Valve	--	--	--	--	Open / Close	Open / Close

I0: C&I TECHNICAL SPECIFICATIONS
SEC-XIXA : CONTROL DESIGN CRITERIA

ANNEXURE-3

I/O redundancy criteria

The parameters of the following control loops/system/equipment, can be considered for provision of I/O redundancy, as a minimum:

- Feedwater control
- Furnace draft control
- Drum level control
- Reheated Steam Temperature control
- Superheated Steam Temperature control
- Deaerator control
- Condenser hotwell level control
- Air flow control for combustion
- Primary air pressure control
- Fuel flow control
- Mills
- Coal feeder
- BFP
- CEP
- CWP
- ID fan
- FD fan
- PA fan
- Condenser Vacuum system
- Lube oil system
- Trip oil system
- Turbine speed
- Turbine vibration
- ETS (Triple Redundant)
- MFT (Triple Redundant)
- FSSS
- DEH

I0: C&I TECHNICAL SPECIFICATIONS
SEC-XIXA : CONTROL DESIGN CRITERIA

ANNEXURE-4

Redundancy criteria for transmitters

Triple Redundant transmitters shall be provided for the following controls / measurements, as a minimum:

- Drum level
- Feed water flow : (One no. of Flow nozzle.)
- Main steam flow :
- Main steam pressure
- Furnace pressure
- Primary Air flow
- Secondary air flow

Dual Redundant transmitters shall be provided for the following controls/measurements, as a minimum:

- Fuel_flow (Non redundant)
- Primary air pressure
- Oxygen analyzer at economizer oultlet
- Windbox to furnace differential pressure
- Fuel oil pressure
- Hotwell level
- Deaerator pressure
- Deaerator level
- HP heaters level
- LP heaters level
- CBD level
- Condensate flow
- Heater drain flow : For Heater drain no flow element and transmitter will be connected. However necessary arrangements shall be provided for PG Test.
- Mill outlet temperature
- Feeder speed
-
- BFP recirculation flow
- CEP recirculation flow
- .
- Soot blower pressure
- Soot blower temperature
- Primary SCAPH outlet temperature
- Reheater Desuperheater temperature
- Reheater Outlet temperature

- Superheater Desuperheater temperature
- Superheater Outlet temperature
- Secondary Air flow

WARDHA POWER CO. PVT. LTD.
3600 MW COAL BASED POWER PROJECT
AT NARIYANA, JANJGIR-CHAMPA DIST. CHATTISGARH

ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB1

DISTRIBUTED CONTROL SYSTEM

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB1: DISTRIBUTED CONTROL SYSTEM

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I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB1: DISTRIBUTED CONTROL SYSTEM

1.00.00 INTRODUCTION

1.01.00 This specification presents all aspects of design, engineering, manufacture, assembly, acceptance testing at manufacturer's works, delivery at site, erection, site acceptance test and commissioning of Distributed Control System (DCS), required for centralized, effective and optimum control and monitoring for 3 600 MW Coal based Power Plants being set up by , Wardha Power Co. Pvt. Ltd (WPPL) at Nariyana village, Janjgir-Champa District, Chattisgarh, India.

1.02.00 System shall be state of the art microprocessor based & of proven design, the performance & high availability having adequately demonstrated over a substantial period of successful operation. The CONTRACTOR shall furnish sufficient document evidence to satisfy the Owner in this regard.

1.03.00 CONTRACTOR shall accept full system responsibility for all supplied hardware and software and provide necessary training, supervision, and spares. They are fully responsible for construction, pre commissioning and commissioning assistance until successful handover to Owner.

1.04.00 The process, operational and functional requirement for the system shall take precedence over other related information contained within the specification. Any omissions in the specification shall not relieve the CONTRACTOR from his obligation to provide a system compatible with the intent of the specification.

1.05.00 The CONTRACTOR responsibility shall include but is not limited to the following items.

a) Detailed functional design specification for the hardware and software.

b) System engineering.

c) System hardware

d) System programming & configuration

e) Factory testing.

f) Packing, shipping & storage at site.

g) System documentation on electronic media/CD. (Auto CAD latest version) as well as hard copy and reproducible tracing.

h) Power supply distribution for the entire DCS system.

i) Loop checking

j) Integration of the third party hardware/software envisaged including SOE and PLC etc. & necessary co-ordination.

k) Pre-commissioning including tuning.

l) Erection & Commissioning & initial operation during stabilization of the plant.

m) Site Acceptance Test.

n) Hand over of a complete working system.

o) Warranty

p) Training

q) Installation

r) Recommended spare parts for 2 years as per commercial contract.

s) As built documentation

2.00.00 CODES & STANDARDS

2.01.00 All equipments, systems and works which are in the scope of the CONTRACTOR shall comply with the latest statutory regulations and safety codes as applicable in the locality where the equipments and the system will be installed.

2.02.00 As a minimum the supply items shall conform standard codes, Govt. & local regulations.

a) National Electrical Safety Code (NESC).

b) National Electrical Code (NEC).

c) Instrument Society of America (ISA).

d) Indian Standard Institute (ISI).

e) International Standard Organization (ISO).

f) IEEE - 796

g) IEEE - 802.4/ 802.5

h) Modbus Protocol

3.00.00 GENERAL REQUIREMENTS

3.01.00 The system shall have distributed intelligence architecture and will comprise independent multifunction processors for execution of open loop and closed loop control and data acquisition function. (Suggested DCS makes are: ABB/Westinghouse/Foxboro)

3.02.00 The design philosophy of the system shall encompass state-of-the-art technology and architecture, providing a cost effective installation. It is foreseen that geographically distributed system with smart sensors and actuators may be used in the plant selectively to arrive at the optimum cost-performance benefit.

3.03.00 The DCS System shall have the following capabilities, as minimum:-

a) Scan, acquire, validate, time-tag, process, store, update, archive, retrieve and display all analog and digital data and parameter.

b) Monitor real and calculated variables for multi-level alarm conditions.

c) Accept and execute operator's commands and pre-programmed routines and run-times.

d) Perform all open and closed loop control functions.

e) Display plant mimics, bar-graphs, control templates, point description, trend graphs (real time & history) in interactive mode with the operator.

f) Prepare and print logs and reports.

g) Dynamically reconfigure itself on command from engineering station.

h) Run its own diagnostics, watch dogs, system checks and consequent fallback routines.

i) All system information and diagnostic alarm like failure of I/O channel, I/O card, Multifunction controller, communication modules, node failure, CPU loading, Network loading, workstation diagnostic etc. shall be annunciated and displayed at any workstation.

j) Dynamic data exchange (DDE) for communication with other computers.

k) Historisation of all parameters including analog parameters, SOE and operator actions etc.

l) DCS shall have facility of capturing the process information with specified interval in a spread sheet for defined time period. Operator shall have facility to assign the tags.

m) Energy Management of the plant and equipment by measuring consumption of power of all equipment in the plant, measurement of fuel, steam and all other relevant parameters.

3.04.00 All the controllers shall be connected to a common data highway for global distribution and access of data. Any data will be available to any point of the network as and when required.

3.05.00 The control system shall have open system architecture so that expansion of the system is possible by adding extra stations on the data highway modularly without disturbing operation of rest of the system and by the extensive use of public-domain software and hardware. The system shall be expandable to allow at least 15% future expansion only by addition of extra module without removing or modifying any existing hardware.

3.06.00 The control hardware will be located in Control Equipment Room (CER) in air-conditioned environment (25+/-2 deg C temp. approx). However, none of the system components shall suffer damage or performance degradation during air-conditioning failure. The worst environmental conditions are as below :-

Temperature: 4 to 55 c max.

Humidity: 5 to 95% (non-condensing)

3.07.00 Critical signal exchange between different cabinets shall be hardwired.

3.08.00 When more than one device utilizes the same signal for measurement and control, signal splitting will be performed in such a way that disconnecting, shorting or failure of one receiver device will not cause any upset at any other consumer point or cause any change in transmitter calibration.

3.09.00 Comprehensive self-diagnostic features shall be provided to facilities easy fault location and detection of failure without individually checking each module. On-line testing facility of control system while the unit is in operation, shall be provided with suitable indication for easy identification of faulty module.

3.10.00 The system will operate on the power supply as per following specification,

Voltage	: 240 V AC +/-10% , Single phase
Frequency	: 50 HZ +/- 3%
P.F.	: 0.8

The above power supply from Redundant UPS shall be made available at one point. The system shall not be damaged due to power black-outs

(Minimum 2 hrs) and shall be capable of automatically boot-up on restoration of power.

3.11.00 DCS offered shall have 'open' system architecture with open connectivity for viewing at remote locations without virus infection to control network and employing non-proprietary hardware/software. Latest hardware models & software versions shall be offered.

High grade quality components and proper design of system electronics are required for the system. Redundancy shall be provided, as a minimum, as specified in this specification. The system shall have modular construction and it will be expandable in future by adding additional modules. The type of modules shall be kept to the minimum possible in order to have interchangeability and low spares inventory.

3.12.00 DCS shall be of distributed architecture type with VDU based operation. The entire system shall be bus organized and the plant operator shall run the plant through console consisting of 21" color flat LCD screens, Mouse and Keyboards. All the screens and key boards membrane type with pre-configured function keys for ease of operation shall be of same design and shall enable the operator to view process data, control outputs, shut down status and to change all parameters necessary to control the plant.

Client Server Architecture shall not be accepted.

3.13.00 The system software shall be governed by the operating system running in a real time mode. It shall meet all functional requirements specified in this specification as a minimum. The latest version of software at the time of SAT shall be supplied even if it is introduced after order finalisation.

All softwares supplied should be licensed software. Wherever user name is required to be mentioned, the name of OWNER shall be mentioned and the name of supplier shall not be mentioned. If launched any software upgrade by the DCS manufacturer during the defect liability period should be done free of cost.

3.14.00 All the analog inputs shall be galvanically isolated and digital inputs shall be optically isolated, provided with suitable noise filter and routed through individual fuse. Isolation shall also be provided between operator console and related sub-systems connected to it. The digital outputs shall be routed through interposing relays. Each output shall be short circuit proof and protected by fuse.

3.15.00 The system shall be capable to detect open, short and earth fault conditions. The open sensor reading will be either upscale or downscale and it will depend on field requirement and shall be programmable from engineering station.

3.16.00 On-line replacement of any module shall be possible in such a way that removal and addition of a module shall not disturb the system.

3.17.00 The system shall be suitable for power supply as specified in the section. High speed random access memory (RAM) offered shall be of complimentary metal oxide semiconductor (CMOS) type. The RAM shall be provided with rechargeable battery backup of at least seventy two (72) hours duration. Low battery alarm to be provided on VDU for taking necessary replacement action.

3.18.00 Bought out items make shall be approved by Owner during detail engineering.

4.00.00 SYSTEM CONFIGURATION

4.01.00 The proposed system configuration is shown in 'Plant Control System Architecture' Dwg. No. K7V12-000-DWG-I-001.

Dual redundancy (hot standby) shall be provided at the following levels as minimum-CPU, Memory, Power supply, Communication network, communication modules, critical I/O modules.

The following functional segregation philosophy shall be followed as a minimum, in addition to the processor worst case loading criteria while deciding the number of dual redundant processors required for DCS:

ii) FSSS/BMS (BCS + FSS)
ii) Boiler SCS
  a) BFP/CEP etc
  b) ID fan/SA fan/PA fan/Air heater
iii) Boiler MCS
  a) For fuel system
  b) For air & flue gas system
  c) For steam and feed water system
  d) For condensate & drain system, cooling water system etc.
iv) SBC
v) CMC
vi) Turbine SCS
vii) Turbine MCS
viii) DEH
ix) Turbine HP/LP bypass
xi) Boiler DAS
xii) Turbine DAS
xiii) Common systems
xiv) Electrical systems

MFT and ETS/TPS shall be implemented in TMR. This can be either in DCS or separate PLC.

Grouping of controllers shall be finalized during detail engineering.

4.02.00 HMI REQUIREMENT

a) Four nos. Operator Stations (OS) for each BTG, and Two nos. OS for common systems and three nos. OS for offsite systems shall be provided to consolidate and present all relevant informations in standard & user configurable format, through which the plant operator will be able to manipulate and monitor the plant operation. Each

operator station will be full function type, i.e. any display and control function will be available on any operator station. All VDUs shall have exchangeability with one another according to operational requirements.

b) One Engineering Station (ES) for BTG and One ES for Common systems shall be provided for program developing and diagnosing, control system configuration, database and graphic editing and modifications. ES will be able to call up any of defined displays, system configuration information and related data base stored in each distributed processing controller. Each ES shall be provided with one CD writer and one color laser printer.

c) Separate operating station shall be provided for shift in charge with one dedicated color laser printer.

d) Separate operating station shall be provided for diagnostic/maintenance one each for three units.

e) Deleted

f) Turbine stress calculationfunction shall be part of DEH operating station.

g) One Operating station for two numbers Large Video Screen of each unit at CCR shall be provided.

e) One dedicated dot matrix printer for SOE.

f) In the CCR, One Dot Matrix Printer & One Laser B/W printer for BTG alarms & logs respectively. One Dot Matrix Printer & One Laser B/W printer for common systems. Similarly One Dot Matrix Printer & One Laser B/W printer for offsite systems.

g) One MIS station consisting of server with firewall to access all process data, alarm message, history report, trend display etc. via the plant network and open connectivity for viewing at remote locations without virus infection to control network.

h) One station shall be provided for Plant In Charge who sits in central control room for viewing the plant parameters of six units.

i) For three units, one vibration monitoring and analysis station complete with data acquisition software, rack config. software, operator software along with one standalone TSI monitor shall be provided. One dedicated B/W laser printer shall be provided.

j) One HART management workstation shall be provided. However, no hand-held calibrators for smart transmitters shall be provided.

k) One Engineering Station (ES) with dedicated B/W laser printer and One Operator station (OS) shall be provided for switchyard SCADA system. .

l) One no. laptop with engineering software backup & one no. 2GB pen drive for data backup shall be provided for each DCS system.

4.03.00 DCS HARDWARE & SOFTWARE REQUIREMENT

CONTRACTOR shall develop a complete Bill of Material for the DCS based on the functional requirements to arrive at the size of historical storage both in terms of capacity and worst-case data archiving capacity (duration), I/O support capability with the given configuration including remote I/O; enumerating the type of each I/O and spare capacity, I/O support capability of each type of controller, number of controllers and OPC servers offered, number and type of operator's terminals, printers, hard copiers etc., length of different prefab cables, total power required indicating number of feeders and capacity of each feeder.

CONTRACTOR shall also furnish the following information related to hardware and software performance criteria :

a) Expected duty cycle of each controller with the proposed assignments

b) Capacity (baud rate) of each level of highway and expected data traffic at each level under normal and worst-case situations.

c) Failure analysis of the complete system; detailing the MTBF and MTTR of individual items viz. main power supply, panel power supplies, I/O cards, field sensors/transmitters, controllers/communication processors, drive control modules, highways, OPC servers, bus couplers, consoles, bulk storage etc. indicating the most critical cases and combinations. The analysis shall e projected to system availability computation.

d) Total number of displays and logs offered; indicating the system and user configurable logs and displays. CONTRACTOR shall indicate, with the global memory offered, how many more displays and logs of normal menu and / or complexity can be generated without affecting the operation of the system.

e) Latency of the monitoring consoles and the control console. Response time of the control keyboard (from initiation to execution of a command).

5.00.00 SYSTEM SIZING

5.01.00 The system shall be sized considering the following spare capacity and expansion capability,

a) Process I/O racks shall contain 15% installed spare I/O modules. Other system components to support the spare I/O such as I/O power supply, I/O cables. Communication processors, terminal blocks etc shall also be

installed with 15% spare capacity. All spare I/O modules must be pre-wired up to terminal blocks.

b) Process I/O racks shall have an additional 15% spare rack space only without installed modules. However all other system components must be available in the system to accommodate this future requirements.

c) Process control devices shall be sized such that no more than 50% of processing capability and memory is utilized.

d) The communication network ,in any case ,shall not be loaded more than 50% even after above I/O additions.

e) The system design shall include the capability for atleast 15% future expansion in respect to process I/O's, which shall be achieved by addition of equipment, without modifying or replacing existing equipment's, communication cables, system operating software etc.

5.02.00 Sufficient and additional software capacity shall be available in the system to take care of spares requirement as specified earlier to meet all functional requirements. CONTRACTOR shall furnish the calculation for processor power and memory for all nodes. Also, the dynamic processor load for all nodes either in terms of idling time or percentage load shall be available in VDU.

5.03.00 For power distribution board 20% spare feeder fully wired ready for use with MCBs fuses, TBs etc. Other hardware such as signal distribution isolation, trip amplifiers etc. of approved makes of Owner shall be provided with 15% spares wired ready for use.

6.00.00 DCS SUB SYSTEMS

Different sub-systems of the DCS shall be as follows :-

a) Input / Output

b) Data Acquisition

c) Controller

d) Communication

e) Operator Station

f) Engineering and Configuring Station

g) Historical Storage & Retrieval

h) Turbine Stress Calculation(DEH)

j) Sequence of Events Recording

k) Large Video Screen

6.01.00 I/O SUB SYSTEM

All the validation function, signal conditioning, linearization, conversion etc. will be performed at I/O interface card level.

Each analog signal will be monitored for excursion beyond accepted values and will be reported to monitoring console.

Sensors will be checked for open and short circuit conditions Failure of sensor/transmitter shall not lead to malfunction of the corresponding control system.

The system input/output cards should have programmable scan time configuration, Protection features as Short circuit protection for O/Ps, fuse protection for DO, current limiting features on AI.

I/O modules for CLCS and OLCS shall be intelligent type so that :

a) Every channel can be addressed by CPU during routine diagnostic check.

b) Any failure in the module, breakage in signal wire from sensor's transmitter to DCS and any signal input crossing the range domain on either side (below 4 mA and above 20 mA in case of Analog Input) are immediately detected and displayed in the VDU monitor even without the help of the CPU.

Analog inputs and Analog outputs are galvanically isolated and Digital inputs shall be optically isolated. For Digital outputs interposing relay shall be provided.

All printed circuit cards shall be properly tropicalized.

Field termination of all inputs/outputs shall be terminated as per clause no. 11.06.00. System shall be able to accept both grounded/ungrounded type inputs. An input shall be employed to attenuate any high frequency noise components which may be coupled with the signal. Thermocouple inputs (configurable for all type) shall be checked for open circuit within each scan cycle. Series mode signal-to-noise rejection ratio shall be not less than 60 db for thermocouples and other low-level signals.

Contacts inputs will be dry/potential free type. Alarm contacts shall be either close or open to alarm (configurable). Contact inputs shall be provided with contact bounce filtering to protect against input device bounce and electrical noise on input lines.

Contacts outputs shall be provided for various drives such as solenoid valves, MCC / Switchgear control circuits etc and the contact rating shall be 5 amps at 240 V AC, 50 HZ / 0.5 amps at 220 V DC. Provision in output card shall be such that use of external snubber resistors shall not be required. Each output shall be fed through an independent interposing

relay having minimum 2 NO & 2 NC contacts (mounted in separate relay panel).

All DI/DO modules shall have protecting fuses and LEDs for status indication. All digital I/Os shall meet the surge withstand capability in accordance with the ANSI C37.90A (1971) or IEEE std. 472 (1974). All DI modules should have differential inputs (i.e. no common return).

In case of any earth fault or short circuit in field for a particular channel should not affect other channels.

All I/O modules shall have redundant configuration support facility. Hot removal and insertion and in case of insertion in wrong cage slot shall not cause any damage to the system. I/O processing shall be totally independent of control processing, so that I/O scan rates are independent of controller loading.

A. HIGH LEVEL ANALOG INPUT MODULES

01.	Number of inputs/module	:	8
02.	Types of input (Linear)	:	4-20 mA and 1-5 V
03.	Accuracy	:	0.1% or better
04.	A/D Converter	:	Integrating, 15 bit + Sign or better
05.	Temperature effect	:	0.01% / Deg.C or better
06.	CMRR	:	60 db (at 50 Hz) or better
07.	NMRR	:	20 db (at 50 Hz) or better
08.	Stability	:	0.03% / year or better
09.	Diagnostics	:	i) Limit check ii) A/D converter fault iii) Channel fault iv) Wire break v) Short circuit vi) Auto gain correction

B. LOW LEVEL ANALOG INPUT MODULES

01.	Number of inputs/module	:	8
02.	Types of input	:	Thermocouples (J,K,R,S,T)

	[Grounded & Ungrounded]		RTD (Pt -100 Ohm) [Two wire, three wire]
03.	Cold junction compensation	:	On module / local RTD
04.	Accuracy	:	0.1% or better (Linearized)
05.	A/D converter	:	Integrating, 15 bit + sign or better
06.	Temperature effect	:	0.01% / Deg.C or better
07.	CMRR	:	60 db (at 50 Hz) or better
08.	NMRR	:	20 db (at 50 Hz) or better
09.	Stability	:	0.03% year or better
10.	Diagnostics	:	i) A/D converter fault ii) Channel fault iii) Wire break iv) Short circuit v) Auto gain correction

C. BINARY INPUT MODULE (SLOW SCAN)

01.	Number of inputs/module	:	16
02.	Types of input	:	24/48V DC
03.			N.O/N.C/ch.over contacts
04.	Input current	:	5-10 mA
05.	Diagnostics	:	i) Input simulation ii) Wire break detection iii) Short circuit

D. BINARY INPUT MODULE (FAST SCAN SOE)

Same as above but resolution 1 m sec.

E. PULSE INPUT MODULE

Generally same as Binary input modules but with 8 inputs/module (maximum) and leading/trailing edge detection. Minimum pulse width 1 m sec.

F. ANALOG OUTPUT MODULES

01.	Number of points/module	:	8
02.	Types of output (Linear)	:	4-20 mA
03.	Accuracy	:	0.4% or better
04.	Load	:	600 Ohms (min.) [Current] 1 K Ohm [Voltage]
05.	Diagnostic	:	Channel fault

G. BINARY OUTPUT MODULES

01.	No. of points/module	:	16
02.	Type of output	:	Relay with 1 change-over contact
03.	Contact rating	:	60 VA
04.	Contact voltage rating	:	60 Volts
05.	Switching frequency	:	2 Hz
06.	Contact life	:	1 million operations

H. SERIAL DEVICE INTERFACE MODULE

Shall be capable of providing communication interface with serial devices. The Modbus interface shall support Modbus RTU/Modbus TCP/IP protocol and use EIA-422/485 multi loop configuration by establishing direct digital communication. The nominal capacity of a link shall not be less than 5000 digital and 200 analog inputs. The acquired & transmitted data shall integrate seamlessly with DCS database. The physical medium of communication can be twisted wire, co-axial or fiber optic cable, depending on transmission distance and surrounding electrical interference.

If any requirement of above modules is not able to meet by the approved DCS vendor's available modules, the same shall be informed to OWNER for acceptance before ordering DCS.

6.02.00 DATA ACQUISITION SUB-SYSTEM

The CONTRACTOR shall provide a Control Data acquisition system for monitoring of the STG Boiler and balance of plant. This shall be made possible by collecting the plant data, time tagging, storing formatting and transmitting from each of the unit control system. The following types of plant data shall be acquired –

a) Data from field transmitters and sensors; both analog and digital.

b) Hardwired data from other control systems.

c) Data acquired through links and OPC server from other systems.

Data acquisition system shall provide various process information to the operator to meet the following basic functional requirements.

(a) Monitoring of different parameters.

(b) Sequential open loop control.

(c) Initiation of VDU based alarm signal.

6.03.00 CONTROLLER SUB-SYSTEM

The specification of control capability presented in this section is intended to be functional in nature.

6.03.01 CLOSED LOOP CONTROL SYSTEM (CLCS)

a) The CLCS will perform modulating controls that will act on valves, dampers or other regulating devices to achieve stable control action under steady state condition and for load changes with permissible variation in parameters.

b) The Closed Loop Control System envisaged shall be Electro-pneumatic type. All the final control elements for regulating loops shall be provided with pneumatic type of actuators driven by I/P Converters. Actuators for regulating dampers shall be Power Cylinder type and the same for Control Valve shall be Spring Diaphragm type. All actuators shall be brought to the fail-safe condition under following conditions: -Loss of Control Signal, Loss of Compressed Air Supply, Wire Breakage

c) The CLCS will consist of several redundant multi loop controllers, which shall be operating in a hot back up mode. Each of these multiloop controllers will cater to a group of related CLCS Loops and will have its own dedicated communication controller for interfacing with the system bus. The CONTRACTOR shall ensure that loss of power in controller at least for 2 hrs. does not result in loss of memory.

d) Controls functions shall be judiciously assigned to various controllers such that,

i. Controllers are uniformly loaded.

ii. Loops are assigned logically to the controllers so that peer-to-peer active data transactions are kept at minimum.

iii. There remains a simple correlation between plant equipment/system and corresponding controller (hardware wise).

iv. The controllers have at least 50% CPU spare time under worst data loading conditions.

e) The execution time of closed loop control loop shall be between 50 to 250 milli seconds depending on process requirements. For faster phenomena like drum level, furnace draft, ATRS, turbine governing system it should be 50 milli seconds. The changeover from working controller to redundant controller shall be without loss of control. Tracking feature for bumpless transfer during changeover from auto to manual and vice versa, shall be provided. It shall generate a diagnostic alarm.

6.03.02 OPEN LOOP CONTROL SYSTEM (OLCS)

a) The open loop control (OLC) subsystem will perform sequential interlocking operations, drive control interlocks etc.

b) The OLC subsystem will consist of redundant multi loop controllers each which will have its own communication controller for interfacing with the system bus in redundant mode.

c) Various sequences and interlocks shall be assigned to the controllers following similar principles to that outlined for CLC controllers.

6.03.04 It shall be possible to change set point, tuning constant, operating code, controller configuration from the operator's interface keyboard.

6.03.05 All open loop control (logic and sequence function) shall execute at 100 m sec scan time or better. For ID fans, FD fans, PA fans, boiler feed pumps, air heater, condensate pumps scan time shall be 50 ms scan time or better.

6.03.06 Loop integrity shall be able to operate in controller subsystem architecture by providing one to one controller back up with automatic transfer switching which shall transfer the whole configuration and database of the failed controller to the back up one. Design must ensure that data integrity is maintained during switchover and no portion of data to be transferred is corrupted before and during switch over to the back up controller. The back up controller must perform all functions of main controller. The

indication of the failed controller shall be displayed at local as well as on the central level.

6.03.07 Loop integrity shall also be applicable to I/O cards and any other device associated with the controller subsystem.

6.03.08 In cascade loops, the primary controller shall be able to track the set point of the secondary controller when the controller is not operating in cascade mode.

6.03.09 All controller racks shall be provided with redundant floating power supply.

6.03.10 The regulatory control level shall provide preprogrammed algorithms which can be configured by the OWNER. The vendor's system shall be able to perform, as a minimum, the following functions with one or more algorithms and programme, if provided, in the regulatory control system.

a) PID Control & Auto manual control

b) PID with cascade control

c) PID with ratio control

d) Computation of Arithmetic functions :
(addition, subtraction, multiplication, division, average & sq. root).

e) Computation of Logical functions.
(AND, OR, NOR, NOT, NAND ETC).

f) Sequential control

g) Ladder logic function

h) Time delay

i) High/low select

j) Totalizing/Integration

k) Open sensor detection

l) Linearisation & compensation for thermocouple cold junction.

m) Thermocouple/RTD burnt out protection

o) Pressure & Temperature compensation for flow measurement.

p) Processing of linear & nonlinear analogue inputs.

q) General equation block to perform other functions.

6.03.11 Controller sub-system shall incorporate adequate process interface to accommodate all types of field instruments, e.g.

a) 4-20 mA signals from transmitters.
b) Thermocouple signals.
c) RTD signals
d) Digital signals .
e) Pulse signals.

6.03.12 The advance control capability shall be an integral part of DCS system. It shall provide flexibility and computing power to closed loop control, open loop monitoring and does not have to be implemented in the regulatory capability. The advance controls will utilise the regulatory equipment for all process input and output. The advanced control shall be able to access data from any location in the regulatory control and input modules. Also the operator will interact via the operator's console with advance controls in the same manner as with the regulatory controls. The engineers console that will enable them to programme and monitor the real time control.

6.03.13 As a minimum advance control shall provide algorithm for Boiler/equipment efficiency calculation.

6.03.14 All the close loops of the system shall have self-tuning facility based on `Search' method or Zieglar nicholas method.

A. CONTROLLER SPECS

01.	Type	:	Microprocessor based, multi-loop, multi-function, dual redundant cofiguration.
02.	Number of loops	:	40 (maximum / per controller)
03.	Word length	:	32 bits
04.	Register add cycle time	:	1 microsecond (typical)
05.	Instruction cycle time	:	75 microseconds (maximum)
06.	I/O address capability	:	256 points (minimum)
07.	Memory	:	RAM 12 MB (minimum) battery backup
08.	Redundancy Supported	:	Yes

09.	Whether fall back transparent	:	Yes
10.	Power Supply	:	24 V, 5V D.C.
11.	Mounting	:	Sub-rack
12.	Configuration	:	From Engineering Terminal through plant data network.
13.	Diagnostics	:	Invalid command checking, Automatic periodic illegal address detection, routine check and memory parity check, watch dog report to engineering terminal, time - out checking, processor status display LED, processor fault.
14.	Indication		Processor status and fault display

6.04.00 COMMUNICATION SUB-SYSTEM

6.04.01 Communication subsystem shall have 1:1 redundancy. The redundant system should take over the charge without time lag and without disturbing the process and giving indication/alarm of fault section or changeover. The CONTRACTOR shall indicate the scheme details of switchover along with operational status of both networks.

6.04.02 The data highway shall generally be as per the following specification.

(a) Data highway shall be 100% redundant passive co axial cable or a fiber optic freeway for data transmission without repeaters or couplers with balanced differential line drivers. The system shall be fully operational with one highway out of service and with no degradation in performance.

(b) The design shall be such as to minimize interruption or alternation of signals i.e. it shall be effectively immune to electrostatic and electromagnetic interference typical in such power plants. It shall ensure, that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted.

(c) Built in diagnostics shall be provided for easy fault detection. Failure of a data highway or of any station on the highway shall

be alarmed and reported on an appropriate video terminal. Changeover to the standby data highway shall be automatic.

(d) Adequate memory for sharing the control data with minimum overhead shall be envisaged to meet all functional requirements of the specification.

(e) The design and installation of the data highway shall take care of the environmental conditions and hazardous area classification requirements as applicable to similar services.

(f) The communication bus shall not be loaded beyond 60%.

6.04.03 Time required for updating console shall be less than one second. The overall system performance shall not be degraded due to the loading of the bus.

6.04.04 The System offered shall be an open system and shall conform to Open Industry Standard (IEEE). A redundant 10 / 100 MBPS Ethernet based high-speed switched fault tolerant Data Highway System shall be deployed that provides for multiple simultaneous bi-directional communications. Communication will be full duplex and with TCP-IP protocol. All interfaces links of controllers, OPC servers, HMI stations, switches and all other communication devices on the network will be dual so that a single point failure will not lead to system shutdown. Network shall be capable of handshaking with any third party system following standard protocol. The primary objective shall be centralized monitoring, presentation & report of data for information and analysis of entire plant. All the controllers shall be connected to a common high-speed data network for global distribution and peer-to-peer data communication. Any data will be available at any point on the network as and when required. The control system shall be modular, expandable and flexible so the expansion of the system is possible by adding extra stations on the data highway. Comprehensive self-diagnostic features have been envisaged to facilitate easy fault location and detection of hardware and software while the unit is in operation. It shall be able to direct intelligent routing of messages without the drawbacks of traffic jamming etc.

a) All messages received through highways will be validated for error and fidelity on both the highways. Erroneous messages will be flagged and rejected. The previous value will be retained until the fault is cleared.

b) Highway involved in real-time operation shall utilize protocols that guarantee the worst-case service time (token passing etc.).

c) The features of the data highway shall include the following minimum requirements:

i. Mastership of the highway will not reside in a single device. No single failure will prevent the orderly and timely transmission of data.

ii. Any station on the highway in an unavoidable instance of its failure or upon its removal shall not cause any interruption in full communication of all other stations.

iii. Both redundant highways will operate at all times. There will be no need to 'Fail Over' and initiate to a stand-by cable. Diagnostics to check the status of both highways will run continuously.

iv. Hot repair capability of the highways shall be furnished.

6.05.00 OPERATING INTERFACE SUB-SYSTEM

6.05.01 It is required for monitoring and controlling process parameters and performing other process related functions. It shall give indication of all analog and digital process variables, and manipulation of closed control loops, such as change of output, change of mode.

6.05.02 This shall include monitoring/control terminals. Each terminal shall be fully capable of addressing any plant data. Each terminal shall be independent with its support hardware including adequate local memory for resident database to reduce data traffic through the highways. The resident data shall be continuously updated at all terminals and in no case real-time plant data shall have to be retrieved from other resident memories. The VDU's shall be of high resolution, minimum 21 inch display screens (1280 x 1024 pixel or better) color monitors. All the monitors shall have fall back feature. Quantity of monitors etc. has been indicated in "Control System Architecture" drawing no. K7V12-000-DWG-I-001. In general Operator stations envisaged as follows,

a) Steam Generator and Auxiliaries Control Station – For closed and open loop controls within boiler area and also for monitoring measurement and alarm variables within boiler area.

b) Turbine Generator Control Station - For closed and open loop controls within turbine-generator area and also for monitoring measurement and alarm variables within turbine-generator area including Auxiliaries for Turbine and generator and also with generator Synchronizing facility

c) Balance Of Plant Control Station - For closed and open loop controls for B.O.P area and also for monitoring measurement and alarm variables for B.O.P equipment (HP & LP Heaters, Condenser Hotwell, Deaerator, Auxiliary & pegging steam, Condensate Extraction Pumps, Boiler Feed Pumps, Extraction &

drain valves etc.), Electrical auxiliaries control, Cooling Water system control.

6.05.03 The following VDU displays shall be available as a minimum. These displays shall be windows based. More than one dynamic and interactive operator display shall be available on the screen, as minimum requirement.

- Alarm display (First out facility for annunciation shall be provided. Different status of alarms and most important alarm also shall be indicated by different colors).
- Overview display for monitoring the entire plant.
- Group display for control and monitoring of STG, Boiler & BOP along with detailed individual loop display.
- Dynamic Graphic display of offsite plant status.
- Cumulative running status of equipments for maintenance management.
- Trend display for both real time and historical data.
- Tuning display for tuning parameters.
- Operator guide message display.
- System configuration and health status of controllers, OS/ES & communication system.

6.05.04 A few typical displays & logs have been indicated below :

a) Real Time Parameter/Status Display (default screen)

b) Real Time Trend/Historical trend graph display

c) Alarm Summary display/printout (on demand)

d) Alarm limit display / print out (on demand)

e) Boiler Start-up log/printout (event actuated)

f) Turbine Start-up log/printout (event actuated)

g) Synchronization / Loading log/printout (event actuated)

h) Shift log/daily log/printout (on demand)

i) Generator trip log/printout (event actuated)

j) Turbine Trip log/printout (event actuated)

k) Boiler Trip log/printout (event actuated)

l) Operator Control Screens

m) Group display screen (at least 8 loops)

n) Flow chart/logic screens

o) Operator's guidance message screen

p) Process subsystem display screens

6.05.05 The alarm status on VDU should be indicated by change in colour and flashing accompanied by audible alarm. Provision of configuring alarm setting and single alarm inhibit feature shall be provided. Latest alarm shall appear on the screen irrespective of acknowledgment of previous alarm. Control of Boilers and auxiliaries through graphics should be possible, and necessary software for the same shall be included. Variable scan time assignment for process I/O's should be possible from the operator's terminal.

The following maintenance functions shall be provided as a minimum.

- Online compilation of graphic display with contractor supplied symbols.
- Virtual panel/ annunciator message maintenance.
- Sequence message maintenance
- Tag comment maintenance
- Tag list maintenance
- Key lock assignment to select functions/parameters.
- Adding/deleting/modifying a loop on line.

6.05.06 All VDU's shall be interchangeable i.e. any VDU shall have access to any data page and with minimum nominal diagonal dimension of 21 inch. VDU's shall be non glare from external lighting.

6.05.07 The VDU's shall communicate with rest of the system at high speed so that complete change in the screen contents takes place within 1 second. The refresh rate of the screen shall be 1 sec. maximum.

6.05.08 The normal display shall be clearly readable at a distance of 4 meters. The radiations shall be well below the hazard limits. The display unit shall not emit high frequency noise and the screen flicker shall be in excess of 30 Hz.

6.05.09 The formats for Plant overview display, Group display, Loop display. Alarm display, Alarm Summary display & Trend Display shall be

finalised by the CONTRACTOR taking into account specific requirement of Owner if any. However the CONTRACTOR may furnish the manufacturer's standard formats for review of Owner/Consultants along with their offer.

6.05.10 All the Workstations shall have ethernet port and RS232 port with necessary driver software.

6.05.11 VDU's shall have high resolution. The graphic resolution should be 1,280 x 1024 dots or better.

6.05.12 In alarm summary display atleast 20 process alarm shall come in order of occurrence.

6.05.13 The VDU's shall have scrolling facility and multiple display with zooming facility. The type of display shall be at least like follows :

a) Alarm display - At least five process alarm shall appear.

b) System help display - It displays information about illegal key operation.

c) Help display - Operator's instruction.

d) Trend display - It displays one or eight pen trend recording graph.

e) Process display - This display process data.

6.05.14 The printers shall be of heavy duty impact type and shall be dedicated to the printing of alarm and return to normal messages, printing of hourly logs, shift log, daily log, alarm summary logs, operator logs and keyboard entries etc. The printer shall be buffered to have direct memory access to leave the CPU free while printing is carried out. The printer shall be dot matrix type with speed of at least 300 characters per second and resolution shall be at least 144 x 144 DPI. Bicolour print out shall be preferred. Line printers, if offered, shall have a minimum of 163 character positions per line and the speed shall be a minimum of 264 character/sec. Parity checking shall be utilised. All printers shall be provided with suitable enclosure designed to protect the same from accidental external contact. The printer shall be provided with auto shut off features. Printer shall be non-proprietary. Noise level spec with printer cover closed.

6.05.15 Colour Laser Printer and B/W Laser Printer units shall be provided, as applicable, to print out the VDU display on command from the keyboard and printing time should not be more than 3 minutes/display. The display data locking time shall be 1 second or less. The resolution shall be a minimum of 150 dots/inch. Selection facility shall be available for selection of any of the VDU screens for copying. Copy size shall be

244 mm x 183 mm. Printer shall be covered disk type and printing noise shall be 47 or less from 1m distance.

6.05.16 Real time trending for all the variables at 1 sec. scan rate for 2 hours shall be available. Historical data display and printout shall be effected from the operator's console. Permanent storage devices for automatic downloading at selected intervals shall be available. The following data should at least be stored in memory for future reference and trend generation.

(a) 5000 latest alarms.
(b) 100 events ammendment.
(c) 25% of the analogue inputs with 1 secs. sampling rates for 4 days. storage.
(d) 50% of analogue inputs with 5 sec. sampling rate for 10 days storage.
(e) Rest of analogue inputs with 10 sec. sampling rate for 15 days storage.

Owner's approval is required incase of any change in the above data storage requirement.

6.05.17 Assignable time base for the trend display/record should be possible from operator's console and multi-trend capability of upto a minimum of six (6) variables per page should be available for display on VDU. It shall be possible to display both current and historical trend for any process variable on the same page.

6.05.18 The system shall be designed to display and print the following minimum logs such as general log, shift log, alarm log, sequence of events log, post trip analysis log, maintenance log, performance log, etc.

(a) The general log shall give selected analogue and status points, with the point description in words, the value in engineering units the used and the time log of each data point.

(b) The shift log shall brief the shift coming to work, on the activity during the previous shift. It shall provide a summary of activities during the previous shift including the alarm history and operator selected parameters.

(c) The alarm log shall give the description of the alarm, the date and time that the alarm first occurred and when the condition was corrected. A minimum time resolution of 20ms shall be provided. Interlocks those are bypassed by the operator and duration of such bypass shall also be logged and printed. This log shall have precedence over normal logging. The alarm stamping shall be 1 sec. minimum.

(d) The post trip analysis log shall be provided to record data during the period immediately before and after the unit trip. In the event of a trip the post trip analysis of data shall be frozen into memory.

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The display of all the data and the events leading upto the trip in chronological order can also be called for display on VDU.

(e) Maintenance data log shall provide schedule of preventive maintenance and routine equipment inspection. Schedule for easy maintenance the maintenance data shall provide a comparative analysis of unit start up and shutdown with typical values stored in the computer.

6.06.00 ENGINEERING INTERFACE SUB-SYSTEM: -

6.06.01 Minimum following operations shall be performed from Engineering station.

(a) Configuring

(b) Tuning / Change of system constants.

(c) Graphic Builder

(d) Digital ladder Builder

(e) On line transfer of data from Engineering Station to Operating Station.

6.06.02 1 (one) no. dedicated Engineer's Console including colored VDU monitor (20/21"), keyboard/mouse and printer will be provided to serve as configuration station. The engineering station shall have at least one CD and one FD drive with security function. Also one CD writer is to be used with the engineering station with proper required software. The station will interface with plant highway and will be capable of individually addressing the controllers for configuration and downloading. It will be possible to configure all displays and perform all software functions in Engineering Workstations. Three (3) levels of password shall be provided on Engineering Station.

6.06.03 One no. dedicated MIS station is required to access all process data, alarm message, history report, trend display etc via the plant network. One 20/21" color monitor along with 80 GB Hard disk, CD drive, FD drive are to be provided for this purpose.

A. OPERATOR STATION/ENGINEERING STATION SPECS

01.	Processor	:	Intel Pentium Dual Core
02.	Configuration	:	Tower
03.	Internal clock	:	3.2 GHz or better

04.	Architecture	:	32 bit or better
05.	Video Card	:	PCI
06.	System Memory	:	1 GB DDR-2 or more(2 GB or more on engineering station)
07.	Hard drive	:	160GB SAS
08.	Cache	:	2 MB Level 2
9.	DVD cum CD Drive	:	Read & Write
10.	Audio controller	:	32-bit
11.	Monitor support	:	Dual (optionally)
12.	Operating system	:	Licensed industrially proven Windows OS with latest versions of service packs
13.	Graphic accelerator	:	8MB (Minimum)

B. MONITOR SPEC

01.	Type	:	Table-top (vertical inclined 0-15 degree)
02.	Sync.	:	Multisync.
03.	Screen diagonal	:	20/21" flat square
04.	Display	:	Super Video Graphic Array
05.	Array	:	1600 x 1280 non-interlaced, refresh rate min. 85Hz
06.	Colors	:	256 color palette
07.	Dot Pinch	:	0.28 mm
08.	Degree of protection	:	IP-30
09.	Screen	:	Direct-etched , high contrast , optical quality , antistatic , anti-glare
10.	External Controls	:	Brightness, contrast, Horizontal / Vertical amplification & shift
11.	Power supply	:	240 V, 50 Hz, 1 phase

12.	Ambient temperature	:	0-50 ^{O} C
13.	Humidity	:	95% non-condensing.
14.	Version	:	To suit industrial application.

C. KEY BOARD SPEC

01.	Type	:	Flat, spill proof, dust proof membrane type.
02.	Different Keys	:	a) Soft and user defined function keys. b) Select keys for alarm summary, control loop display, overview, trend, graphic, operator guide message etc. c) Standard Alphanumeric keys d) Alarm acknowledge keys e) Cursor keys f) Loop status keys g) Print-out command keys h) Other keys as required to operate the system
03.	Key lock	:	Lockable type push button mounted on keyboard
04.	Life Expectancy	:	50 million cycles per key
05.	Version	:	To suit industrial application

D. DOT MATRIX PRINTER SPEC.

01. Printer Head	: 24 pin
02. Speed	: 200 cps @ 12 CPI (approx)
03. Print Density	: Standard Cell – 34 x 24 Dots/character
04. Buffer	: 8K Characters
05. Interface	: Serial RS 232 – C or equivalent

06. Character Sets	: ASCII, IBM (Sets 1 & 2), Italics, user defined
07. Type of Paper	: Cutsheet/Funfold (front feeding)
08. Power Supply	: 240V, 50Hz, 1 phase
09. Ambient temperature	: 0-50°C
10. Humidity	: 95% non-condensing
11. Printing Features	: Graphic printout, Emphasised, Double width, Underlined, Subscript, Superscript, Double strike, Backspace, Margin Setting
12. Reliability	: MTBF more than 8000 hours
13. Other features	: i) Easy paper loading ii) Noise shield
14. Noise Level	: Less than 60dBA at 1M
15. Accessories	: i) Ribbon cartridges ii) Printer stand iii) Table top receiving tray iv) Interface cables etc.

E. LASER PRINTER SPEC.

01. Type	: Electro-photographic laser, table top
02. Printer Memory	: 256 MB (min)
03. Speed	: Monochrome 24 ppm-A4 Color 6 ppm – A4
04. Resolution	: 1200 x 1200 DPI in color
05. No. of color (Basic)	: 4(four) minimum
06. Duty cycle	: Monochrome 75000 pages/month
07. Power supply	: 240V, 50Hz, 1phase
08. Ambient temperature	: 0-50°C
09. Humidity	: 95% non-condensing
10. Size of paper	: Letter, A4, Legal, Ledger, A3

11. Print media	: Plain paper, transparencies, thick stock, glossy stock, envelops
12. Accessories	: i) Adapters ii) Connector Cable iii) Multiplexer switch (4 point)

F. FURNITURE

CONTRACTOR shall include a complete set of furniture for the Control Room and computer Room of ergonomic design from reputed manufacturer especially designed for computer peripherals . The set of furniture shall include but shall not be limited to Control Operator's chairs, tables for mounting printers (if any), tables for console units of Terminals etc, all necessary furniture for Computer Room peripherals , cabinets for storage of manuals / booklets/recorder charts, storage racks for special tools/ diskettes and Shift Charge Engineer's desk/chair/side rack etc.
List of furniture shall be submitted by the CONTRACTOR for OWNER'S approval.

6.07.00 HISTORICAL STORAGE & RETRIEVAL SUBSYSTEM (HDSR)

a) The Historical Storage Unit (HSU) will augment the global memory available in the system and will archive data and parameters for logs and historical records.

b) Assignment between globally distributed memory and the historical storage will be judiciously determined during system engineering stage.

c) Minimum storage period should be at least 30 days sampled at 1 minute after which the old data may be transferred to CD/ZIP. Historisation of set point and controller output for all the critical controls is also envisaged for every second for the maximum of two days.

d) It shall be suitable to store complete database and sufficient for historical storage. 25% memory of the disk shall be spare for future use. It shall have the facility of flexi disk with FDD for recording periodical events/operation/data whenever required.

e) The hard disk for database as well as history storage purpose shall be redundant. Archiving of history and reports shall be achieved on a removable electronic media within the system. These shall also take care of the data received from the system integrated through serial link.

Type : SAS SCSI Hard Disks With RAID-5 for all Software, database and Historical /Trend

Alarm /Event Storage..

Capacity	:	To suit the application(Min. 160 GB with RAID-5)
Number	:	To suit the application, redundancy required.
Spare capacity	:	25% under worst condition when fully implemented
Accessory	:	Controller cards.
Interface	:	Both DMA & program control
Feature	:	CD writer for program loading, backup etc.

6.08.00 Plant Optimsing Functions and Peformance Calculation Subsytem:

Implemention of Plant Optimsing Functions and Peformance Calculation Subsytem is not in the scope of CONTRACTOR. However CONTRACTOR ensures this function can be integrated with DCS on later date if the OWNER desires.

6.10.00 SEQUENCE OF EVENTS RECORDING SYSTEM (SOE)

Sequence-of-events recording shall be an integral part of the DCS to minimize parallel wiring of inputs, to allow integration of steam generator, STG, and balance- of-plant events into a common time base, and to provide maximum reporting flexibility. Special sequence -of-events inputs which time-tag the event at the input card level shall be utilized. (In case of stand alone SER system, all the SOE points shall be available in DCS). Sequence-of-events recording shall be limited to those conditions which can directly cause a steam generator, steam turbine, generator, and auxiliary electric system trip for which one millisecond time resolution shall be required for post trip analysis. To facilitate post-trip troubleshooting, the SER system shall be designed such that any SOE input may be selected as a trigger point. The system shall generate a SOE report recording the status changes of all SOE points following a status change of the trigger point The recording shall stop after the trigger point reverts to the normal condition or on a command by the operator.

Sequence of event recorders shall have following features as minimum:

a) Automatic event buffering on printer failure or event avalanche due to major shutdown.

b) Automatic manual shelving to inhibit any input.

c) Variable dead band setting to present multiple logs from the same contact.

d) Auto manual status log to give a periodic list of all abnormal points together with a log of shelved points.

e) Separate occurrence and clearance comments.

f) Easy legend editing

The SER system shall be sized to accept the inputs described above and provide at least 15 percent spare capacity for future modification.

Sequence-of-events Recorder shall be for 256 points per unit including spares.

6.11.00 LARGE VIDEO SCREEN (LVS)

a) Size (diagonal) : 72 inch

b) Type : LCD Projection type with rear – screen configuration (other type proven technology eg. that based on digital light processing shall also be acceptable subject to approval).

c) Resolution of each screen : 1600 x 1280 pixels

d) Configuration of LVS : Single tier with screens seamlessly combined with provision of expansion of one screen on each side.

e) Control Unit/Graphical Generator :
   i. With 512 MB RAM, 20GB HDD graphical cards for projecting HMI displays over a part of screen to multiple screen. Any combination of windows shall be possible. Facility for overlays to be provided.
   ii. Facility of projecting a particular display on a selectable area of the screen upon activation of a predefined event.

f) Video signal interface : Interfacing with Video signals, to receive & project pictures from CCTV, Live camera, VCP

g) LVS shall be designed for continuous viewing (24 hours in a day) under normal room ambient lighting without any need to darken the room. Suitable darkening of the projection screen for light absorption shall be provided for this purpose.

h) The LVS and its accessories shall be designed in such a way that the brightness in the center of the screen and the edges of the screen is uniform and there is no perceivable difference in the quality of the picture

on the center and on the edges of the screen. The screen should be flicker free and there shall not be any screen burn in due to display of same information for a long time. If any extra hardware has to be provided for achieving the above feature, same shall be provided by the CONTRACTOR at no extra cost.

i) Two numbers of LVS shall be provided for data display in CCR for each unit of the power plant.

6.12.00 MASTER & SLAVE CLOCK SYSTEM:

A master and slave clock system, capable of receiving time signals broadcasted by National Physical Laboratory / GPS signal and processing it and transmitting and synchronizing this time with DCS, SOE and PLCs etc control systems in the plant, shall be provided. The clock system shall include a master clock and slave display units. Necessary hardware and software requirements shall be fulfilled by the CONTRACTOR.

The master clock shall employ highly stable crystal oscillator to ensure accurate time indication. The stability shall be better than 0.5 sec per day. Facility for manual setting of time i.e hours, minutes, seconds shall be provided in the master clock. The system shall have the facility to receive GPS signals through antennae .

The master clock shall drive the slave display units. It shall be ensured that loss of any slave display unit does not affect the display of any other slave unit. The use of system bus for driving the slave units shall not be acceptable. The DCS shall be synchronised with the working master clock once in every 24 hours.

The National Physical Laboratory (NPL) has been allotted one of the five R .N. Channels of transponders II of INSAT for standard time and frequency signal (STFS) discrimination in one-way mode .The down link frequency of this channel is 2599.675 MHz. The R.F. bandwidth of this channel is 170 KHz. The STFS covers entire Indian Subcontinent and have high order of synchronization accuracy.

The receiving system of master clock of he CONTRACTOR shall consist of a parabolic dish antenna (8 feet mesh), a low noise amplifier, a down converter combined as a head unit, a co- axial cable (100 mtr) minimum to carry the converted signal to indoor unit which consist of a decoder. The decoder time signal shall be employed for synchronization of the signal of DCS, SOE and PLCs etc control systems in the plant.

The Master clock system shall have spare channels to give time synchronization signal to other computer-based system in future especially for DCS and SOE for other units in the same station.

The display specification shall be as follows :

No.of Digits	:	6 2 hours, 2 minutes, 2 seconds
Glass cover	:	Non-glare type
Viewing distance	:	10 meters
Display element	:	Red LEDs
Digit Size	:	84mm (minimum)
Mounting	:	Wall/Panel mounting
Protection	:	Shall conform to protection class IP 22 for all units located indoor and in air-conditioned environment and confirming to IP42 for all other units located indoor and in non-air conditioned but ventilated environment.
Operating Temperature	:	0-50°C
Relative Humidity	:	95% maximum
Cabling	:	The CONTRACTOR shall provide all required cabling and interfaces between the real time clock of DCS, the master clock and slave display units. Considering the transmission distance, modems etc. may be provided.
Power Supply	:	The CONTRACTOR shall provide stable, regulated power as required by the system.

7.00.00 SYSTEM PERFORMANCE REQUIREMENT

The system shall fulfill following Scan times/ Response times :

a) Controller Cycle Time shall be within 200m.sec. (adjustable).

b) All analog inputs to CLCS shall be acquired and data base updated within a maximum interval of 250m sec. For faster phenomena like drum level, furnace draft, ATRS, turbine governing system it should be 50 milli seconds.

c) All open loop control (logic and sequence function) shall execute at 100 m sec scan time or better. For ID fans, FD fans, PA fans, boiler feed pumps, air heater, condensate pumps scan time shall be 50 ms scan time or better.

d) All remaining analog inputs (4-20 ma. TE), which are not connected to CLCS, OLCS but solely used for Data Acquisition System shall be scanned and database updated within 1 sec.

e) Key board command to field equipment shall be executed in less than 1 sec under worst loading conditions.

f) The updating of dynamic data on VDU displays shall be done in 1 sec. (maximum).

g) The response for Operator request display (time between pressing of last key and appearance of last character on screen) shall be 2 seconds maximum under worst loading condition.

8.00.00 SYSTEM SOFTWARE

Software to be supplied under this specification shall include but not be limited to the following to perform all the functions specified under this specification. All software shall be in ENGLISH.

Software for distributed microprocessor based system shall include the following software packages:-

a) Real time operating system

b) Input scanning, processing and alarm monitoring.

c) Open and closed loop control software.

d) Graphic utility

e) Communication between process modules through data bus

f) On line diagnostics.

g) Human-machine communication

h) Input data base generation and maintenance, etc.

i) Log generator

j) Utilities for software development

k) Background executive for software development in a time sharing mode

l) Visual C (Fortune) or equipment complier.

m) Screen editor for software modules

n) File handling utility

o) Library facility for object modules

p) On-line debugging facility for the purpose of software development

q) Utility of data transfer from magnetic tape to disk and vice versa in EBCDIC and ASCIT mode.

r) Software for communication with systems supplied by others

s) Full scale steam/water property routines conforming to ASME 1967 steam tables.

t) Any other software as required to meet all the specification requirements

The CONTRACTOR shall have the total responsibility for the design, development and implementation of software for the I & C system

The CONTRACTOR shall include in his scope of work the following :-

i) All computations for alarm cut outs, variable alarm limits

The application software for implementing control algorithms, interlocks, generation of mimics shall be using a graphics editor and graphic tool kit and not using a programming language approach.

Graphic blocks, engineering blocks etc. shall be used to configure the software.

9.00.00 DIAGNOSTICS

9.01.00 On line diagnostic routine shall be run continuously or periodically. Detected failure shall be displayed in VDU terminal with proper description. The following minimum diagnostic checks shall be performed by the system.

(a) Peripheral failure.

(b) Memory failure.

(c) Parity error.

(d) Programme hang-up.

(e) Power supply failure.

(f) Input failure.

(g) Interface failure.

(h) Output failure.

(i) Short circuit/Open circuit.

(j) Input/Output card failure.

9.02.00 If one operating station or electronic system fails, the other operating station or engineering station shall be any position to point out the faulty hardware of failed electronics.

10.00.00 POWER SUPPLIES

10.01.00 GENERAL

Two feeders of 240V AC 50 Hz AC UPS power supply shall be provided upto the CONTRACTOR's power distribution cabinet & balance distribution of the power to various cabinets with various protections as per sound engineering practice shall be provided by CONTRACTOR. The power distribution cabinet shall be provided by the CONTRACTOR and the cabinet shall have additional 20 nos. of MCBs_isolation and 2 nos. 2KVA feeder for other consumers. The exact numbers shall be confirmed during detail engineering.

10.02.00 All the distribution for system shall be through MCBs. All non-system power supply distribution shall have MCBs with isolating switch. CONTRACTOR shall indicate the make of all the PDB components for the approval from Owner.

10.03.00 All the sub-system shall have dual-redundant power supply with capacity to accept two feeders.

10.04.00 Power Supply Tolerance

The system shall have the power tolerance of 100 msec. for interruption +10% voltage level and frequency - 3 Hz to 6 Hz.

10.06.00 POWER DISTRIBUTION INFORMATION

The CONTRACTOR shall provide a preliminary sketch of the power distribution scheme for the quoted equipment. In addition, the CONTRACTOR shall be provide an estimate of the power requirements for each component and for the total system. CONTRACTOR shall also indicate all branch loads. This is required to arrive at UPS sizing as UPS pose limitations of maximum branch load. This is applicable for whole power supply.

10.07.00 FAULT DISCRIMINATION

The fault discrimination shall be such minimal equipment will be affected by any particular fault. Power distribution to control devices shall be arranged such that the loss of an individual circuit does not result in

complete loss of control capability or create unsafe operating conditions. An alarm shall be generated to alert the operator to loss of power to a device.

10.08.00 NON-SYSTEM POWER SUPPLIES

The power supply requirement shall be met as much as possible by the system power supplies. However the external redundant and floating power supplies are required for solenoid valves, interposing relays. These power supplies shall be from reliable CONTRACTOR and shall meet the specifications mentioned including 100 msec. tolerance to input power.

10.09.00 All the 24 V dc power supplies for the system shall be supplied and mounted on system racks by the CONTRACTOR and made redundant with both continuously active. It shall be possible to remove at least one power supply for maintenance without affecting the overall load requirements of the system. The CONTRACTOR shall clearly state in the quote the power supplies needed. The 24V DC power supply shall be distributed to all transmitters/solenoid valves/relays with separate fuses for each equipment, so that proper supply isolation can be made for each.

10.10.00 There shall be provision to power all field transmitters from the 24 volt system. The minimum resistance for the 24 V dc is 600 ohms; the CONTRACTOR to state the maximum resistance for the 24 V dc.

10.11.00 The system shall have a power supply monitoring facility that checks that internal power output voltages are within tolerance. The monitoring facility shall be fed into the system diagnostic facilities. Appropriate alarms shall occur on any power supply failure.

10.12.00 The operator shall by means of a system alarm, be informed about the failure and switchover. No loop shall be lost by the failure of a single power supply.

10.13.00 Internal power supplies shall be fused for short circuit protection and have thermal overload self-resetting protection. Outputs shall be electronic current limiting, with over voltage protection unit. Every power failure shall generate a system alarm plus a local indicator (LED or flag).

10.14.00 In general all cabinets/racks are to be provided with earthing point.

11.00.00 CABINETS

11.01.00 Cabinets to install the different hardware mentioned under various sections shall be made from 3mm thick. CRCA sheet steel and structural steel, totally enclosed, free standing floor mounting type, suitable for indoor use, with bottom cable entry. Protection class shall be IP-41 minimum as per IS:13947 Part I. The system shall be designed for front & back access to components, terminals and wiring.

11.02.00 The cabinet construction shall be bolted type. The components/printed circuit boards shall be suitably mounted within the cabinets for easy access. The cabinets shall be lockable.

11.03.00 All the cabinet steel structures shall undergo chemical degreasing, pickling through 7-tank cleaning and phosphate coating. Two coats of epoxy paint of supplier's STD shade for all inside and outside surfaces of the cabinets be provided. The final coat shall be acid and alkali resistant to resist the corrosive atmosphere prevalent in the plant. The details of corrosion protection carried out on panels and other subsystem inclusive of modules shall be provided in the offer.

11.04.00 The cabinets doors shall be provided with sheet steel hinged doors with Neoprene gaskets. Hinges shall be concealed and shall be such that the door open through 120°. Doors & covers shall be provided with stiffners wherever necessary to improve rigidity.

11.05.00 The cabinets shall be provided with bottom glanding plate which shall be removable from inside and shall be provided with sufficient no. of knockouts. The details of knockouts shall be provided during detail engineering. All knockouts shall be provided with pluggable grommets.

11.06.00 No field termination shall be envisaged in the cabinets housing P.S, and DPU modules. Termination of field cables shall be either in marshalling cabinets or in I/O cabinets as per manufacturer standard. Where as the CONTRACTOR ensures in case the field cables will be terminated in I/O cabinets:

a) Terminal blocks used shall be of proven and internationally reputed make. SEPCO shall take approval for the same from the OWNER.
b) All terminals and I/O modules shall be easily accessible.
c) Cabinets shall be of Rittal or internationally reputed make subject to OWNER's approval.
d) Field cabling shall not be hindrance while system is powered.
e) Sufficient space (for 25% of I/Os field cabling) for future cabling will be ensured in each cabinet.
f) Replacement of damaged field cable while the system is in service shall be carried out with out disturbing the normal operation of the unit.
g) All Cables shall be glanded/clamped such that the terminals will not be subjected to tension.

11.07.00 The cabinets shall be of max. 2200mm height including base channel. The base channel shall be of 100 ISMC. All cabinets shall be of same height. Construction shall be modular. CONTRACTOR shall give the overall dimensions of each system and non-system cabinets.

11.08.00 All cabinets power & control/signal wiring shall be of PVC insulated, stranded tinned copper conductors of suitable size. All inter system cabinet cables are in DCS supplier's scope.

11.09.00 Before mounting the hardware inside the cabinets, Owner/Consultant will inspect and clear the cabinets at manufacturer's work shop.

11.10.00 All cabinets lighting shall be 240V AC, 50 Hz.

11.11.00 All the panels shall have fans for cooling purpose.

11.12.00 System & non-system cabinets shall have "look alike" appearance.

11.13.00 All Control panels having 24V DC control circuit to have installed & wired spare power supply. System to give alarm if anyone power supply fails and the system to function normal without interruption on failure of power supply. Replacement should be possible without affecting system function.

11.14.00 Control panels having power connection/ supply looping, the joint cables to be crimped to one common lug to enable replacement of defective items without affecting the system.

11.15.00 CONTROL PANEL/CABINETS

01.	Application	:	Indoor panels including single vertical control panels completely enclosed marshalling racks, relay cabinets etc.
02.	Material of Construction	:	CRCA
03.	Thickness of Sheet	:	i) 3 mm for faces supporting instruments/relays. ii) 2 mm for other sides, doors and tops.
04.	Construction	:	Welded throughout.
05.	Enclosure Class	:	As applicable for location & use. .
06.	Primer	:	Spray coat of Epoxy Surface. 2 coats; 1.5 mil/coat thickness
07.	Finish Coats	:	2 coats; 2 mil/coat thickness
08.	Wiring	:	Termination of incoming & outgoing at terminal block, Interior wiring with markers, supports & through trays.
09.	Doors	:	i) Double, turned back edges, chromium plated handles with built-in locking facilities. ii) Stainless Steel hinges, neoprene rubber gasket, outward opening.

10.	Colour of Exterior/ Interior	:	To be decided later.Same colour for all panels.
11.	Cable Entry	:	Bottom
12.	Cable Gland	:	Brass glands suitable for armoured cables.
13.	Accessories	:	i) Predilled base channel ISMC-100 or equivalent for all sides. ii) Foundation bolts. iii) Vibration dampers of 15 mm rubber pad fixed to base channel.
14.	Ventilation	:	Fans should be provided at the top and louvers with mesh in the bottom, to limit the temp. rise above ambient to 10°C under worst conditions.
15.	Illumination for Panel & Desk	:	Two (2) fluorescent tubes at the top with door switch for auto ON/OFF.
16.	Power Socket	:	3-Pin, 240 V, 15 A, 1-Phase AC power supply provision for each panel.
17.	Grounding bus	:	Safety ground & shield ground

12.00.00 WIRING PRACTICES

12.01.00 All field termination shall be as per clause no 11.06.00.

12.02.00 Marshalling rack wiring philosophy shall be mutually discussed.

12.03.00 Instrument cubicle/panel wiring shall be such that minimum crossing of signal cables are encountered. Instrument/device located in left (and right) hand side of panel/cubicle should be terminated in left (and right) side terminal block respectively so as to minimize inter crossing of wires in panel/cubicles.

12.04.00 The connection between different panels or equipments placed in control room shall be done by prefabricated cables. Prefabricated cables shall have suitable male female connections & locking arrangements.

12.05.00 CONTRACTOR shall use type terminals with marker plate and engraved acrylic shrouds.

12.06.00 Power, control, signal and communication cables shall be laid and routed separately with the help of underneath trays. Supply of trays & installation is in the CONTRACTOR's scope.

12.07.00 All electrical terminals inside the system racks and consoles shall be clearly numbered and permanently identified on the terminals and the system wiring drawings with permanent marker on modules chassis and panels.

12.08.00 Electrical wiring shall be in accordance with applicable electrical standards. Wiring diagrams shall be complete with grounds in recommended wire sizes, type, and shielding required for the electrical circuits between components that are to be wired.

12.09.00 Instrument Cable shall be as follows :

For 4-20 mA signal :
Single pair twisted screened cables of 1.0 mm^2 stranded copper conductor and multipair screened cables of 1.0 mm^2 stranded copper conductor.
For thermocouples :
1.0 SQMM single pair and 1.0SQMM multipair compensating cables.
For RTD :
1.0 mm^2 triad and 1.0 mm^2 multi-triad_ screened cables stranded copper conductor.
For Power Cables :
Untwisted multicore armoured cables of 2.5 mm^2 or above (as required) stranded copper conductor.
For Control Cables :
Untwisted multicore armoured cables of 1.5 mm^2 stranded copper conductor.

12.10.00 Instrument cables shall be screened & FRLS type.

13.00.00 EARTHING

13.01.00 Each panel, console, cabinet and other equipment in control room shall be provided with an earthing lug which will be completely isolated from the A.C. mains earthing bus.

13.02.00 Electronic grounds, shields and drain wires of signal cables shall be connected with the instrument ground bus. This bus will be made of 25 mm wide and 6 mm thick copper and it will be completely electrically isolated from the main power supply earthing bus. Independent instrument ground buses will be connected with the main instrument ground bus through insulated wires.

13.03.00 The zener barrier grounding wire shall be capable of carrying 0.5 amp current at 250 v r.m.s.

13.04.00 Cable shields of the thermocouple cables shall not be grounded in the field.

13.05.00 CONTRACTOR has to give detail earthing requirements of their system. CONTRACTOR shall indicate the total no. earthpits required. Earthing requirement shall be met at one point inside the control room below false floor. Further distribution inclusive of all hardware, earthing cables, wires etc. shall be in CONTRACTOR's scope.

14.00.00 TRAINING

14.01.00 The requirements of training for Owner/consultant personnel (one group consisting of operators and other group consisting of hardware/software maintenance engineers) in the operational software and diagnostic programs, are set forth herein.

14.02.00 CONTRACTOR shall be responsible for furnishing details of course outlines, manuals of training, equipment necessary to conduct the training exercises to evaluate trainees progress. CONTRACTOR shall also be responsible for any other requirements necessary to train the engineers deputed by Owner within a time limit so that they acquire the necessary expertise to operate and maintain the programs and the equipments supplied.

Contractor shall provide all operation and service manuals with relevant training materials.

14.03.0 Contractor has to give training to purchaser's and customer's personnel at contractor's works and at site

15.00.00 INSPECTION & TESTING

15.01.00 This specification defines the basic guidelines to Distributed Digital Control System and SOE for Factory testing and acceptance (FAT), Installation, Commissioning and Site acceptance(SAT), of the fully integrated system.

15.02.00 These guidelines shall also be applicable to all sub-system and hardware bought by DCS CONTRACTOR.

15.03.00 Quality assurance plan shall be submitted for review and approval after the placement of order clearly marking Owner hold point.

15.04.00 On the basis of this specification, CONTRACTOR shall submit his own testing, installation, commissioning and acceptance procedures. (For hardwares, the procedures shall include purpose of test. Test definition of input, procedure, results expected and acceptance criteria. For softwares, it shall include details of the method, list of tests, sequence of execution, results expected and acceptance criteria).

15.05.00 The testing and acceptance of the system shall be carried out on the mutually agreed procedures and criteria based on this specification and CONTRACTOR's standard procedures.

15.06.00 CONTRACTOR shall test and demonstrate the functional integrity of the system hardware and software along with integration carried out for Turbine governor & BMS systems.. DCS system hardware & software that shall be factory tested ready to function as soon as it is connected to the electrical power & input/output signal wiring. No material or equipment shall be transported until all required tests are successfully completed and certified `Ready for shipment' by Owner/Consultant.

15.07.00 The Owner/Consultant reserves the right to be involved and satisfy himself at each and every stage of inspection. The Owner /Consultant shall be free to request any specific test on any equipment considered necessary by him although not listed in this specification. The cost of performing all tests shall be borne by the CONTRACTOR.

15.08.00 CONTRACTOR to note that acceptance of any equipment or the exemption of inspection or testing shall in no way relieve CONTRACTOR's responsibility for delivering the equipment meeting all the requirements as specified elsewhere in this document.

15.09.00 It shall be CONTRACTOR's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

15.10.00 CONTRACTOR shall not replace any system component/module/sub-systems unless it is failed. A log of all failed components in a sub-system shall be maintained which shall be give description of the failed component/module, effect of failure on the sub-system cause of failure and number of hours of operation before it failed.

15.11.00 If malfunction of a component/module in a sub-system repeat, the test shall terminate and CONTRACTOR shall replace the faulty component/ module. There after the test shall commence all over again. If even after this replacement, the sub-system fails to meet the requirements, CONTRACTOR shall replace the full sub-system meeting the requirements and the system shall be tested all over again.

15.12.00 If a sub-system fails during the test and it is not repaired and made successful operational within four hours of active repair time after the failure, the test shall be suspended and restarted all over again only after the CONTRACTOR has replaced the device into the acceptable operation.

15.13.00 New cards will be installed. Repaired modules are not acceptable. Site acceptance Test (SAT) shall be done at site prior to acceptance.

15.14.00 The Owner will take over the system from the CONTRACTOR after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks for all units of the plant. CONTRACTOR's personnel shall be present during the test. Any

malfunctioning or insufficiency of the system components shall be replaced/repaired as required. Once the system failure is detected, the acceptance test shall start over again from the beginning. The warranty period commences from the day owner takes over the system.

WARDHA POWER CO. PVT. LTD.
3600 MW COAL BASED POWER PROJECT
AT NARIYANA, JANJGIR-CHAMPA DIST. CHATTISGARH

ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB2

PROGRAMMABLE LOGIC CONTROLLER

I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB2: PROGRAMMABLE LOGIC CONTROLLER

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I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB2 : PROGRAMMABLE LOGIC CONTROLLER

1.00.00 PLC DESCRIPTION (GENERAL)

1.01.00 The PLC described in this Specification shall be a microprocessor based system that will accommodate digital inputs, outputs and dry contact inputs from field devices located throughout the plant. Logical decision shall be made internally by the controller's preprogrammed logic. The output from a logical sequence shall be used to control the equipment.

1.02.00 PLC system shall consist of :

PLC mounted in rack with redundant CPU, Memory, Power supply, Communication modules and cables and Non redundant I/Os.

2.00.00 TECHNICAL REQUIREMENTS

2.01.00 The PLC shall provide all basic functions for binary gating operations, modulating controls, storage, counting, timing, logging, transfer operations and comparison functions. The CONTRACTOR in his bid shall submit full details regarding various functions along with expansion capability.
Suggested PLC makes are: Allen Bradley/Siemens/Schneider/Modicon)

2.02.00 The programmable system shall be delivered completely programmed for the complete and reliable operation of the plant.

2.03.0 Each PLC unit shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically. The transfer from main processor to standby processor shall be totally bumpless and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. The facility for manual switchover also shall be provided.

The PLC shall respond rapidly to process upsets and provide output for safe shutdown of various process areas by solving the programmed logic.

System response time (reading input condition, solving the logic and initiating output(s)) shall be 100 millisecond maximum.

2.04.00 The processor unit shall be capable of executing the following functions:-

a. Receiving binary and analog signals from the field and operator initiated commands from OWS/ control panel.

b. Implementing all logic functions for control, protection and annunciation of the equipment and systems.

c. Implementing modulating control function for certain application as specified elsewhere in the specification.

d. Issuing control commands.

e. Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.

f. Performing self-monitoring and diagnostic functions(hardware and software). Routine checks should be scheduled to run automatically at frequent intervals. Diagnostic packages and related equipment shall be printed on the printer.

g. PLC processor loading shall be 50% at normal loading and 70% during worst case loading.

2.05.00 The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future. Programmed operating sequences and criteria shall be stored in non-volatile semi conductor memories like EPROM. All dynamic memories shall be provided with buffer battery back up which shall be for at least 50 hours. The batteries shall be lithium or Ni-Cd type.

2.06.00 The PLC system shall be provided with necessary interface hardware and software for dual fibre optic connectivity & interconnection with BOPNET for transfer of signals for the purpose of information sharing and supervisory monitoring. The plant information shall be made available through an OPC compliant duplex Ethernet link following TCP/IP standard. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalized during detailed engineering.

2.07.00 For each PLC system one (1) no. operator station and one (1) no. engineering cum operator station, each with 21" color TFT LCD display and key boards for control & monitoring and programming functions shall be provided in the respective local control room. One (1) number A4 size colour laser network printer shall be provided in each local control room.

PC based OWS (Operator Work Station, Spec. as provided at the end of this chapter) shall perform control; monitoring and operation of all auxiliaries/ drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC. It shall basically perform the following functions. In case the PC based OWS cannot be used as programming station of the PLC, then a separate PC based programming station shall be provided.

a Operator interface for PLC based control system. Operator functions shall as minimum include local/ remote selection, A/M selection, open/ close operation, sequence auto, start/ stop selection, ON/OFF, bypassing criteria etc.

b Supervisory functions like:-

Mimic displays, which shall depict the process in graphical form and shall cover all the process areas being monitored.

Alarm monitoring/reporting, generation of logs, calculations, printing of logs & reports etc.

SPECIFICATIONS OF OWS PC

The minimum requirement for PC shall be as below:

CPU	Latest with adequate no. of Ethernet/ LAN connectivity port.
Main memory	512 MB or more
Drives	3 1/2" floppy drive, 48 x CD ROM R/W drive
Hard disk	80 GB
Monitor	21" TFT,LCD, multi-sync color monitor, 0.26 mm dot pitch, Resolution 1600 x 1280 non-interlaced, refresh rate min 85 Hz
Graphic accelerator	8 MB
Communication port	2 serial plus one parallel, 1 USB port
Expansion slots	5
Other Features	101 Keys Keyboard and Mouse

Accessories	Industrial grade furniture (computer table & chair) for PC & its printer, as approved during detailed engineering.	
Software	a	General – Operating system and all other software required for system functionality, anti-virus, etc.
	b	Application specific - to suit specific requirement

2.08.00 PC based OWS (operator Work Station) of PLC shall be mounted on table type control desk to house PC/ keyboards/ mouse etc. Control desk shall be freestanding tabletop type with doors at the back and shall be constructed of 3 mm thick CRCA steel plates. A 19 mm thick wooden top shall be provided on the desk with proper finish of acrylic PVC/Polutherane paint. The keyboard shall be capable of being pulled out through a tray. The profile and dimension shall be decided during detailed engineering and shall be subject to Owner's approval.

2.09.00 The A4 size colour laser network printer in each local control room shall print out all alarm/trip conditions and event changes in plant status along with date and time of occurrence. The time least count for event recording shall not be more than 100 milliseconds.

2.10.00 One no. laptop with engineering software backup & one no. 2GB pen drive for data backup shall be provided for each PLC system.

2.10.00 Programming station shall have access to the processor of the control system for programming. Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

Programming shall be possible in any of the following formats :

a) Flow-chart or block logic representing the instructions graphically.

b) Ladder diagrams.

A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program. Programming of HMIS shall be possible through user friendly menus etc. All programming functionalities shall be password protected to avoid unauthorized modifications.

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2.11.00 Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

2.12.00 In PLC controller, memory should exist as to where the sequence was aborted due to power supply failure so that further operation from that point can restart after power supply restoration. This restart after recovery of the power supply shall be through operator intervention so as to enable verification of readiness of other related equipments.

2.13.00 Provision shall be made in PLC based systems to accept clock signal from Master / Slave clock system for time synchronization.

3.00.00 INPUT/OUTPUT MODULES

3.01.00 The PLC system should be designed according to the location of the input/output cabinets as specified.

3.02.00 Input Output modules, as required in the Control System for all type of field input signals (4-20 mA, RTD, Thermocouple, non change over/change over type of contact inputs etc.) and outputs from the control system (non change over/change over type of contact, 24 VDC output signals for energizing interface relays, 4-20 mA output etc.) are to be provided by the CONTRACTOR.

3.03.00 Electrical isolation of 1.5KV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment.

3.04.00 The Input/output system shall facilitate modular expansion in fixed stages. The individual input/output cards shall incorporate indications on the module front panels for displaying individual signal status.

3.05.00 Individually fused output circuits with the blown fuse indicator shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses preferably for each input, alternatively suitable combination of inputs shall be done and provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems.

3.06.00 All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.

3.07.00 The CONTRACTOR shall provide the following features:

a Power supply monitoring.

b Contact bounce filtering.

c Optical isolation for digital input and interposing relays for digital output signals.

d In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode.

3.08.00 Further, keying-in of individual wire connectors shall be provided to ensure that only the correct card is plugged on the I/O module. It shall be possible to remove I/O module without disconnecting wiring from field inputs or outputs. There shall be at least 20% spare capacity available on input, output and memory modules, over and above the system requirement. 10% spare complete with wiring upto the module level is to be provided.

3.09.00 Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA at 24 VDC. Analog output modules shall be able to drive an load impedance of 500 Ohms minimum.

3.10.00 Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc.

3.11.00 Only one changeover contact shall be provided in MCC for control and interlock requirement. Further multiplication, if required, shall be done by the CONTRACTOR in PLC system.

3.12.00 All input field interrogation voltage shall be 24V/48V DC.

3.13.00 In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be decided during detailed engineering) with proper annunciation.

3.14.00 CONTRACTOR shall provide for 20% spare I/O modules in each system cabinet to take care of any further addition.

3.15.00 CONTRACTOR shall provide remote Input/Output modules Housed in freestanding cabinets/racks (with suitable redundant data link to the central PLC system) as specified. These Input/Output modules shall meet the technical requirements as mentioned in the above clauses. Further these Input/Output modules shall be designed to continuously work under the environment expected to be encountered in assigned areas without any air-conditioning support. Wherever the cable route distance of these I/O cabinets/racks exceeds a distance of 300 meters from the Central PLC, fibre optic data link has to be provided.

3.16.00 The maximum number of inputs / outputs to be connected to each type of module shall be as follows :

1.	Analog input module	16
2.	Analog output module	16
3.	Binary input module	32
4.	Binary output module	32
5.	Analog input/output combined	16
6.	Binary input/output combined	32

3.17.00 The maximum loading for input/output capacity shall be 65%.

4.00.00 SYSTEM SOFTWARE

4.01.00 All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The CONTRACTOR shall provide sufficient documentation and program listing so that it is possible for the Owner to carry out modification at a later date.

4.02.00 The CONTRACTOR shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.

4.03.00 Industry standard operating system like UNIX/WINDOWS NT etc. to ensure openness and connectivity with other system in industry standard protocols (TCP-IP/ OPC etc.) shall be provided. The system shall have user oriented programming language & graphic user interface.

4.04.00 All system related software including Real Time Operating System, File management software, screen editor, database management software As required for PLC. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.

4.05.00 All application software for PLC system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.

4.06.00 The CONTRACTOR shall provide all the software locks and passwords to Owner's engineers at site for all operating & application software so that

Owner's engineers can take backup of these software and are able to do modifications at site.

4.07.00 All software supplied should be licensed software. Wherever user name is required to be mentioned, the name of OWNER shall be mentioned and the name of supplier shall not be mentioned. Any software upgrade during the defect liability period should be done free of cost if launched by the manufacturer.

5.00.00 POWER SUPPLY

5.01.00 Each off site plant control system shall be powered from their own packaged completely redundant 240VAC 50 Hz UPS units.The rating shall be suitable designed.The CONTRACTOR shall furnish all necessary equipment cubicles, switch devices, fuses, distribution boards and other equipment necessary for distribution, including wiring required for conversion and/or stabilization of the plant available power supply to all other levels which may be necessary for meeting the individual requirements of the equipment/systems furnished by the CONTRACTOR.

All major equipments shall be served by 2 x 100% capacity feeders with a provision of auto change over to ensure uninterrupted supply on loss of one feeder.

Power distribution to control devices shall be arranged such that the loss of an individual circuit does not result in complete loss of control capability or create unsafe operating conditions.

System shall be capable of detecting failure of power to a loop, an open input circuit etc.

The maximum resistance to ground shall be clearly specified.

The Contractor shall review panel grounding system connection and advise as to whether or not the hardware is properly grounded to ensure proper operation.

6.00.00 ENVIRONMENT

6.01.00 All PLC equipment shall be capable of operating continuously for environmental conditions given below:

Operating Temperature	:	0 to 50*C
Relative Humidity (Non - Condensing)	:	10 to 90%

7.00.00 INSPECTION AND TESTING

7.01.00 <u>QUALITY ASSURANCE</u>

The CONTRACTOR shall submit a complete summary of the proposed quality assurance program to OWNER for review and approval.

This program will include provision for OWNER nominated inspector(s) to have access to the manufacturing and test facilities by prior arrangement with the CONTRACTOR.

The CONTRACTOR must notify the OWNER four weeks in advance of the Factory Acceptance Test. The excepted duration of the test is 3 days. The CONTRACTOR shall specify the time allowed in the Quotation for this test.

It is required that prior to a final assembly all component parts and sub assemblies should have been subjected to a 100 percent functional test. The functional test shall be fully described and documented, and "subject to approval" by OWNER. Bought-out subassemblies shall be thoroughly retested by the CONTRACTOR/vendor and, where possible, copies of the manufacturers test procedures and documentation shall be obtained.

Prior to, or on completion of the final system assembly, and prior to the Factory Acceptance Tests, a complete list of subcomponent serial number and test certificates shall be made available to the OWNER. Also all system documentation should be made available at this time.

OWNER may require the right to witness certain tests prior to the Factory Acceptance Test. OWNER shall be given at least 14 day's notice of the proposed date of such tests.

The CONTRACTOR shall ensure that all components used in manufacture meet the operating and environmental conditions applicable to their use.

OWNER shall have access to all quality control documents that record the design, testing and integration of the system.

7.02.00 SYSTEM TESTING

The CONTRACTOR shall be required to execute a comprehensive system test including environmental simulation tests to verify the system hardware and software performance prior to shipment. Following the environmental test a system burn-in-test shall be performed for a minimum of 100 hours. This test shall document trouble free operation at normal ambient conditions, including functional exercising of all inputs, outputs and peripheral devices algorithm and calculation exercising and monitoring for errors.

During this period all system self-test diagnostic shall be fully operational, and diagnostic messages shall be recorded on a hard-copy recorder,

preferably the system alarm printer. The test will be considered to be terminated 100 hours after the last recorded fault, or by prior agreement in writing from OWNER. OWNER shall be informed by telex and telephone of the start of the test and any subsequent faults. If any failures discovered and any replacements made, shall be noted and logged.

7.03.00 FACTORY ACCEPTANCE TEST (FAT)

Customer acceptance tests will include visual checks on engineering workmanship, insulation tests and functional tests, with full simulation of all inputs and outputs. The PLC supplier shall provide all the personnel, test facilities, equipment and tools to assist with this. Appropriate test record sheets will be prepared in conjunction with the CONTRACTOR.

- The functional testing shall include a performance check of all redundancy features and fault diagnostic features of the system. FAT shall include but not be limited to :

- Testing of all response times.

- Automatic switch over to backup on controllers, power simulation the Highway Failure' alarm should be generated.

- As part of factory acceptance test, the known system problems and limitations shall be demonstrated, especially with regard to the latest version of software.

The OWNER will provide engineers to participate full time in the Factory Acceptance Test. It is proposed that the following sections will form a minimum starting point describing what is to be tested in general terms. The appropriate Test Record sheets will be prepared in conjunction with the CONTRACTOR.

1) Check system manuals are complete.

2) Check all drawings are complete, legible and understandable.

3) Check general appearance - paint-work, finish, cable dress and cleanliness.

4) Check all equipment complete, marked and located according to the parts lists, termination schedules. Check serial numbers.

5) Confirm that all scales, charts and nameplate details are correct.

6) Check that all cables, plugs and sockets, termination blocks and connections are clearly and unambiguously labeled.

7) Check that all power supply units are connected for the correct primary voltage and adequately labeled.

31-Mar-09

Note:

Mining excavation activities of Gurha (East) Lignite is under way. Very shortly Lignite is going to be exposed. Power plant work is in full swing and Primary crusher (Feeder Breaker) work has been allotted to M/s Zuberi Engineering Company.

As per our planning and Contract work given to M/S HD Enterprises, produced lignite shall be weighed and fed to feeder for crushing and then it will be transported to plant. On the basis of the data, contractor shall be paid and lignite production shall be known. To fulfill the above, it is required to establish a rated capacity Weigh bridge at mine site. As the other activities have already started, procurement and establishment of Weigh Bridge should undertake early. Considering the present flying vehicles capacity, the specifications of proposed Weigh Bridge shall be as under.

1. CONFIGURATION
   - Weighing Capacity - 60 Metric Tonnes [60,000 kgs.]
   - Type - Surface Mounted Type
   - Mechanism / Principle - Electronic with Load Cells
   - Weight Indication - Digital Indication System

2. BASIC DESIGN & CONSTRUCTIONAL FEATURES
   - The basic design shall be suitable for electronic measuring system using digital load cells and digital indication system.
   - The measuring accuracy shall be as per Class-III Accuracy and abided by Indian Weights & Measures Act.
   - The weigh bridge indicator cum display system shall be compatible to get connected to a PC, for taking print-outs, data entry to hard disk of the PC and giving connectivity to external IT network system through suitable and reliable communication cables and ports.

3. ENVIRONMENTAL PERFORMANCE OF THE MACHINE
   - The machine shall be suitable for extreme climatic conditions like minimum temperature of 0^0 C and maximum of +55 ° C.

By considering the above requirements, the detailed specifications shall be prepared and sent to the bidders for their offers.

Submitted for necessary action please.

8) Check power and grounding systems according to drawings.

9) With the mains power disconnected, test the earth on the power supply systems by checking that there is an open circuit between cabinet frame and power rails.

10) Connect mains power and check that the appropriate voltage is developed on all power rails.

11) Disconnect the primary supply to, or unplug one power module in all power supply systems. The system should be unaffected in operation and a "power supply failure" alarm should be generated to the operator for each system.

12) Disconnect highways in sequence and check :

Operation of redundant highway maintains the system performance.

A "highway failure" and back-up highway selected" alarm is generated.

13) Check the operation of redundant equipment by unplugging redundant printed circuit cards. Check continuing operation and notification of loss of redundancy to the operator.

14) Check system self-diagnostics by simulating faults revealed by such diagnostics.

15) Check transducer limit alarms by injecting out-of-limit signals on 50 analog inputs. Check response to open and short circuits.

16) Using a switch and lamp assembly, check all shutdown and sequential operations are performed correctly.

17) Turn of mains for 10 seconds. Restore mains and check that the system remains configured.

18) The PLC supplier shall provide with his quotation preliminary test procedures detailing the activities to be performed. This shall include the timing of activities, the personnel attending the tests and their responsibilities. Methods of which deficiencies shall be identified, recorded and rectified.

The supplier shall notify purchaser four weeks in advance that the system is ready for FAT.

7.04.00 SITE ACCEPTANCE TEST (SAT)

A full integrated site acceptance test shall also be performed, immediately before hand over of the PLC to purchaser. This test shall demonstrate that the installed PLC functions correctly. The PLC supplier shall provide all the personnel, test facilities, equipment and tools to assist with this.

A test procedure is required for approval twelve weeks prior to the scheduled site acceptance test.

7.05.00 PERFORMANCE GUARANTEE TEST

A Performance Guarantee Test will be performed after the plant startup. The test is described below.

a. The test shall take place within the first six months of plant operation.

b. The test shall be 168 hours in duration

c. During the Test, all hardware and software shall operated without failure. Failures shall be detected by system diagnostics and status indications such as LEDs.

d. During the test, no plant disturbance shall be caused by failure of CONTRACTOR-supplied hardware or software or CONTRACTOR services.

e. If any failure occurs during the test, it shall be completely repaired within the stated MTTR, and the test clock will be reset to zero.

WARDHA POWER CO. PVT. LTD.
3600 MW COAL BASED POWER PROJECT
AT NARIYANA, JANJGIR-CHAMPA DIST. CHATTISGARH

ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB3

FIELD INSTRUMENTS

I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB3:FIELD INSTRUMENTS

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I1: C&I TECHNICAL SPECIFICATION

SECTION-XIXB3:FIELD INSTRUMENTS

1.00.00 GENERAL

1.01.00 The technical specifications are intended as a general guideline and does not relieve CONTRACTOR of any responsibility/liability in selection/engineering or meeting any guarantee or availability figures.

1.02.00 Detailed purchase specifications, makes & models etc. shall be subjected to Owner's/Consultant's approval.

1.03.00 All accessories shall be provided for the instruments on as required basis.

1.04.00 Instruments in hazardous areas or in contact with hazardous fluid shall be of explosion proof design.

1.05.00 Instrument sensing element and all other wetted parts shall be compatible to the process fluid and operating condition. Diaphragm seal shall be used for slurry, viscous and corrosive application.

1.06.00 Fluid system temperature sensors shall be equipped with thermowells as per PTC 19.3. Thermowells shall be threaded and constructed to allow seal welding after installation. Each thermowell shall be provided with stainless steel extension nipple to extend a sufficient length outside the insulation and lagging for accessibility. Thermowells shall be designed such that the resonance frequency is above the vortex induced vibration. Thermowells shall be IBR certified as per IBR for systems calling for IBR certification..

2.00.00 TEMPERATURE GAUGE

2.01.00 Type-1

01.	Type	:	Filled System
02.	Material	:	i) Bourdon, Bulb & Capillary - AISI 316 SS ii) Armoring - SS flexible, Movement - AISI 304 SS
03.	Accuracy	:	±1% of full scale.
04.	Repeatability	:	Less than 0.5% of FS.
05.	Response Time	:	40 seconds
06.	Range	:	Normal Operating Temperature 60% - 75% of range (appx.).

07.	Over range Protection	:	120% upto 400 Deg.C 115% above 400 Deg.C
08.	Thermowell connection size	:	¾" NPTM / ¾", 1" SW as applicable (for Process), ½" NPTF (for Element).
09.	Immersion length	:	To suit individual application requirement
10.	Enclosure	:	Die cast aluminium, conforming IP 65.
11.	Others	:	Capillary and case compensation, zero adjusting by screw from front.
12.	Applicable Standard	:	BS 1401

2.02.00 Type-2

Sensing element	:	Bimetal Helical Spring
Stem	:	AISI 316 SS.
Dial size	:	150 mm.
Case & Bezel	:	Die-cast aluminium, black epoxy finish with screwed bezel.
Enclosure type	:	Weather-proof to IP-65
Instrument connection	:	3/4 inch NPT/engineering requirement
Connection location	:	Bottom
Scale	:	Black numerals on white back ground is 270 deg.C
Dial window	:	Crystal clear glass of minimum 3 mm thickness
Pointer	:	Externally adjustable.
External zero reset	:	To be provided
Accuracy	:	± 1.5% of FSD
Repeatability	:	Deviation to be less than 0.5% full range.

Response time	:	To be less than 50 seconds in a drilled bar-stock thermowell.
Over-range protection	:	To withstand a maximum of 20% intermittent over-range fluctuation.
Thermowell connection size		¾" NPTM / ¾", 1" SW as applicable (for Pr NPTF (for Element).
Immersion length	:	To suit individual application requirement

3.00.00 THERMOCOUPLE

01.	Element	:	Type J, K, R; Ungrounded (Duplex); Wire gauge 16AWG for Type J & K and AWG20 for Type R,S.(Extension wire of T/C material)
02.	Connection Head	:	Die Cast Aluminium body and universal screwed cover Zinc plated with S.S retaining chain, heat & moisture proof gaskets, IP 65, dust / water / weather proof type. ¾" ET gland and grommet for cable connection
03.	Terminal Block	:	Ceramic with Screwed type Brass, Silver plated
04.	Response Time	:	Less than 10 sec for control & 20 sec for measurement.
05.	Protecting Tube	:	AISI 316 SS seamless (8mm OD) filled with MgO powder (99.4% pure).
06.	Codes & Standards	:	ANSI - MC 96.1
07.	Thermowell connection size	:	¾" NPTM / ¾", 1" SW or 1½" direct weld to pipe as applicable (for Process), ½" NPTF (for Element).

4.00.00 RESISTANCE TEMPERATURE DETECTOR (RTD)

01.	Type	:	PT-100(Duplex), ungrounded, 3 wire, (Extension. Wire - Silver/Constantan)
02.	Tolerance	:	As per DIN 43760

03.	Head	:	IP 65 universal, Die-cast Al/ Better, Silver plated TB, Terminal Head Cover with SS Chain & suitable gasket. ¾" ET gland and grommet for cable connection
04.	Accuracy	:	0.6% (600 Deg.C span) or better
05.	Stability	:	0.05% after thermal cycling
06.	Response	:	Less than 10 sec for control & 20 sec for measurement..
07.	Protecting Tube	:	AISI 316 SS seamless (6mm OD) filled with MgO powder (99.4% pure).
08.	Thermowell connection size	:	¾" NPTM / ¾", 1" SW as applicable (for Process), ½" NPTF (for Element).
09.	Codes & Standards	:	IS-2848, DIN-43760

5.00.00 THERMOWELL

a) Thermowells shall be provided for all thermocouples, resistance temperature detectors, temperature switches and direct reading thermometers except for temperature sensors used for metal temperature bearing casing temperature measurements.

b) The design of thermowell shall take into consideration the temperature, pressure and velocity of the fluid.

c)	Standard	:	PTC - 19.3 - 1974
d)	Design	:	Tappered design and drilled from solid bar stock. For flue gas/furnace applications protecting sheath/tube of adequate strength with welded cap on the end located inside the duct shall be provided.
e)	Material	:	In general AISI 316 SS. 440 CSS may be used for furnace/flue gas applications.
f)	Connection	:	Shall be as per the process temperature and pressure. In general, all thermowells shall be 40 NB ANSI (RF) flanged. However for

IBR piping screwed thermowells are acceptable.

g) Bore : Suitable for insertion of the respective temperature elements.

h) Calibration : Temperature elements with thermowells, shall be calibrated with the specified thermowell as per assembly.

i) IBR Certificates : Shall be provided for all thermowells as steam & feed water application.

6.00.00 ORIFICE PLATE

01.	Design Standard	:	i) BS-1042 : Part-II; 1984 ii) ASME PTC19.5 (1972) [Interim supplement Part-II]
02.	Measuring element	:	Square edge orifice
03.	Element Material	:	AISI-316 SS
04.	Construction	:	With integral handle with Orifice Plate data stamped on upstream side with 6 mm lifting hole.
05.	Pressure tap	:	Flange / D-D12
06.	Flange material	:	A105
07.	Beta ratio	:	0.4 to 0.7
08.	No. of Root Valves	:	i) Two for static pressure above 40 kg/cm^2 ii) One for static pressure upto 40 kg/cm^2

7.00.00 FLOW NOZZLE

01.	Design Standard	:	i) BS 1042 ii) ASME PTC 19.5 (1972) [Interim supplement Part-II]
02.	Material of Nozzle	:	AISI 316 SS / 321 SS
03.	No. of Root Valves	:	i) Two for static pressure above 40 kg/cm^2 ii) One for static pressure upto 40 kg/cm^2

8.00.00 LEVEL INDICATOR

01.	Type	:	Float type mechanical level gauge with linear scale
02.	Accuracy	:	± 1.0% of scale range
03.	Material	:	Gauge Board - Al. Epoxy Supports - M.S. Guide Wire & Float - AISI 316 SS Elbow - Al. Indicator - Al. & SS

9.00.00 LEVEL GAUGE

01.	Type	:	Reflex type
02.	Material	:	AISI 316 SS (Liquid Chamber), Tempered Borosilicate (Glass)
03.	Visible Length	:	Not less than C/C distance (separate scale to be provided).
04.	Accessories	:	Two nos. gauge valves with integral ball check.

10.00.00 PRESSURE GAUGE

01.	Type	:	Bourdon/Bellow/Diaphragm
02.	Sensing Element	:	AISI 316 SS or as applicable.
03.	Movement	:	AISI 304 SS or non-ferrous for Phosphor Bronze Bourdon.
04.	Enclosure	:	Die cast Aluminium, conforming IP 65
05.	Dial Size	:	150 mm, in general.
06.	Range Selection	:	Normal Operating Pressure 60% - 75% of range approx.
07.	Accuracy	:	±1.50% of span
08.	Others	:	External zero adjustment, Block & Bleed SS Valve
09.	Ambient Temperature	:	0 - 50 Deg.C

10.	Over range protection	:	125% of range by internal stop, External stop at zero
11.	Applicable Standard	:	IS : 3624/PTC 19.2
12.	Accessories	:	Pulsation dampener, Syphon, Diaphragm seals, 2 valve manifold etc. as required.

11.00.00 DIAPHRAGM SEAL TYPE PRESSURE GAUGE

i)	Sensing element	:	Flanged or wafer type diaphragm seal element with sealing fluid to transmit the pressure to a Bourdon Tube element through a capillary extension.
ii)	Diaphragm element	:	Minimum 316 L SS. material
iii)	Process connection	:	Suitable for mounting on 50 NB ANSI 150 lbs, RF flange.
iv)	Capillary Extension	:	Minimum 3.0 meters of capillary extension to be provided. The capillary shall be protected with a S.S. Sheath.

12.00.00 DIFFERENTIAL PRESSURE GAUGE

01.	Type	:	Bellows/Diaphragm
02.	Sensing Element	:	AISI 316 SS
03.	Enclosure	:	Die cast aluminium , conforming IP 65
04.	Dial Size	:	150 mm, in general.
05.	Range Selection	:	Normal Operating D.P. 50% - 70% of range approx.
06.	Accuracy	:	±1.50% of span
07.	Repeatability	:	Less than 0.5% of FS
08.	Others	:	External Zero Adjustment, 5-Valve SS Manifold

13.00.00 PRESSURE SWITCH

01.	Type	:	Bellow or Diaphragm, Blind type.
02.	Sensing Element	:	AISI 316 SS or other as applicable

03.	Enclosure	:	Die cast aluminium conforming IP 65
04.	Over range protection	:	150% of range
05.	Switch Type	:	Snap acting micro switch, shock & vibration proof.
06.	Configuration / Rating	:	2 nos. SPDT, 240V AC/5A, 220V DC/0.5A
07.	Adjustability		i) Set point over span range ii) Differential by 10% of span
08.	Accuracy	:	±1%
09.	Repeatability	:	Less than 0.5%
10.	Accessories	:	2-Valve SS Manifold and Diaphragm seal with capillary, if required.

14.00.00 DIFFERENTIAL PRESSURE SWITCH

01.	Type	:	Bellow or Diaphragm, Blind type.
02.	Sensing Element	:	AISI 316 SS or other as applicable
03.	Enclosure	:	Die cast aluminium conforming IP 65
04.	Over range Protection	:	Static pressure on one side, the other side being open to atmosphere
05.	Switch Type	:	Snap acting micro switch, shock & vibration proof.
06.	Configuration / Rating	:	2 nos. SPDT, 240V AC/5A, 220V DC/0.5A
07.	Adjustability		i) Set point over span range ii) Differential by 10% of span
08.	Accuracy	:	±1%
09.	Repeatability	:	Less than 0.5%
10.	Accessories	:	5-Valve SS Manifold

15.00.00 TEMPERATURE SWITCH

01.	Type	:	Filled in system / Bimetallic strip, blind type

02.	Material	:	i) Bourdon, Bulb & Capillary - AISI 316 SS ii) Armoring-SS, Movement - AISI 304 SS
03.	Enclosure	:	Die cast aluminium conforming IP 65
04.	Switch	:	2 nos., SPDT, 240 V AC/5A, 220 V DC/0.5A, Shock & Vibration proof
05.	Accuracy	:	± 1%
06.	Repeatability	:	Less than 0.5%
07.	Adjustability	:	i) Set point adjustable over the span externally. ii) Differential adjustable by 20% of span (minimum).
08.	Overrange Protection	:	120% upto 400 Deg.C 115% above 400 Deg.C

16.00.00 FLOW SWITCH

01.	Type	:	Paddle Type
02.	Switches	:	SPDT 2 nos., 240 V AC/5A, 220V DC/0.5A. Magnetic operated in a hermetically sealed enclosure.
03.	Adjustability		i) Set point throughout the range. ii) ON-OFF differential
04.	Repeatability	:	±0.5% of F.S. or better
05.	Material	:	Paddle - AISI 316 SS,
06.	Enclosure	:	Die cast aluminium conforming IP 65

17.00.00 LEVEL SWITCH

01.	Type	:	External Cage float operated. Magnetically coupled.
02.	Material	:	Float & Wetted Parts - AISI 316 SS External Cage - CS (welded)
03.	Enclosure	:	Die cast aluminium conforming IP 65

04.	Type of Switch	:	Snap acting, magnetically operated hermetically sealed, shock & vibration proof.
05.	Configuration / Rating	:	SPDT 2Nos., Electrically isolated 240 V AC/5A, 220 V DC/0.5A
06.	Repeatability	:	Less than 0.5%

18.00.00 CONDUCTIVITY TYPE LEVEL SWITCH

01.	Type	:	Conductivity discrimination.
02.	Mounting	:	Flanged – on standpipe.
03.	Probe MOC	:	Stainless steel with high purity ceramic.
04.	Probe rating	:	> Maximum design pressure of vessel.
05.	Input	:	Four independent channel with selectable switching threshold for water conductivity.
06.	Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
07.	Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
08.	Local Display	:	Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
09.	Power supply	:	Dual 240V AC, 50 Hz, 1Ph.
10.	Enclosure	:	IP–65, corrosion resistant & wall mounting type.
11.	Remote indicator	:	At control room.
12.	Accessories	:	i) PTFE cable from probe to electronics ii) Mounting accessories iii) Standpipe iv) Washer & gasket
13	Test pressure	:	Two times rated pressure
14.	Cable connection	:	3/4" ET

19.00.00 PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER

01.	Type	:	Capacitance type, 2-wire, (loop powered) Smart.
02.	Output	:	4-20 mA DC, Linear, Superimposed Digital Signal. Standard protocol like HART.
03.	Material	:	Measuring Capsule - AISI 316 SS or better; Body – CS / Stainless Steel as per fluid application.
04.	Span & Zero	:	Continuously adjustable externally non-interacting, both local and remote calibration facility.
05.	Enclosure Class	:	Die cast aluminium conforming IP 65
06.	Ambient Temp.	:	0 - 50 Deg.C
07.	Accuracy	:	± 0.1% of span.
08.	Range	:	About 1.5 times normal value (min.)
09.	Repeatability	:	± 0.05% of span or better
10.	Sensitivity	:	0.05% of span or better
11.	Body/Element Rating	:	1.5 times the maximum span / Full static Pressure on one side with other side venting for DPT.
12.	Over range limit	:	150% of maximum span.
13.	Turn down ratio	:	40:1 or better
14.	Output Indicator	:	LCD type.
15.	Hand held calibrator	:	Yes.
16.	Instrument Valve Manifold	:	2-Valve for PT / 5-Valve for DPT (Stainless Steel)

20.00.00 DISPLACER TYPE LEVEL TRANSMITTER

01.	Type	:	SMART
02.	Float movement	:	Vertical
03.	Stages of operation	:	Continuous
04.	Material -		

	a) Displacer/Float	:	AISI 316 SS/304 SS
	b) Wire rope, spring housing, sleeve pipe	:	AISI 304 SS/316 SS
	c) Torque tube	:	AISI 304 SS/316 SS/Inconel
05.	Transmission	:	2-wire
06.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. Standard protocol like HART.
07.	Signal processing	:	Solid-state electronic circuitry
08.	Static/overload pressure	:	Maximum static pressure without permanent deformation or loss of accuracy.
09.	Turn-down ratio	:	10 : 1 minimum
10.	Zero & Span	:	Easily accessible (local zero & span adjustment and non-interactive type)
11.	Zero Suppression / elevation	:	i) Suppression = 150 % of span (min.). ii) Elevation = 50 % of span (min.).
12.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
13.	Body/Cage	:	Forged Carbon Steel or Stainless Steel depending upon fluid condition.
14.	Output Indicator	:	LCD type
15.	Performance -		
	a) Accuracy	:	±0.5 % of span or better
	b) Repeatability	:	±0.05 % span or better
16.	Accessories	:	i) ANSI RF Counter Flange; rating as per process pressure. Necessary nuts, bolts, gaskets etc. ii) Special calibration tool / configurator, if any. iii) Stilling chamber

21.00.00 TEMPERATURE TRANSMITTER

01.	Type	:	Solid State, Smart

02.	Input	:	RTD Pt 100 Ohms (3-wire), T/C-J/K/R/S .
03.	Output	:	4-20 mA DC, Linear, Superimposed Digital Signal. Standard protocol like HART.
04.	Adjustments	:	Zero & Span, Local & Remote calibration facility. In-built cold, junction compensation for T/C
05.	Enclosure Class	:	Die cast aluminium conforming IP 65
06.	Accuracy	:	± 0.1% of span
07.	Zero Drift	:	1 micro volt per Deg.C or better

22.00.00 MASS FLOW METER

01.	Application	:	Measurement of Oil Flow.
02.	Working Principle	:	Coriolis principle.
03.	Type	:	Smart
04.	Output	:	4-20 mA DC, Linear, Superimposed Digital Signal. Standard protocol like HART.
05.	Material of Wetted Parts	:	SS 316 L
06.	Enclosure	:	IP 65 corrosion proof/Ex. Proof as required.
07.	Accuracy	:	±0.2% of F.S.
08.	Display	:	4 line LCD for flow rate, temp, density & total flow.

23.00.00 ROTAMETER

The Rotameter shall be of the following specifications but not limited to the same.

i)	Type	:	ON-LINE for line size upto and including 50 mm NB. By-pass for line size above 50 NB.
ii)	Metering tube	:	Metal tube

iii) Float	:	AISI 316 SS unless the process fluid demands some other material
iv) End fittings	:	AISI 316 SS or as suitable
v) Packing material	:	Teflon
vi) Casing	:	Steel
vii) Gland rings/followers	:	Steel
viii) Scale	:	250 mm nominal lengths
ix) Graduation	:	Direct reading
x) Process connection	:	RF flanged to line size as per ANSI standard - for on-line type & 3/4 inch 150 lbs (RF) ANSI flange for by-pass type.
xi) Accuracy	:	± 2% of full scale reading for online type & +/-4% of full scale reading for by-pass type
xii) Reproducibility	:	Within 0.5% of instantaneous reading
xiii) Accessories	:	Slip-on orifice plate of 316 SS, carrier ring with corner taps of C.S./304 SS as per application requirements & range orifice - for bypass type rotameters.

24.00.00 AIR FILTER REGULATOR

01.	Filter Element	:	Sintered Bronze
02.	Filter Size	:	15 (fifteen) microns (maximum), 5 microns preferred.
03.	Output	:	Adjustable from 0-7.0 Kg/Sq.Cm (continuous)
04.	Effect of supply pressure variation	:	Maximum 0.02 Kg/Sq.Cm for a change in supply pressure of 4 Kg/Sq.Cm
05.	Bowl Material	:	Clear transparent polycarbonate/ metallic
06.	Accessories	:	2" dial size output pressure gauge

07.	Desirable	:	No perceptible drop of pressure on Feature opening the drain port.

25.00.00 I / P CONVERTER

01.	Type	:	Analog, Direct acting
02.	Output	:	0.2 to 1.0 Kg/Sq.Cm
03.	Enclosure	:	Die cast aluminium conforming IP 65 / Explosion proof as applicable.
04.	Accuracy	:	± 0.5% of span
05.	Repeatability	:	± 0.1% of span
06.	Ambient Effect	:	0.5% of span / 50 Deg. C

26.00.00 JUNCTION BOXES

1) Type	. Flame proof/weather proof and dust tight
2) Enclosure	: IP-65
3) Material	: Die cast aluminium with protective coating
4) Cable entry	: Bottom
5) Cable glands	: Double compression type – Nickel plated brass with PVC hoods.
6) Mounting	: Outdoor
7) No. of terminals, mounting rails, end clamps, lugs	: As required with standardization
8) Terminals	: Phoenix/Wagon
9) Grounding	: Two terminals for body and shield ground
10) Door	: Hinged, lockable type.
11) Gasket	: Gasket between door and body to be provided
12) Name plate	: SS name plate to be firmly fixed

If any other type of instrument is required for a particular application, CONTRACTOR shall take the approval of the same from OWNER.

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ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB4

INSTRUMENTATION & CONTROL CABLES

I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB4: INSTRUMENTATION & CONTROL CABLES

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I1: C&I TECHNICAL SPECIFICATION

SECTION-XIXB4: INSTRUMENTATION & CONTROL CABLES

1.00.00 GENERAL

1.01.00 This specification is intended to cover the general requirement for design, manufacture, testing at Manufacturers works and delivery of properly packed PVC insulated signal cables and control cables.

2.00.00 CABLE DESIGN AND CONSTRUCTION

2.01.00 650/1100V GRADE SINGLE PAIR TWISTED INSTRUMENTATION SIGNAL CABLE

CONSTRUCTION

a) Conductor: Each core shall be seven stranded annealed copper electrolyte grade conductor of cross section 1.0 mm2 generally complying to IS-8130.

b) Insulation: Each core shall be provided with extruded HR PVC conforming to IS:5831 Type 'C'. Insulation thickness shall be >=0.8 mm and shall conform to relevant IS/other standard. Color of insulation shall be white and black in a pair.

c) Twist: Every 2 core shall be twisted to form a pair and number of twist shall be 10-12 per meter.

d) Shielding: The individual pair shall be shielded. Shield shall be Aluminium backed by Mylar tape bonded together side down helically applied with either side 25% overlap and 100% coverage. Minimum shield thickness shall be 0.05mm Drain wire shall be 0.5 sq mm multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.

e) Inner sheath: Cables shall be provided with extruded HR PVC inner sheath as per IS 5831 type ST2. The color shall be black and minimum thickness shall be >= 0.4 mm.

f) Armouring: Armouring applied over inner sheath shall be of galvanised steel wire 1.4 mm dia as per IS 1554 part I and IS 3975.
Armouring is only for cables laid under ground.

g) Overall sheathing: The cable shall be sheathed with extruded

HR PVC type ST2 as per IS 5831 Color of sheath be Black. Thickness of the sheath shall be as per IS 1554 Part. I and >= 1.24 mm. FRLS PVC outer sheath shall be provided.

3.00.00 650/1100V GRADE 6 PAIR TWISTED INSTRUMENTATION SIGNAL CABLES

3.01.00 GENERAL

6 pair twisted instrumentation cables shall be same as Single pair shielded cable.

Following additional features shall be applicable: -

3.02.00 a) Shielding: In addition to individual shielding of pair, overall shielding shall be provided. Overall shield shall be Aluminium backed mylar tape helically applied with metallic side down either side 25% overlap and 100% coverage. Shield thickness shall be 0.075 mm.
Drain wire shall be similar to individual pair drain wire and shall be in continuous contact with the Aluminium side of the overall shield.

b) Twist: Overall twist of all pair shall be as per manufacturer standard

c) Pair-Identification : Pairs shall be identified by printing pair numbers by black indelible ink on the white core at interval not more than 250 mm. Conductor insulation shall be black and white for each pair.

4.00.00 600/1100V GRADE SINGLE TRIAD SHIELDED CABLE

4.01.00 CONSTRUCTION

a) Conductor : Each core shall be seven stranded annealed electrolyte grade conductor of cross section 1.0mm^2. generally complying to class 4 of IS-8130.

b) Insulation : Each core shall be provided with extruded HR PVC insulation conforming to IS 5831 type 'C'. Thickness shall be 0.8mm minimum.

c) Twist : Every three core shall be twisted to form a triad and no of twist shall be not less than 20 per meter. Color of core insulation shall be black, white and red.

d) Shielding : The individual triad shall be shielded. Shield shall be Aluminium backed by Mylar tape bonded together with metallic side down helically applied with either side 25% over lap and 100% coverage minimum shield thickness shall be 0.05mm. Drain wire shall be 0.5sq.mm multi stranded bare lined annealed copper conductor. The drain wire shall be in continuous contact with Aluminium side of the shield.

e) Inner sheath : Cables shall be provided with extruded HR PVC inner sheath as per IS 5831 type ST2. The color shall be black and minimum thickness shall be 0.5mm.

f) Armouring : Armouring applied over inner sheath shall be of galvanised steel wire 1.4 mm dia. as per IS 1554 part I and IS 3975.
Armouring is only for cables laid under ground

g) Overall sheathing : The cable shall be sheathed with extruded HR PVC type ST2 as per IS 5831. FRLS PVC outer sheath shall be provided. Colour of sheath shall be Black. Thickness of the sheath shall be as per IS 1554 part I & >= 1.24 mm.

5.00.00 600/1100V GRADE 6 TRIAD SHIELDED CABLE

GENERAL:

6 Triad twisted instrumentation cables shall be same as single triad shielded cable; following additional features shall be applicable.

5.01.00 a) Shielding : In additional to individual shielding of triad overall shielding shall be provided. Overall shield shall be of up by Mylar tape helically applied with metallic side down either side 25% overlap and 100% coverage. Minimum shield thickness shall be 0.07mm. Drain wire shall be similar to individual triad drain wire and shall be in continuous contact with the Aluminium side of the overall shield.

b) Twist : Overall twist of all triad shall be as per CONTRACTOR's standard.

c)Triad Identification: Triad shall be identified by printed triad number by black indelible ink on the white core at interval not more than 250mm.

6.00.00 650/1100V GRADE 2 CORE CONTROL CABLE

6.01.00 CONSTRUCTION

a) Conductor: Each core shall be seven stranded annealed tinned copper conductor of cross section 1.5mm2 generally complying to IS 8130.

b) Insulation: Each core shall be provided with extruded HR PVC insulation conforming to IS 5831 Type 'C'. Insulation thickness shall be >= 0.8 mm. Color of core insulation shall be black with core numbers printed in white indelible ink at max. 150mm apart on each conductor.

c) Inner sheath: Cables shall be provided with extruded HR PVC inner sheath as per IS 5831 type ST2. The color shall be black. Thickness of sheath shall be >= 0.3 mm.

c) Armouring : Armouring applied over inner sheath shall be of galvanised steel wire 1.4 mm dia. as per IS 1554 part I and IS 3975.
Armouring is only for cables laid under ground

d) Overall sheathing : The cable shall be sheathed with extruded HR PVC type ST2 as per IS 5831. Colour of sheath shall be black. Thickness of the sheath shall be >= 1.24 mm as per IS 1554 part-I. FRLS PVC outer sheath shall be provided.

7.00.00 650/1100V MULTI CORE CONTROL CABLES (7 CORE, 12 CORE AND 19 CORE)

7.01.00 GENERAL

Multi core untwisted instrumentation cables shall be same as two core unshielded untwisted cable except for the following features.

The core identification can be done by numbers. In that case, the insulation of cores shall be of same color and number sequentially sorting with number 1 for inner layer. The number shall be printed in Hindu Arabic numerals on the outer surface of the cores. (All the numbers shall be of same color which shall contrast with the color of the insulation. The numerals shall be 1 eligible. CONTRACTOR may alternately offer color coded conductors).

8.00.00 **650V/1100V GRADE SINGLE PAIR (1P) & TWELVE PAIR (12P) THERMOCOUPLE CABLE (TYPE-K)**

a)	Conductor size	:	1.0 sqmmas per IEC 60584-3
b)	Conductor Material	:	Positive chromel; Negative Alumel
c)	Insulation	:	Heavy duty PVC type 'C' compound as per IS-5831 with thickness 0.5mm minimum & suitable for maximum conductor temperature of 85°C. Primary insulation color code shall be YELLOW (+Ve) and RED (-Ve)
d)	Inner Sheath	:	Cable shall be provided with extruded HRPVC inner sheath as per IS-5831 type ST2. The color shall be black and minimum thickness shall be ≥ 0.3mm
e)	Shield	:	The pair shall be shielded, shield shall be aluminium backed by Mylar tape bounded together and helically applied with the metallic side down with either side 25% overlap and 100% coverage. Minimum shield thickness shall be 0.05mm. Drain wire shall be 0.5 sq mm multi strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with Aluminium side of the overall shield.
f)	Color Coding	:	As per ANSI MC 96.1 Positive Yellow (Chromel) Negative Red (Alumel)
g)	Twist	:	The minimum number of twist per meter should be 20.
h)	Tolerance	:	Tolerance in overall diameter of cable shall be within ±2mm over offered value for cables with O.D. less than 30mm & ±3mm for cables with O.D. more than 30 mm.

i) Armouring : Armour over inner jacket shall be galvanized steel wire of 1.4mm dia as per IS-8784.
Armouring is only for cables laid under ground

j) Communication Wire : A pair of communication wire shall be provided for multi core cables. Each wire shall be 0.5 sq.mm of plain annealed single or multi strand copper conductor with 0.4mm thick 85°C PVC insulation.

A pair of identification shall be numbers at interval of not more than 250mm.

k) Overall sheathing : The cable shall be sheathed with extruded FRLS HR PVC type ST2 as per IS 5831. The shielding and sheathing shall be so done that it fits firmly to the cable and are easily removable without damage to core. Thickness of the sheath shall ≥ 1.24 mm, as per IS 1554 part-I. For K Type, the color of the outer sheath shall be Yellow for non-intrinsic and Blue for intrinsically safe.

9.00.00 TESTS AND INSPECTION

9.01.00 Manufacturer shall provide inspection to establish and maintain the quality of workmanship to ensure the mechanical accuracy of each components, identity and acceptability of all materials, parts and equipment. The manufacturer shall conduct all tests required to ensure that the instrument cables furnished shall conform to the requirements of applicable standards and specification.

9.02.00 The inspection shall be carried out in a manner satisfactory to and shall be subject to the approval by OWNER / Consultant. Manufacturer shall submit along with the bid the inspection and quality control plan and procedures for the approval by the OWNER / Consultant

9.03.00 All work covered by this specification shall be subject to quality surveillance by OWNER / Consultant its authorised representative.

9.04.00 Following tests shall be carried out on the cable specified.

	TYPE OF TESTS	STANDARD	SPECIFICATION	
(1)	Persulphate Test. (for copper)	IS-8130 IS 10810 (part-4)	Wire dia. (mm)	Permissible Mass of Cu. dissolved, max.(g/m2)

			=<0.41	5
			>0.41	3
(2)	Annealing Test. (for copper)	IS 8130 IS 10810 (Part-1)	Wire dia. (mm)	Elongation. min.(%)
			=<0.21	9.0
			>0.21 to=<0.41	13.5
			>0.41 to=<1.36	18.0
			>1.36	22.5
(3)	Tensile strength elongation at break of insulation and sheath.	IS 5831 IS 10810 (Part-7)	Tensile strength -min.12.5 N/mm2. Elongation at break -min.125%.	
(4)	Thermal ageing.	IS 5831 IS 10810 (Part-11)	-do-	
(5)	Loss of mass.	IS 5831 IS 10810 (Part-10)	Loss of mass shall not exceed 2mg/cm2.	
(6)	Hot deformation test.	IS 5831 IS 10810 (Part-15)	Depth of indentation shall not exceed 50%.	
(7)	Heat shock test.	IS 5831 IS 10810 (Part-14)	There shall be no signs of cracks or scales.	
(8)	Shrinkage test.	IS 5831 IS 10810 (Part-12)	Shrinkage of insulation, sheath shall not exceed 4%	
(9)	Cold bend test. (Dia =<12.5) Cold impact test. (Dia > 12.5)	IS 5831 IS 10810 (Part-20,21)	There shall be no signs of cracks or scales.	
(10)	Color fastness to daylight & water.	IS 5831 IS 10810 (Part-18)	------	
(11)	Thermal Stability.	IS 5831	Stable for minimum 100 min at 200°C.	
(12)	Bleeding and blooming test.	IS 5831 IS 10810 (Part-19)	The indicator compound filler paper shall not get stained.	

(13)	Water absorption test.	IS 5831 IS 10810 (Part -33)	Water absorbed after 14 days 85°C shall not exceed 10 mg/cm2.
(14)	High Voltage test.	IS 694 IS 10810 (Part -45)	The cores shall withstand 1.2 KV for 240 hrs. 6KV(rms) min. water immersion. 3 KV (rms) or 7.2 KV for 5 min at room temp.
(15)	Spark Test.	IS 694 IS 10810 (Part 44)	Thickness of insulation. (mm) / Test Voltage. KV (rms) =< 1.0 — 6 > 1.0 to=< 1.5 — 10 > 1.5 to=< 2.0 — 15 > 2.0 to=< 2.5 — 20 > 2.5 — 25
(16)	Flammability Test	IS 694 IS 10810 (Part 53)	Burning shall not exceed 60Sec. after removal of flame and the unaffected portion from the lower edge of the top clamp shall be 50 mm (min.)
(17)	Noise Rejection Ratio(NRR).	---------	Ratio should be more than 76 db.
(18)	Limiting Oxygen Index.	ASTM-D-2863	LOI value should be greater than 29%.
(19)	Fire Resistance.	IEEE-383	Flame should not propagate to the top of the cable.
(20)	Temperature Index.	ASTM-D-2883	Temp. index should not be less than250%.
(21)	Smoke Generation.	ASTM-2643	Smoke density rating should not exceed 60%.
(22)	HCL gas emission.	IEC-754-1	HCL Emitted should not exceed 20% by weight.
(23)	Flame retardancy.	ASS-424-14-75 (F-3)	Unaffected portion of the cable should

not exceed 300 mm.

10.00.00 ROUTINE TESTS

1) Physical Dimensions.

2) Color Code & appearance.

3) Continuity test.

4) Capacitance, Inductance.

5) Conductor resistance -As per IS-8130, ANSI MC 96.1 and IS 10810 (Part 5).

6) Insulation resistance - As per IS-5831 and IS 10810 (Part 43).

7) HV tests:

- 1.5 KV between core to core for 5 min.
- 1 KV between core & armour for 1 min.
- 0.5 KV between shield & armour for 1 min.
- 0.125 KV between two adjacent shields for 1 min.

11.00.00 PERFORMANCE GUARANTEE

The instrument cables shall be guaranteed to meet the performance required by specification. The Manufacturer shall guarantee that each part of cables and any accessories furnished shall be suitable for the service indicated, shall conform to the requirements of all applicable codes and standards and shall meet safely and completely all conditions of performance and design requirement. Rectification if any shall be carried out by the Manufacturer.

12.00.00 IDENTIFICATION

The outer sheath of all the cables specified herein shall have following information embossed at regular intervals.

a. Manufacturer's Name.
b. Customer name .
c. Voltage grade.
d. Code size/Type (eg. 12 P/1.5 sq.mm/SHD/ARM).

13.00.00 PACKAGING

All the cables shall be packed in wooden drums as per the following with +/- 5% tolerance.

Drum size: Min 500 MT, Max 1000 MT.

Each drum shall have following information printed on both sides:

- Cables Specification (Voltage Grade/ Cable size/ Type).
- Consignee Address
- Project Name

14.00.00 SHIPMENT

Manufacture shall be responsible for ensuring that the cables are suitably and carefully packed for shipment, so that they arrive at site in good condition and remain so during storage at site. No shipment shall be made unless clear instructions are received from purchaser, in form of shipping release.

DRAFT

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VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB5

CONTROL VALVES

I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB5:CONTROL VALVES

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I1:C&I TECHNICAL SPECIFICATIONS
SECTION-XIXB5:CONTROL VALVES

1.00.00 GENERAL

1.01.00 Control valves for regulating service shall be pneumatically operated and shall be provided with characterized plugs. In general, equal percentage flow characteristics shall be offered for throttling service and quick-opening characteristics for ON/ OFF service.

1.02.00 The type of Control Valves envisaged for this Specification are as follows :-

i) Straight through Globe Body.

ii) Angle Body.

iii) Three-way diverting body.

1.03.00 All on/off valve shall be provided with limit switches.

2.00.00 VALVE SIZING

2.01.00 For modulating services, sizing shall be based on the specified allowable pressure drop at the maximum flow conditions and the valves should be sized to allow the specified maximum flow at between 70% and 85% opening.

2.02.00 For cavitating and flashing services, the valve size is to be calculated based on 'delta -P (allowable)' and the manufacturer's certified 'Cavitation Index' (Kc) & FL values.

2.03.00 For gas or steam services, where critical flow is likely to occur, the valves shall be sized utilizing equations as per I.S.A. SP 39.1 and 39.3.

2.04.00 When the ratio of pipe size to valve size selected is 2:1 or more, the effect of pipe reduction factor (Fp) is to be considered in calculating the flow co-efficient (Cv).

2.05.00 For applications where noise level is likely to exceed 75 DBA without insulation, sound pressure level calculations are to be furnished along with manufacturer's certificate tables/graphs. In no case should be un lagged noise level be allowed to exceed 75 DBA.

3.00.00 VALVE BODY

3.01.00 Straight through globe type valve body material shall be generally be Cast Carbon Steel as per ASTM A-216 WCB for moderate services. For high liquid velocity, severe cavitating and flashing applications & high temperature services Cast Chrome - Moly Steel as per ASTM A-217

WCB shall be the body material. For corrosive applications Type 316 Stainless Steel as per ASTM A-351 CF8M shall be provided as body material.

3.02.00 The valve body size shall be checked to comply with the manufacturer's recommended maximum velocity limitations. In general, for continuously modulating liquid services the maximum inlet velocity shall be limited to 20 ft/sec. or (6.1 m/sec.) for Carbon Steel valve bodies, and to 32 ft/sec. (10 m/sec.), for Alloy Steel or Stainless Steel bodies up to valve size of 200 mm (8"). Where the inlet velocities exceed these limits, one size larger body shall be used with reduced port trim.

For critical steam services, the valve outlet velocities should be checked and the valve size increased, if necessary, to comply with the minimum outlet valve diameter to avoid sonic velocity.

3.03.00 The valve body end connections shall, in general, be flanged as per ANSI B16.5 - 1975. However, for high pressure and temperature applications such as for feed water and main steam services, welded end connections comparable with the piping specs., shall be provided.

3.04.00 For application up to 450 deg.C in Carbon or Low Alloy Steel bodies, the body to bonnet and packing flange studs & nut material should preferably be :

Studs ASTM A-193 or B7
Nuts ASTM A-194 or 2H

3.05.00 The control valve permissible leakage class shall be as per ANSI B16.104.

4.00.00 VALVE BONNET

4.01.00 The valve bonnet should be of the same material as that of the body. Bonnet packing shall be graphite impregnated braided asbestos. Teflon impregnated asbestos is to be used for temperatures upto 200 deg.C. The plug guide bushing, when employed, shall be made of a hard material such as heat treated AISI type 440-C Stainless Steel or 17-4 pH Stainless Steel. Grafoil lines Stainless Steel guide bushing is also acceptable to reduce guide/stem galling. Cast Extension Bonnets shall be provided for high fluid temperature applications above 232 deg.C (450 deg.F). Finned Bonnet shall be provided for temperatures above 200 deg.C.

5.00.00 PACKING

5.01.00 Standard TFE V-Ring Stem packing shall be supplied for moderate service applications up to 232 deg.C. TFE Impregnated Asbestos packing shall be preferred for more severe applications viz. Cavitation/flashing and for temperatures above 200 deg.C. Graphited Asbestos packing shall be provided for steam service applications.

For TFE-Impregnated Asbestos and Graphited Asbestos Packings a Lubricator assembly shall be supplied as a standard feature.

6.00.00 VALVE TRIM

6.01.00 Material for 'TRIM' shall be minimum 316 Stainless Steel with guide bushings of hardened Stainless Steel such as 17-4 PH, 440-C or 316 SS Stellite faced. The valve stem shall preferably be of chrome plated 316 SS, Condition B.

6.02.00 For cavitation and/or flashing application, the seating surfaces of the plug and seat ring shall be hard-faced with "Stellite No. 6". Also hardened plug & seat ring of 440-C Stainless Steel shall be acceptable.

6.03.00 In general, for all steam services and for high pressure drop, high velocity and high noise applications, cage guided valve trim shall be supplied. For cage guided valves, the trim supplied shall be of hardened 410/420 Stainless Steel (Hardened to 38 Rockwell C (min.)) with the cage material as 17-4 PH Stainless Steel (hardened to 40 Rockwell C (min.). For corrosive applications 316 SS Trim is to be provided with either chrome plated plug or Nickel coated cage.

6.04.00 For services with high inlet pressure and/or high pressure drops, balanced cage type construction shall be used to reduce actuator size. Multistage pressure drop trim shall be preferred for such applications.

6.05.00 For severe cavitating services special anti- cavitation trim with linear characteristics, shall be preferred.

6.06.00 For applications, where the noise level is likely to exceed 75 DBA at the valve outlet, special Lo-dB style trim to attenuate noise level to 75 DBA by source treatment, shall preferred.

6.07.00 Wherever Lo-dB Trim have been specified, linear flow characteristics shall be acceptable in lieu of equal percentage characteristics.

6.08.00 For ON/OFF applications, valve plug with quick opening flow characteristics shall be provided.

7.00.00 VALVE ACTUATOR

7.01.00 Direct or Reverse acting spring-opposed pneumatically operated diaphragm actuator shall be provided with all Globe Body Control valves for throttling applications. Nylon reinforced moulded nitrile shall be provided as diaphragm material. Actuators shall be designed for operation on a maximum supply air pressure of 4.5 kg/sq.cm. High temper zinc plated highly passivated alloy steel shall be provided as spring material. The casing shall be of rugged walled construction to provide stability, corrosion protection and protection from deformation or over- pressure.

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7.02.00 For all ON/OFF applications, pneumatically operated double-acting piston-cylinder actuator shall be preferred. The actuator shall preferably be of weather-proof construction in cast aluminium cover with piston rod and extension of chrome plated stainless steel and seal ring of nitrile.

8.00.00 VALVE POSITIONER

Control valves for modulating service shall be supplied with force balance type, high capacity and high gain pneumatic valve positioner with integral input, output and supply gauges. The valve positioner shall be rugged and SS tubes shall be used for connection.

9.00.00 VALVE POSITION TRANSMITTER

9.01.00 2-wire 4-20 MA DC output position transmitter shall be provided wherever indicated in the specification.

10.00.00 HAND-WHEEL

10.01.00 Side-mounted hand-wheel furnished with a spring- loaded ball detent to prevent vibration from changing the setting, shall be provided as per application requirements.

11.00.00 ACCESSORIES

11.01.00 All control valves shall be supplied with air supply filter regulators and gauges and air lock relays to keep the valve in the safe position during air supply failure.

The specification of control valve shall be as follows:

01.	Type	:	i) Globe Cage guided balanced construction wherever applicable. ii) Vee-ball for slurry/solid bearing fluid service.
02.	Opening at maximum flow	:	80% approx.
03.	Opening at minimum flow	:	10% approx.

04.	Body Rating & Material	:	To be designed with at least 10% margin on design pressure & temperature of the pipe. Material must be sufficiently corrosion resistant and conform to the requirements of ANSI for dimensions, material thickness and material specification for their respective pressure classes.
05.	Trim Material	:	i) SS 316 with stellite facing or nitride or equivalent corrosion & erosion resistant material. ii) For flashing service 17-4PH or equivalent shall be used.
06.	Overall Noise	:	85 (dbA) maximum at 1 meter from surface. Noise reduction shall be achieved by proper body and trim design.
07.	Fluid outlet Velocity	:	6 meters/sec. (maximum) for liquid service 150m/sec for steam service 50% of sonic velocity for flashing service.
08.	Testing	:	Following test certificates should be produced before installation - i) 100% radiographic test. ii) Magnetic particle inspection. iii) Hydrostatic test. iv) CV test (type test). v) Seat leakage test vi) Functional test vii) IBR certificate wherever applicable.
09.	Codes & Standards	:	Control Valve Sizing : i) Incompressible Fluids - ISA S39.2 - 1972 ii) Compressible Fluids - ISA S39.4 - 1974
10.	Actuator	:	i) Pneumatic Spring Diaphragm / Piston type ii) Stem/Piston Rod - AISI 304 iii) Diaphragm Material - Neoprene
11.	Positioner	:	i) Stroke Adjustment - Shall be possible. ii) Gauges - Supply, signal, output

iii) Travel time of valve-< 10 seconds

iv) Hysteresis - ±0.5% of F.S.

v) Linearity - ±1.0% of F.S.

vi) Dead Band -± 0.5% of F.S.

12. Accessories : Integral tubing, Positioner, Position Transmitter (4-20 mA output), Limit Switches (as applicable), Volume booster air lock relay (as applicable), AFR with Gauge, Solenoid valve (as applicable) Junction boxes, Hand wheel, any other devices as required. All accessories shall be duly mounted, tubed and wired.

13. Special Application : For critical application like PRDS, Feed Control, Attemperator Spray Control, minimum flow etc. Multiport, multistage anti-cavitation trim shall be provided.

14. **Notes :**

a) Control valve sizing shall be based on the specified allowable pressure drop at the maximum flow conditions and the valves should be sized to allow the specified maximum flow at between 75% to 85% opening.

b) Direct or reverse acting spring opposed pneumatically operated actuator shall be provided for control valves having throttling applications and for all on/off applications pneumatically operated, double acting piston-cylinder actuator shall be preferred.

c) Control valves for steam and water applications shall be designed to prevent flashing, cavitations and wire drawing on down stream of valve and piping. Anti cavitation trim shall be considered for these cases. CONTRACTOR shall submit calculation whether cavitation will occur or not.

d) Control valves for application such as HP & LP Bypass control, SH & RH spray control, PRDS (Pressure reducing and de-sperheating) control for boiler and turbine auxiliary steam, BFP minimum recirculation, CEP minimum recirculation, Emergency DM water makeup to condenser, GSC minimum flow, Deaerator drain to condenser hotwell, Condenser hotwell normal makeup control, Gland seal steam pressure control, Condensate dump to storage tank, HP & LP heater emergency level control shall have Leakage class-V. All other control valves like normal HP/LP heater level control etc shall be of Leakage class-IV.

e) For temperature above 280 Deg.C extended bonnet shall be provided.

f) Valves downstream connected to vacuum service shall be provided with suitable gland packing like double vee type chevron packing.

g) End preparation for weld ends valves:

i) Butt welded type as per ANSI B 16.25 for valve sizes 65 mm and above.

ii) Socket weld type as per ANSI B 16.11 for valve sizes 50mm and below.

h) Quick replacement type trim shall be provided. It shall be possible to remove and replace the trim while the valve body is installed in the pipe line.

i) In general control valves shall be provided with Hand wheel.

j) Steam Turbine Vacuum Breaker: DC solenoid operated pneumatic vacuum breaker valve along with local air receiver & one NRV in the air filling line to receiver shall be provided.

Incase of any deviation about the material of control valve for a particular application based on recommendation of manufacturer, the same shall be brought to the notice of OWNER for approval with proper explanation. OWNER may accept the same based on material superiority .

12.00.00 SOLENOID VALVE

Solenoid valves and limit switches for open and closed position of the valve shall be supplied as per interlock requirements. The limit switches shall be SPDT-type micro-switches rates for 5 Amps at 240 V AC. The casing shall be water and dust tight conforming to IP-65 in general and explosion proof type for hazardous area applications. Solenoid valves shall be separately mounted.

12.01.00 The solenoid valve coil shall be rated for continuous operation. The enclosure shall also meet the requirements of IP-65.

The specification for solenoid valve as follows:

	Operating Principle	:	Electromagnetic (Noiseless)
01.			
02.	Coil Voltage	:	220 V ±10% DC / 240 V ±10% AC
	Supply		24 V ±10% DC / 48 V ±10% DC
03.	Material	:	Body - SS Bar Stock, Trim - SS 316

			Spring - SS 316, Coil Enclosure - SS Coil Enclosure - IP-65 /Explosion-proof in hazardous area
04.	Insulation	:	Class - H
05.	Mounting	:	On pipe or on panel
06.	Working Fluid Pressure	:	10 - 15 Kg/cm^2
07.	Manual Operator	:	In-Built
08.	Others	:	3-ways universal type / as applicable
09.	Seating	:	Air tight and heat-proof

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ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB6

STEAM AND WATER ANALYSIS SYSTEM (SWAS)

I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB6:STEAM AND WATER ANALYSIS SYSTEM (SWAS)

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I1: C&I TECHNICAL SPECIFICATION

SECTION-XIXB6:STEAM AND WATER ANALYSIS SYSTEM (SWAS)

1.00.00 STEAM & WATER ANALYSERS (SWAS)

The basic purpose of this system shall be the continuous monitoring of water and steam purity in the plant cycle.

2.00.00 GENERAL REQUIREMENT

a) The sampling system shall obtain samples from steam and water system, which shall be adequately conditioned (pressure and temperature conditioning) and shall be fed to the analysers for continuous monitoring. At the same time, facility shall be provided by the Contractor, so that parallely grab samples shall also be taken from sampling panel.

b) All the analysis transmitters shall have output indication.

c) Output from the transmitters shall be (4-20) mA D.C.

d) Alarm for significant parameter measurement having group repeat facility in the control room.

e) System shall be furnished complete with sample conditioning panel, analyzer panel housing monitoring instruments (for pressure, temp. & flow), computing devices, transmitters, recorders, annunciators, etc.

f) The system shall be designed in accordance with the recommendation in ASME PTC 19.11, Part-II, Water and Steam in power cycle ASTM Standards-31 water and ASTMD 1066-69 Standard method of sampling system.

g) All piping, tubing fittings and other wetted parts in the sampling and analysing system shall be of type 316 stainless steel.

3.00.00 SAMPLE CONDITIONING SYSTEM

a) This shall include at least the following :

i. Sample filtering.

ii. Primary and Secondary sample cooling and temperature control.

iii. Pressure reduction and control as required.

iv. Flow rate control.

v. Any other treatment as required by individual analysers.

b) The sample conditioning system shall provide sample at 25 deg.C or at any other process temperature within tolerance of 1 deg.C and at a pressure of about 2 Kg/sq.cm and at flow rates as required by individual analysers/stream.

c) Suitable arrangement shall be made to condition the sample by way of providing chiller and isothermal bath.

4.00.00 TECHNICAL SPECIFICATIONS OF CONDUCTIVITY ANALYSER

a)	Applicable standard	: ASME PTC 19-11-1970 except as modified in this specification
b)	Type :	
	i) Cell	: Flow through type/removable type (withdrawable with sealing valve)
	ii) Monitors	: Electronic (Microprocessor based) indicating type with multi range facility
c)	Material :	
	i) Cell	: Epoxy resin
	ii) Electrode	: Platinised
	iii) Monitors body	: Carbon steel
d)	Monitor output	: 4 to 20m Amp. DC isolated output for DCS
e)	Power supply	: 240V, AC, 50Hz
f)	Accuracy	: ±1% of full scale span
g)	Stability	: ±1% of full scale per month non-cumulative
h)	Repeatability	: ±0.3% of span
i)	Annunciation contacts for monitors :	
	i) Number	: 2SPDT
	ii) Type	: Snap action microswitch

iii) Rating		: 5 amp, 240V, 0.2 Amp, 220V DC
iv) Cell		: On line/pipe mounted (ON LINE in sample table)
j)	Accessories	: i) Automatictemperature compensation in the range 0-100°C ii) Ammonia(NH3)removal equipment. iii) Sample coolers iv) Flow and pressure regulators v) SS impulse tubing and fittings vi) Isolation & drain valves as required vii) Other accessories as required viii)Adequate length of cables for connecting coils to monitors ix) Sample rate set valves x) Alarm settings and Alarm indications on monitor.
k)	Range	: As per sample stream
l)	Other particulars	: Cell shall be suitable for maximum pressure of 7 kg/cm^2 kg/cm^2 and maximum temp. of 100°C

5.00.00 TECHNICAL SPECIFICATIONS OF pH ANALYSER

a)	Applicable Standard	: pH electrodes shall conform to IS-6804-1972 except as Modified in this specification.
b)	Type :	
	i) Cell	: Measuring and Reference Electrode Combination with Flow through type (Polypropylene flow chambers)
	ii) Monitors	: Electronic(microprocessor based) indicating type with adjustable range facility.
c)	Material :	

	i) Measuring & reference	: Toughened sensitive
	ii) Electrode	: pH glass
	iii) Monitor body	: Die-cast alauminium
d)	Monitor output	: 4-20m Amp DC isolated output for dCS
e)	Power supply	: 240V AC, 50Hz
f)	Accuracy/Repeatability	: ±0.03 pH/±0.02PH
g)	Resolution	: ±0.01pH or 1mV.1C
h)	Stability	: 0.02 pH per week
i)	Annunciation contacts for monitors :	
	i) Number	: 2 SPDT 'Hi' and 'Lo'
	ii) Type	: Snap action microswitch
	iii) Rating	: 5 amp., 240V AC, 0.2 Amp. 220V DC
j)	Mounting :	
	i) Cell	: Pipe Mounted
	ii) Monitors	: Flush panel mounting
k)	Accessories	: i) Automatic temperature compensation with fast response integral temperatue sensors in the range 0-100°C
		ii) Co-axial cables as required
		iii) Sample coolers
		iv) Flow and pressure regulators
		v) Standard pH solutions
		vi) SS impulse tubing and fittings
		vii) Isolation & drain valves as required
		viii) Electrode holders
		ix) Other accessories as required
		x) Sample rate set valves

xi) Alarm settings and indications on monitor

xii) RFI/EMIshielded,weather and corrosion proof casing

l) Ranges : As per sample stream.

6.00.00 TECHNICAL SPECIFICATION OF DISSOLVED OXYGEN ANALYSER

a) Applicable Standards : ASTM PTC 19-11-1970 except as modified in this specification

b) Type : Electro-chemical

c) Material : Die Cast aluminium ,

d) Output : 4-20m Amp., DC isolated output for DCS.

e) Supply : 240V AC, 50Hz

f) Accuracy : ±2% of full scale value

g) Response :

i) Sensitivity : ± two(2) per cent overall

ii) Time (sensor) change : Less than 30 sec. for 90% step

h) Accessories : i) Sample cooler assembly with shut off valve at cooling water inlet, with thermometer and reducing valve at sample outlet.

ii) Flow stabilizer

iii)Automatic temp. compensation

iv) Other accessories as required including chillier.

v) Calibration device

i) Ranges : As per sample stream

j) Mounting : Flush

k) Annunciation contacts :

i) Number	: 2 SPDT
ii) Type	: Snap action micro switch
iii) Rating	: 5 Amp. 240V AC, 0.2 Amp. 220V DC

7.00.00 TECHNICAL SPECIFICATION OF SILICA ANALYSER

a)	Applicable standard	: ASTM PTC 19-11-1970 except as modified in this specification
b)	Type	: Multi Channel(six channel) Calorimetric Analyser(with auto Reagent shut off feature in case Of sample loss or power loss) built in phosphate inhibition feature. Microprocessor based.
c)	Material :	
i)	Case	: Die cast aluminium
d)	Cycle Time	: Twelve(12) minutes Maximum
e)	Analyzer output	: 4 to 20m Amp. DC isolated output for DCS
f)	Power Supply	: 240V AC, 50 HZ
g)	Accuracy	: ±1% of span
h)	Repeatability	: ±2% of full scale
i)	Sensitivity	: 0.2 micrograms/litre
j)	Ranges	: As per sample stream
k)	Mounting	: Flush
l)	Annunciation contacts :	
i)	Number	: 2 SPDT
ii)	Type	: Snap action micro switch
iii)	Rating	: 5 Amp. 240V AC 0.2 Amp. 220V DC
m)	Accessories	: i) Chilling plant
		ii) Automatic temperature compensation between 5 to 50°C

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iii) Automatic zeroing provision

iv) SS tubing & vessels

v) All chemical regents for 12 months operation of the analyzer

vi) Sample rate set valves

vii) Comprehensive diagnostic and alarm features.

8.00.00 TECHNICAL SPECIFICATION OF HYDRAZINE ANALYSER

i) Type Electrochemical

ii) Case material : Die-cast aluminium

iii) Analyser output : 4-20 m DC isolated output for DDCMIS

iv) Power supply : 240V AC, 50HZ

v) Accuracy : ±2% of full scale

vi) Sensivity : 1.0 microgram/litre

vii) Annunciation contacts :-

Number	: 2 SPDT
Type	: Snap action micro switch
Rating	: 5A 240V AC, 0.2A, 220V DC
Mounting	: Flush mounting

viii) Accessories : i) Flow regulator
ii) Flow gauges
iii) Other accessories as required
iv) Sample rate set valves
v) Chemicalreagents as applicable for 12 months consumption

9.00.00 TECHNICAL SPECIFICATION OF SODIUM ION ANALYSER

i) Type : Continuous flow through sample type with sodium responsive electrode and reference electrode having pH adjustment facility

ii) Case material	: Die-cast aluminium
iii) Analyzer power supply	: 240V AC, 50 Hz
iv) Analyser output	: 4-20 mA DC isolated output for DDCMIS
v) Accuracy	: Better than ±2% of full scale
vi) Sensivity	: 0.1 ppb
vii) Annunciation contacts :-	
Number	: 2 SPDT
Type	: Snap action micro swich
Rating	: 5A 240V AC, 0.2A, 220V DC
Mounting	: Flush
viii) Accessories	: i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as require to make the system complete

10.00.00 TECHNICAL SPECIFICATION OF PHOSPHATE ANALYSER

i) Type	: Continuous flow through sample type with calorimetric detection system
ii) Case material	: Die-cast aluminium
iii) Analyzer power supply	: 240V AC, 50 HZ
iv) Analyzer output	: 4-20 mA DC isolated out put for DDCMIS
v) Accuracy	: Better than ±2% of full scale
vi) Sensivity	: Better than 1 ppm
vii) Annunciation contacts :	
Number	: 2 SPDT
Type	: Snap action micro switch
Rating	: 5A 240V AC, 0.2A, 220V DC
Mounting	: Flush

viii)Accessories	: i)	Flow regulator
	ii)	Flow guages
	iii)	Sample rate set valves
	iv)	Other accessories as required to make the system complete

Any other type of analyzer is required for a particular application the same shall be with the approval of the OWNER.

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VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB7

CONTINUOUS EMISSION MONITORING (CEM) SYSTEM

I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB7: CONTINUOUS EMISSION MONITORING (CEM) SYSTEM

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I1:C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB7: CONTINUOUS EMISSION MONITORING (CEM) SYSTEM

1.00.00 GENERAL

The online Continuous Emission Monitoring (CEM) System shall be designed to provide accurate precise data, which is representative of actual stack emissions of NO_x, SO_2, CO and particulate matter. In addition to these analyzers, oxygen in flue gas probe shall be provided for oxygen trimming for control purposes.

2.00.00 MAJOR COMPONENTS

The continuous emission monitoring system for each flue of each unit shall include the following major components:-

-	NO_x Analyzer	)
		) Combined analyzer -
-	SO_2 Analyzer	)
-	CO Analyzer	- across duct
-	Opacity Monitor	
-	O_2 in flue gas	Zirconia probe

3.00.00 DESCRIPTION

To demonstrate compliance with emission limits, and as required by the Central/state Pollution Control Board, the plant shall have an online Continuous Emission Monitoring (CEM) System installed in each flue of the stack for each unit. Particulates and sulfur dioxide shall be sampled. Opacity monitor shall be used to measure particulate emissions. Gas analysis shall be used to measure nitrogen oxides and sulfur dioxide emissions. The CEM shall sample and measure stack emissions, store emissions data, and develop emission reports. The system shall comprise of isokinetic sampler/s to draw representative samples, coarse and fine filter, line heater, manifolds etc for drawing the sample from specified elevation recommended by EPA. An analyzer shelter, located near chimney, shall house the SOx, NOx, CO_2 and Oxygen analyzers, span and reference gas bottles, sample processing system, calibration manifold and an operator's console for display and report generation. The 4 to 20 mA signals shall be transmitted to the DCS where it shall be converted into representative stack emissions data. It is the intent of this document that the

contractor should propose his standard CEM system to the extent practicable.

The CEM system shall be tested to demonstrate that the system and each component within the system meets all design and performance parameters designated by the Performance Specifications. The CEM system performance shall be guaranteed.

The CEM system shall guarantee that at no time during the first year of operation after performance certification, shall the monitor availability be less than the minimum of 95 percent.

Equipment shall include all enclosures, mounting and alignment hardware, sample line tubing, tubing heaters and heater controllers, heat tracing, piping, supports, valves, fittings, pressure regulating valves, relief valves, solenoids, blowers, gas dryers, sample pumps, filters, coolers, analyzers, signal conversion equipment, data acquisition system, and other equipment that may be necessary to make a complete system.

A complete system for control of sample collection, purging, and equipment calibration shall be furnished. Controls shall also include component failure alarms to troubleshoot supervisory control problems. Software and logic documentation shall be included. The CEM controller shall be field programmable.

4.00.00 AMBIENT AIR QUALITY MONITORING

(a) To demonstrate compliance with ambient air quality standards, and as required by the State Pollution Control Board, four (4) ambient air quality monitoring stations shall be installed in and around the project area at approved locations. Monitoring station locations shall be determined by air quality impact modelling results and in consultation with the State Pollution Control Board.

b) The monitoring stations shall include SPM, RPM, SO2, NO2 and CO for sampling.

c) For monitoring of ambient air quality, high volume sampler with attachment for gaseous sampling and particulate matter sampler shall be provided.

d) One completely automatic weather station for metrological data collection and recording shall be supplied. The station shall comprise wind-vane, anemometer, thermometer, hygrometer, rain fall recorder, sunshine recorder, evaporimeter etc.

e) The entire station shall be PC based automatic recording type with provision for instantaneous display of different parameters and the same shall be EPA approved.

f) A Mobile ambient air monitoring van equipped with sampling and measuring instruments shall also be provided.

5.00.00 FLUE GAS ANALYSER PROBE DESIGN CRITERIA

All probes and materials exposed to the flue gas stream shall be Hastalloy C-276 or Inconel 625, as a minimum. Enclosures for stack-mounted equipment shall be NEMA 4X.

All equipment necessary to draw, filter, dilute, condition, or transport samples, or to periodically purge sample lines and probes shall be furnished. Sample filters shall remove 99.99 percent of fine particulate matter to 1.0 micron and larger from the sample. Sample collection equipment and analyzers shall be located in racks.

The CEM system shall include timed automatic and local, manual back purge of the probe tip filters.

6.00.00 SO_2, NO_X, CO, OPACITY MONITOR DESIGN CRITERIA

The monitors shall be across the stack double pass transmissometer. The monitors shall have a single lamp for measurements and calibrations. Automatic self-calibration consisting of zero and high-level span checks shall be provided on the instruments with a frequency of at least daily unless the equipment requires more frequent calibration for accuracy. Manual calibration initiation shall be possible from the CEM system controller.

The opacity monitor shall display a digital readout in percent opacity and transmittance, perform zero and span adjustments, and perform manual and automatic daily calibration. The opacity monitor data shall be capable of being utilized to develop an opacity percentage versus particulate matter concentration chart to determine particulate loading in mg/Nm^3.

The flue gas analyzers and monitors shall be sensitive to changes of less than 1.0 percent of full scale. Concentration measurements shall be automatically corrected for flue gas pressure, flue gas temperature, and barometric pressure variations (if required). A barometric pressure transmitted sensing pressure outside the CEM enclosure shall be mounted inside the CEM enclosure. Any indicator necessary for this function shall be provided and incorporated into system design.

For each of the parameters monitored, the CEM system shall provide outputs from the analyzers to the CEM system controller. All necessary modems, interfaces, and software necessary to accomplish this data transmission shall be provided.

8.00.00 SPECIFICATION FOR ANALYSERS

8.00.01 <u>SOx/NOx/ CO /O2 ANALYZER</u>

01.	Gases to be measured	:	SOx/ NOx/ CO /O2
02.	Principle of measurement	:	Infrared absorption
03.	Flue gas Temperature	:	350 ^{O} C
04.	Ambient temperature	:	0 - 60 ^{O} C
05.	Mounting	:	On duct
06.	Measurement range	:	0-3000 ppm fully selectable
07.	Units of measurement	:	PPM, mg / m^3 and mg / Nm^3
08.	Power Supply	:	240V, 50 Hz, 1 Phase
09.	Display	:	Back lit LCD
10.	Measurement of averaging	:	10 sec to 60minutes
11.	Accuracy	:	± 2% of full scale
12.	Repeatability	:	1% of full scale
13.	Response time	:	30 seconds or better for 90% of full scale
14.	zero & Span drift	:	Less than 2 ppm in 24 hours
15.	Calibration	:	Zero and Span calibration in manual and automatic mode. Automatic calibration interval shall be fully selectable.
16.	Analog output	:	4-20 mA DC (in 500 ohm resistor) to DCS for each channel
17.	Alarm output	:	1NO + 1NC rated at 230V AC, 5A
18.	Input normalisation	:	Required–online [With pressure and temperature sensor] and also provision for key pad entry of inputs
19.	Probe material	:	Stainless Steel 316L
20.	Enclosure	:	Corrosion resistant epoxy coated aluminium housing rated to IP-65 for Transceiver and control unit.
21.	Accessories	:	i) Blower unit with all tubing & fittings for calibration and purging

ii) Calibration gas cylinders for SO_2, NOx CO_2 and CO filled in 10 Ltrs. of WC carbon cylinder with necessary SS regulator, SS gauges, SS tubings and SS fittings etc. as required.

iii) Special cables for inter connection

22. Location

The controllers/analyzer system electronics shall be accommodated in the field analyzer house.

8.00.03 SMOKE DENSITY ANALYZER

01.	Type	:	Dry visible light (through LED)
02.	Principle of measurement	:	Transmission & absorption (Dual beam type)
03.	Light source	:	Modulated high intensity LED
04.	Display	:	Back Lit LCD
05.	Measurement range	:	0-999 mg/m^3, 0-999 mg/Nm^3, 0-100% opacity
06.	Measurement averaging	:	Selectable 10sec to 60 minutes
07.	Accuracy	:	0.1% opacity
08.	Resolution	:	0.1% opacity
09.	Linearity	:	0.1% opacity
10.	Repeatability	:	0.1% opacity
11.	Flue gas temperature	:	350 OC (max 600 OC)
12.	Ambient temperature	:	0 - 60 OC
13.	Operating temperature	:	Transmitter & receiver- 0-90OC, Electronic unit - 70 OC
14.	Mounting	:	Transceiver on opposite side of the duct/chimney (as per pollution control norms)
15.	Analog output	:	4-20mA DC (in 500 ohm resistance) to DCS
16.	Alarm output	:	2 SPCO potential free rated at 230 VAC, 5A
17.	Power Supply	:	240V, 50 Hz, 1 Phase

18.	Automatic misalignment detection	:	Required
19.	Automatic compensation of lens contamination	:	Required
20	Purge air Failure	:	Purge air to be provided from Blower unit and to be monitored for failure.
21	Span and Zero Check	:	Automatic periodic with manual override
22	Housing	:	Corrosion resistant epoxy painted aluminium rated at IP-65
23.	Fail safe shutter	:	Automatic fail safe shutter against power and air failure
24.	Input normalization	:	Correction for Temperature, pressure, oxygen and water vapour to be provided
25.	Calibration	:	Auto calibration facility.
26.	Accessories	:	i) Mounting pads suitable for mounting projector and receiver units on duct, flanges, etc. ii) Blower unit (Purging System) iii) Special cables for inter connection

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ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB8

MACHINERY MONITORING SYSTEM

I1: C&I TECHNICAL SPECIFICATION

SECTION-XIXB8: MACHINERY MONITORING SYSTEM

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I1: C&I TECHNICAL SPECIFICATION
SECTION-XIXB8: MACHINERY MONITORING SYSTEM

1.00.00 INTRODUCTION

Microprocessor based standalone online vibration/machinery monitoring system shall be used for condition monitoring of TG and BFP Turbine. It shall identify incipient problems to take care of predictive maintenance of machine/equipment. HT drives/motors online vibration shall be measured and monitored in DCS.

2.00.00 GENERAL DESCRIPTION

The Machinery Monitoring System shall automatically acquire and display vibration and process data for TG and BFP Turbine and carryout machine vibration analysis and diagnostics. The monitoring system shall interface via redundant Modbus (Ethernet / RS 485) links to DEH/DCS for online monitoring. .

TDM system must be able to accept all the vibration/process data from the TSI to fully monitor and analysis of TG and BFP Turbine vibration. DCS shall be able to accept the vibration/process data via vibration monitors of other field critical machinery in the plant _Using machinery condition and process data, TDM/DCS system should be able to provide data in formats fully suitable for analysis of machine problems related to the machinery defects as well as process upsets.

All the process parameters requisite for effective and complete machinery behavior understanding will be imported either digitally from TSI (preferably) or through proportional value/recorder outputs from field devices through a suitable hardware for acquisition of such field based inputs. The DCS in the plant shall have capability/provision to provide required process data through Modbus /OPC. The interfacing to DEH/DCS will be designed and executed by the specialist Machinery Monitoring System vendor.

Machine monitoring system for Main Turbine and BFP turbine/Motorized BFP monitoring shall be Bently Nevada BNC 3500.

3.00.00 CONDITION MONITORING/ MACHINERY MANAGEMENT SOFTWARE:

Vibration analysis system shall be System 1 by Bently Nevada which will be integrated with BNC 3500 for turbine, BFP turbine. All vibrations of HT motors such as motorized BFP CEP, ID/FD/PA, CWP, Mills etc.shall be monitored in DCS.

The TDM software shall have the capability to take process data if required directly from DCS and correlate this data with vibration data.

The System shall utilize both vibration and process information to provide clear analysis and recommendations for effective machinery management. It shall be an extensive and accurate knowledge base to enable quick determination of the condition of a machine by providing alarm of the machinery malfunction.

The TDM System shall be able to specifically evaluate the available data while checking for the presence of the most frequently occurring machine malfunctions.

The TDM system must be equipped with a Desktop based system that can be used to create rules related to acceptable (or non-acceptable) machinery behaviour. Creation of such rules should have possibility to involving any of the parameters (process related or condition related) that have been mapped/measured into the Online data manager system. Moreover, the system must also allow changes being made to the definition of Machine Defect Severity as and when such changes are required to be made by the customer's machinery experts.

4.00.00 SPECIFICATION OF MACHINERY MONITORING SYSTEM

A. PROBE & TRANSDUCERS

NON-CONTACT/PROXIMITY PROBE

01.	Type	:	Eddy Current
02.	Power	:	24 V DC
03.	Linearity	:	0.8 mil.
04.	Environment	:	i) Design temperature = 50 Deg.C ii) Design relative humidity = 100 %
05.	Application	:	Radial vibration, vertical / horizontal bearing.

PROXIMETER/NON-CONTACT TRANSDUCER

01.	Protection Class	:	IP 66 , weatherproof
02.	Cable	:	All special cable with connector etc. to be included to make the system complete.
03.	Output	:	4-20 mA DC

VELOCITY TYPE PROBE

01.	Type	:	Magnetic
02.	Application	:	Machine Case/Structural Vibration, absolute shaft vibration.
03.	Sensitivity	:	25 mV/mm/sec.
04.	Accessories	:	Displacement converter or dual probe, if used for absolute shaft vibration measurement.

VELOCITY TRANSDUCER

01.	Protection Class	:	IP 66, weatherproof
02.	Cable	:	All special cable with connector etc. to be included to make the system complete.
03.	Output	:	4-20 mA DC

B. MACHINE CONDITION MONITOR

01.	Type	:	Channel wise analog indicator / 7 segment LED 8 mm height and HI/HI-HI alarm on front with output contact for both the above cases.
02.	Output	:	4-20 mA DC
03.	Software Port	:	To corresponding analyzer / computer RS 232, but analyzer connection by hardware.
04.	Accuracy	:	± 0.5% FS or better.
05.	Alarm Set point	:	Adjustable preferably from behind.
06.	Relay Output	:	SPDT 1 No. each for each set point. Total 2 Nos. set points per channel.

C. VIBRATION ANALYSIS SYSTEM

01.	Type	:	PC based system. Industrial Grade with suitable IP Enclosure.
02.	Alarm	:	All points HI/HI-HI
03.	Displays	:	i) All reports. ii) Identification of discrete frequencies / amplitude. iii) Frequency Zooming. iv) Tabular.

v) Graphical.

vi) X-Y Pattern.

vii) Historical Storage in Tabular Graphical.

viii) New Kind Display Generation.

ix) Display of Trend, Time and Frequency Spectrum, Alarm Manual Input, FFT etc.

x) Water Fall Plot.

04. Hook-up : i) Connectivity with DEH network.

ii) Portable Data Collector and Analyzer shall be of same family for direct hook-up and downloading.

05. Monitor : 21" colour flat screen.

06. Accessories : All hardware/software/peripherals to make the system complete.

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VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB9

FIRE ALARM SYSTEM

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB9:FIRE ALARM SYSTEM

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I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB9:FIRE ALARM SYSTEM

1.00.00 INTENT OF SPECIFICATION

This specification is intended to cover manufacture, assembly, testing at manufacturer's works, packing and supply of fire detection system complete with accessories for efficient and trouble free operation.

2.00.00 SCOPE OF SUPPLY

Design, manufacture, assembly, testing at manufacturer's works, packing and supply of following items.

a. Ionisation type smoke detector

b. Photoelectric smoke detector

c. Linear Heat Sensing Cable

d. Heat Detector

e. Manual call point

f. Fire detection system panel with remote annunciator.

g. FRLS cable for connecting the detector and call point to the fire detection system panel and annunciator system.

3.00.00 TECHNICAL REQUIREMENTS

3.01.00 CONTRACTOR shall decide the number of detectors, type of detectors required and their location based on the stipulations of IS-2189.

3.02.00 While designing the system, the CONTRACTOR must necessarily use a combination of photoelectric type & Ionisation type detector as recommended in IS-2189.

3.03.00 Detectors shall be housed or mounted in suitable enclosures in such a way that their performance is no way affected by the type of enclosure. Special maintenance procedures, if any, required for the satisfactory operation of the detectors shall be clearly informed to the Owner.

3.04.00 Areas for fire alarm detection shall include Main Control room, Local control rooms, control equipment room, electrical equipment rooms, cable cellar room, oil system areas, cool conveyors, coal stockpiles and administrative building.

3.05.00 No detector shall contain moving parts subject to wear and tear. It should get reset automatically i.e., it must be able to operate afresh after each alarm release, without any replacement or adjustment.

3.06.00 The various fire detectors serving a particular area/zone of plant may be wired-up in group and one common signal for each area or zone is transmitted to the zone indicating panel. The number of detectors to be installed are governed by total area to be protected, type of building construction, air movement, ceiling construction and sensitivity required.

3.07.00 Adequate compensation and considerations shall be made for effects of air velocities such as air conditioning system and exhaust fans where dilution of particles of combustion is greater.

3.08.00 All detectors shall be provided with built-in response indicating LED which shall give local visual indication, on dense smoke condition when it will operate. The failure of indicator shall not impair the function of detector. For detectors normally hidden – like those below false floor and above false ceiling shall have separate response indicator.

3.09.00 The exact location of detectors shall be co-ordinated with other services like air-conditioning grills, light fittings, cable trays etc. to provide aesthetically pleasing appearance. The return air paths of air conditioning shall strictly be avoided for detector location.

3.10.00 Detectors shall have approval of NFPA/FM/UL/TAC or any other reputed international authority.

3.11.00 The detector, which have employed a radio active material, the strength of the same shall not exceed 1 micro curie.

4.00.00 IONISATION SMOKE DETECTORS (ADDRESSABLE)

4.01.00 The Ionisation smoke detectors shall be suitable for detecting invisible products of combustion as well as visible smoke and be of the Dual Chamber Source type to provide good stability in changing environmental conditions.

4.02.00 The radioactive source shall be American 241 mounted in such a way that is mechanically secure.

4.03.00 An indicator LED shall be provided on the detectors which should illuminate when the level has reached a preset value, and should operate independently of the central control panel.

5.00.00 PHOTOELECTRIC (OPTICAL) SMOKE DETECTORS ADDRESSABLE

5.01.00 The Photoelectric (optical) smoke detectors shall be suitable for detecting visible smoke such as produced by slow smoldering fires including burning PVC.

5.02.00 They shall be of the light scattering type using a pulsed internal LED light source and a photocell sensor.

5.03.00 An indicator LED shall be provided on the detectors which should illuminate when the level has reached a preset value, and should operate independently of the central control panel.

6.00.00 MANUAL CALL POINT (ADDRESSABLE)

6.01.00 The call point shall be based on a standard product manufactured by a reputable call point manufacturer. The manual call point shall then be modified to incorporate a communications module within the call point.

6.02.00 It shall be of the `break glass' type and shall be housed in a sealed metallic/high impact plastic enclosure and shall be suitable for both indoor and outdoor use.

6.03.00 The manual call point shall have a red LED which should illuminate when the call point is activated.

7.00.00 MICROPROCESSOR BASED FIRE DETECTION SYSTEM PANEL

7.01.00 Fire alarm control panel shall function both as an independent stand alone system. The fire Alarm panel shall be wall mounted. The Fire Alarm panel shall be packed up by maintenance free battery for at least 12 hours.

7.02.00 Control panel shall be microprocessor based and shall have necessary detector interface, alarm output modules for both hooter/bell/horn and beacon, control output modules for various control functions through relay contacts and communication module for interfacing with the outside world.

7.03.00 The Fire Detection System panels shall be able to monitor the different zones in parallel.

7.04.00 ADDRESSABLE analogue detectors/manual call points, LHS (Linear Heat Sensor) with interface units and required field devices in various areas shall be connected to fire detection system panel by Class A (ring main) wiring to the detector interface unit. The number of such devices per zone shall be 128 and each control panel shall be capable of supporting upto 12 zone.

7.05.00 The Fire Detection System panels shall have a high degree of flexibility with :

(i) A hot standby processor

(ii) Supporting a Repeater/Remote panel having duplicate indications/ alarms & switches for activation/acknowledgement.

7.06.00 It shall be possible to change the sensitivity of each detector to any required value.

7.07.00 The status check of each detector, zone interface unit for alarm, pre-warning, fault disabling/isolating shall be possible from the control panel.

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I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB10

INTER COMMUNICATION SYSTEM

28/3/09

2009.3.30

I1: C&I TECHNICAL SPECIFICATION

SECTION-XIXB10: INTER COMMUNICATION SYSTEM

1.00.00 INTENT OF SPECIFICATION

This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, delivery, properly packed for transport F.O.R. site & handing over of intercommunication system (Public Address System, Telephone System complete with all materials and accessories for efficient and trouble-free operation.

Contractor shall supply fifteen pairs of transceiver without base unit for owner. Statutory approval from Indian govt. shall be applied and obtained by OWNER for transceiver (Walkie – Talkie). Contractor confirms that transreceivers will work without a base station.
UPS for communication system shall be separate from plant UPS.

2.00.00 SCOPE OF SUPPLY

These equipment and materials shall include but not limited to :-

a. All handset and loudspeaker stations, each complete with its own preamplifier, signal processing and power amplifier.

b. Central Control Station, EPABX, Battery, Battery Charger, Distribution frames, complete with all accessories.

c. Cables, wires, splicing/termination/connection accessories.

d. Conduits and accessories, junction and pull boxes, terminal blocks.

e. Grounding materials and connections.

f. All fittings, supports, brackets, clamps & connectors.

g. Spare parts : critical recommended module etc.,

3.00.00 GENERAL REQUIREMENTS FOR PUBLIC ADDRESS SYSTEM

The system shall provide for quick and reliable communication between plant personnel located in different areas for operation and maintenance function..

The design shall be such as to provide highly intelligible two-channel voice communication even in areas of high background noise (50 db to 100 db).

3.01.00 The System characteristic shall be such as to faithfully cover the speech band, particularly over frequency range of 500 Hz to 5000Hz and dynamic range of 40 to 80 db.

3.02.00 The system shall be distributed amplifier type with provision for easy future extension. Each station shall be complete with its own pre-amplifier, signal processing and power amplifier.

3.03.00 The system shall be suitable for operation from available power supply. Separate redundant UPS shall be provided for the intercommunication system.

3.04.00 Equipment shall be self protecting against transients in the input A.C. supply and against failure of any component or cable in the entire communication system.

3.05.00 The plant communication shall be distribution amplifier open line configuration system.

The system shall have a distribution amplifier type of paging and talk back system which will have a private channel for calling/conversation besides up paging.

The announcement system with microphone shall be installed in the control building. Industrial horn type loudspeaker for outdoor use with soundproof enclosure shall be provided for indoor use desk mounted or wall mounted shall be provided.

4.00.00 FUNCTIONAL REQUIREMENTS

4.01.00 The system shall provide two independent and simultaneous channels of communication, viz. page channel and party channel.

4.02.00 The selection of the channel in through a "press to page switch" at the handset.

4.03.00 Page channel is for making any announcement over the system loudspeakers. A call attention gong tone shall automatically proceed all paging announcements.

4.04.00 Party channel is for holding conversation, including conference, between two or more stations without being heard over the loudspeakers.

4.05.00 Master Control station shall have facility for generating and introducing the siren tone in the page channel

5.00.00 SYSTEM OPERATION

The following types of communications shall be possible.

1) Master group control to field system.

2) Field station to master group control station.

5.01.00 Communication within a group.

a. To originate a call, the caller shall lift the handset off the cradle at his station and press the page button.

b. The associated loudspeaker shall get muted to prevent acoustic feedback. A call attention gong shall be heard over all other loudspeakers.

c. The caller shall then make his announcement and release the page button. The announcement shall be heard over all loudspeakers except those muted.

d. On hearing the announcement, the called party likewise shall lift the handset off the cradle at his station and establish two-way communication over party channel.

e. Party channel busy lamp will be lit up at all stations as soon as the channel is in use.

f. Loudspeaker associated with any station engaged in party channel conversation shall be free to receive any paging announcement.

g. An additional switch shall be provided at each handset to mute the associated loudspeaker, if required, when engaged in party channel.

h. The system shall be common talking so that any number of stations can join in conference on party channel.

5.02.00 Communication between field stations of different group.

a) To originate a call, caller shall press the function switch at his field station.

b) LED of corresponding field station will `ON'.

c) Master group control operator shall page desired group and link the two stations.

d) Master group control station operator shall communicate with caller on private line and shall ask for group with whom called person want to speak two groups can communicate private channels.

6.00.00 MASTER GROUP CONTROL STATION

The following control station in desktop construction shall have following facilities.

(1) 16 digital display to indicate calling station number called station display.

(2) Paging zone selection switching metrix.

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Cone-type speaker shall be housed in metal casing with grilled face plate. The housing shall be treated with acoustic undercoat to prevent resonance.

8.03.00 All speaker stations shall have volume and bass controls.

9.00.00 AMPLIFIER

9.01.00 Each handset shall be provided with microphone pre-amplifier and each loudspeaker with power amplifier.

9.02.00 The power amplifier shall be normally housed in handset control box along with pre-amplifier. Where this is not possible, a separate control box housing the power amplifier shall be provided.

9.03.00 Amplifiers shall be heavy duty, designed for high quality amplification. Pre-amplifying stages, if required, shall be provided for low-level inputs.

9.04.00 Electronic-switching circuitry shall be provided to cut off power supply to the amplifiers; when not in use, to avoid unnecessary consumption and increase life of components used.

10.00.00 TECHNICAL SPECIFICATION FOR TELEPHONE SYSTEM

10.01.00 The system shall provide quick and reliable communication between different personnel located at various plants, offices, departments etc. as well as with outside parties.

10.02.00 The system shall be designed to render a highly reliable, efficient and maintenance free system.

10.03.00 The design shall be such as to provide highly intelligible voice communication even in areas of high background noise.

10.04.00 The system characteristic shall be such as to faithfully cover the speech band, particularly over frequency range of 300Hz to 3400 Hz.

10.05.00 The system shall be modular and have provision for future expansion.

10.06.00 The telephone exchanges shall be Microprocessor based Stored Programme Control (SPC) fully digital exchange employing Pulse Code Modulation (PCM) and Time Division Multiplexing (TDM) technology in control and speech path. Mode shall be non blocking type.

10.07.00 Exchange shall cover administrative building, security, stores, railway siding, quarters etc. and complete plant.

10.08.00 The equipments shall be self-protecting against transients in the input A.C. supply and against failure of any component or cable in the entire communication system.

11.00.00 SYSTEM CONCEPT

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Operator console shall be desktop type, economically designed to suit office décor. The enclosure shall be dust and damp proof.

14.00.00 PC TYPE MAINTENANCE & ADMINISTRATIVE CONSOLE

PC type Maintenance & Administrative Console along with Video Display Unit (VDU), Keyboard, Printer etc. shall be desk-top type, economically designed to suit office décor. The enclosures shall be dust & damp proof

15.00.00 TELEPHONE SETS

Telephone sets shall be of the following type:

a. Desk Top push button operated decadic type (ordinary)

All telephone sets shall be suitable for use with digital EPABX system.

Desktop push button operated decadic type (ordinary) (Type-X) telephone sets shall be mounted on desk top,

Telephone sets shall be compact. The body of the telephone sets shall be of injection moulded plastic for strength & durability. The body of the telephone sets shall be available in different colours.

Telephone sets shall provide for side tone balance, impedance level matching, protection against surges, transients etc.

Desktop pushbutton operated decadic type ordinary (Type-X) shall have features like tone ringer, last number redial facility etc.

All telephone sets shall be suitable for decadic signaling.

The microphones and receivers of telephone sets shall be of electromagnetic/piezoceramic type.

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FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB12

C&I LAB EQUIPMENT

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB12:C & I LAB EQUIPMENT

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I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB12:C & I LAB EQUIPMENT

1.00.00 GENERAL REQUIREMENTS

1.01.00 This clause and its sub-clauses sets forth the technical information required for the design, furnishing and construction of an instrument shop, complete with tools and test equipment/devices of proven type and latest design required to maintain the instruments and control devices.

1.02.00 The CONTRACTOR shall provide all the necessary accessories with test instruments/devices, durable boxes of convenient size with various instrument devices, small tool, accessories, carrying cases, etc. for all portable equipment as recommended by the manufacturer.

1.03.00 The instruments offered, shall conform to the relevant codes and standards.

1.04.00 Measuring/ testing instruments, along with allied accessories shall be suitable for continuous operation (both indoor and outdoor installations as applicable).

1.05.00 The CONTRACTOR shall be responsible for proper functioning of supplied items, to check and make any necessary additions of tools as required for proper maintenance and testing of the installed instruments and controls. The furniture for mounting the maintenance & calibration equipment in the C&I laboratory/workshop shall be provided by CONTRACTOR. The CONTRACTOR shall also be responsible for installation and commissioning of the test equipment.

1.06.00 Electrical power supply requirement of the instruments offered under this specification shall be 240 V AC, 50 Hz, single phase.

1.07.00 The CONTRACTOR shall include a complete list of spare parts for these testing/ calibrating instruments/ devices in the list of recommended spare parts. The CONTRACTOR shall render guarantee for easy availability of all the spare parts required especially for the components, which are prone to failure.

1.08.00 (1) The CONTRACTOR shall repair the defective instruments/devices free of cost within the guaranteed period.

(2) The CONTRACTOR shall ensure that all the consumables like batteries, recorder pens, special papers etc, for the testing/calibration or instruments/devices shall be easily available for the life of the project.

1.09.00 The CONTRACTOR shall submit with the proposal a full list, full

description and detail specification, photograph and catalogue drawing as required of sting/maintenance equipment/tools offered. Information for the items offered shall include (as applicable) working principle, power supply and other utility details, dimensional details, mounting details, accuracy, recommendation for installation, storage etc.

1.10.00 The maintenance and calibration equipment specified in this section shall be in addition to similar portable equipment required by the CONTRACTOR for installation and initial calibration of instrumentation and control equipment furnished by the CONTRACTOR. The CONTRACTOR shall hand over to the Owner all equipment specified herein immediately after receiving the equipment at the job site. Use of this equipment by the CONTRACTOR shall not be permitted without the Owner's consent.

The equipment specified in this specification shall be in addition to any special simulator test stands, which shall be recommended and supplied by the CONTRACTOR for use in calibrating electronic components of the instrumentation and control systems to be furnished.

1.11.00 CALIBRATION STANDARDS

The following calibration standards shall be traceable to the National Bureau of Standards of the United States of America, comparable Indian standards, or to applicable standards existing in the country where the equipment is manufactured and tested. The CONTRACTOR shall elaborate in the proposal the standards followed for the following equipment manufacturing & testing:

Dead Weight Tester
Mercury Thermometers
Resistance Temperature Detectors
Aneroid Barometer

1.12.00 Microprocessor based instrument shall be offered wherever applicable. All the microprocessor based maintenance and calibration units should also have provision for data logging facility for keeping calibration/ maintenance record with proper communication facility to down load these data on the lab PC as specified in subsection of DCS details provided.

1.13.00 All Electronic portable instruments shall be powered from rechargeable battery -battery charger system. Battery charger suitable for the instrument shall also be supplied which can be in-

built or stand alone type.

2.00.0 TEST BENCH

2.01.00 ELECTRONIC TEST BENCH

2.01.01 Self contained test bench made of anodized aluminium for testing and repair of electronic instruments and gadgets shall be furnished. It shall be modular in design enabling easy change of arrangement. The test bench shall have approximate dimension (LxWxH) 1000x350x650 (dimension in mm). Test bench shall be furnished with thick laminated top. The front panel shall be made from 3-mm thick anodised aluminium plate and individually engraved in mimic style.

2.01.02 The test bench shall include the following module.

(1)	Main Power supply module	:	It includes main switch for whole workstation 3 ground socket for other instrument, 240V 4A AC low-voltage output, earth leakage circuit breaker etc.
(2)	Isolated supply module	:	It shall include main switch, circuit breaker, 240V AC ±0.5%, 1 phase, 50 Hz, 3 kVA supply socket no. of socket - six 110V AC, 10 Amp, 50 Hz supply socket no. of socket - one
(3)	Variable AC power supply	:	It shall include 0-260V AC*, 1 phase, 50 Hz, 10 Amp, socket and terminal, 0-50V AC/2A, terminals. Digital meter for current (resolution 0.01A) and voltage (resolution 0.1V) no. of socket - one
(4)	Variable DC Supply	:	Module shall include 0-60V DC* 3A stabilised output voltage supply No load/full load regulation shall be ± 0.02% or better, Digital display for voltage and current no of socket - one

(5) Constant DC Voltage supply : ± 48V DC*, 3A
no. of Socket - Two

: ± 24V DC, 6A
no. of Socket - Two

: ± 12V DC*, 10A
no. of Socket - Two

each unit shall include Digital meter for Volts and Ampere.

(6) Digital multimeter : One four and half digit digital multimeter for display of voltage, current, resistance and having 24 measuring ranges, accuracy ± 0.1%

The following facilities shall also be provided.

(1)One DC voltage stabilizer : Regulation ± 0.02% for (0 to 60V, 1A)0-100% load variation

(2) One AC voltage stabilizer : Regulation ± 0.5% for
(240V AC nominal) 0-100% load variation

*(Voltage level is tentative and shall be matched to supply requirements of vendor's range of products)

2.01.03 The test bench shall include socket holders, where the electronic gadgets under test may be plugged. The front equipment shall include multi point connectors and test jacks for inter-connection. There shall be connection between the connector and holder in which device under test shall be plugged in.

2.01.04 The standard high accuracy resistors shall be included to load and measure the current output of devices. Necessary control devices for voltage and current adjustment/control, switches for power supply to feeders, isolation etc., shall be included. All electric circuits shall be protected against overload by fuses, whose holders are located on front of the panel. All electrical circuits and metal structure shall be properly grounded.

2.02.00 PNEUMATIC TEST BENCH

2.02.01 The pneumatic test bench made of anodized aluminium and modular in design enabling easy change of layout/arrangement as and when required shall be provided. The test bench shall be complete with shut-off valves, air filter-cum-pressure regulators and pressure gauges for testing pneumatic transmitters,

controllers, power cylinders, control valves etc. The dimension for the test bench shall be approximately 1000 mm x 350 mm x 600 mm (LxWxH).

2.02.02 The test bench shall be furnished as per the following general specification:

(a) Complete with regulated air supply outlet of 0-20 psi and 0-30 psi, display plate with two four and half digit digital pressure indicator of range vacuum to 20,000 mm WG and 0-30 psi, accuracy ± 0.05% of full scale.

(b) Complete with Built-in selector for read out in five engg. units i.e. kg/sq.cm., psi, mm Wcl, bar, mm Hg.

(c) Complete with overload protection valve

(d) Complete with control plate with mimic panel incorporating three precision pressure regulators, filter reducing unit for the air supply, three 150 mm dial pressure gauges having ranges 0-2, 0-4 & 0-6 Kg/cm^2 respectively and accuracy ± 0.25% full scale.

(e) Complete with two 0-30V 0.5A max. Stabilized DC sources

(f) Complete with current source of 0 to 55 mA, and mV source of 0-100 mV.

(g) Complete with set of supports for the instrument under test, desk with drawers and all other necessary accessories.

The CONTRACTOR shall be responsible for connection of instrument air line from his tapping point and also keep provision of giving supply from Air-Sets also. CONTRACTOR must ensure that the consumption of air in the test bench is within the design capacity of the above tapping/piping or source.

I1: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXB12:C & I LAB EQUIPMENT

ANNEXURE-1

MAINTENANCE & CALIBRATION EQUIPMENT

One set of Maintenance & Calibration Equipment common for all the modules as listed below shall be supplied..

Sl. No	Description of Equipment	Total Quantity
1.0	Dead Weight testers (Low range and high range)	1set each
2.0	Vacuum Tester	1 set
3.0	Barometer	1
4.0	Portable Thermocouple / RTD calibrator/ Simulator	1
5.0	Standard reference RTD and Standard reference thermocouples	1 of each type
6.0	Portable dry block type temperature calibrator	1
7.0	Hand held Pyrometer	1
8.0	Portable Vibration Meter	1
9.0	Portable Digital Tachometer	2
10.0	Hygrometer	1
11.0	Portable Gas Analyser	1
12.0	Portable Electro-pneumatic Calibrator	2
13.0	Megger	1
14.0	Cable tester (Time domain reflectometer)	1
15.0	Deleted	
16.0	Deleted	
17.0	Deleted	

18.0	Electronic test bench	1
19.0	Pneumatic test bench	1
20.0	Soldering/desoldering station with all accessories	2 sets
21.0	Portable multifunction calibrator	1
22.0	Digital handheld Multimeter	3
23.0	Portable milliamp simulator/ meter	2
24.0	Digital channel simulator	1
25.0	Portable Counter	1
26.0	Variac	2
27.0	Digital Storage Oscilloscope	1
28.0	Decade Resistance Box	1
29.0	Laboratory power supply	2
30.0	Signal Generator	1
31.0	Clip-on AC Meter	1
32.0	Stop Watch	2
33.0	Power supply extension boards	4
34.0	Thread gauges	1 set
35.0	Standard tool box	2 sets

(i) Screw Driver set
(ii) Allen key set
(iii) Files
(iv) Tube cutter
(v) Tube bender
(vi) Adjustable Wrench
(vii) Spanner
(viii) Bench Vise
(ix) Wire stripper
(x) Teflon tapes
(xi) Insulation tapes

WARDHA POWER CO. PVT. LTD.
3600 MW COAL BASED POWER PROJECT
AT NARIYANA, JANJGIR-CHAMPA DIST. CHATTISGARH

ENGINEERING, PROCUREMENT AND CONSTRUCTION SPECIFICATION FOR COAL BASED THERMAL POWER PROJECT

VOLUME – II

I0: C&I TECHNICAL SPECIFICATIONS

SECTION-XIXC

C & I ERECTION

I2: C&I TECHNICAL SPECIFICATION

SECTION-XIXC :C & I ERECTION

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I2: C&I TECHNICAL SPECIFICATION

SEC-XIXC:C & I ERECTION

1.00.00 INSTRUMENT INSTALLATION

1.01.00 GENERAL

a) Instrument process tubing and instrument air tubing to be designed in accordance with the instrument installation drawings. Hook-up drawings will be approved by the Owner during detailed engineering.

b) All instruments, process connections, including isolation valves and associated devices, shall be located in easily accessible locations for maintenance, calibration and replacement. All maintenance, calibration and replacement operations on a given device must be possible without interruption of service to adjacent equipment.

c) Instrument mounting height shall 4' - 6" above equipment base or platform.

d) Instrument tubing installation are designed in accordance with ANSI B31.1 " Power Piping".

e) Two number root valves, two number drain valves and one number secondary isolation valve for transmitters/switches/gauges for pressure above 40 kh/sqcm. For pressure less than 40 kg/sq.cm one root valve, one isolation valve and one Blow Down valve will be provided.

1.02.00 INSTRUMENT SENSING LINES

a) Instrument sensing lines shall meet the brief specifications as given below :

For pressure $\geq$ 40 bar, impulse pipe 14.2 OD 1Cr18Ni9Ti. with weld connection shall be used. For pressure < 40 bar impulse pipe/impulse tube 14.2 OD 1Cr18Ni9Ti with weld connection/ double compression 1Cr18Ni9Ti fittings shall be used. Schedule of the pipe will be compatible with process requirement.

b) Minimum bending radius of instrument sensing lines 3 times the tube diameter.

c) Instrument sensing lines are sloped in their horizontal runs, a minimum of 1/2" per foot. In general, liquid and steam lines slope

from their process tap connection down to the instrument. In general, gas and non-condensing vapor lines slope from their process tap connection up to the instrument.

d) Instrument sensing lines shall be routed as directly as practicable from the process root valve to the instrument. The length of instrument tubing from the root valve to the instrument shall be limited to maximum of 12 meters for compressible fluids and 15 meters for non-compressible fluids.

e) Instrument sensing lines are grouped together as much as possible to benefit from the use of common support members and to present a finished installation that is routed in a neat and orderly manner. Care is exercised to assure that spacing between adjacent tubes in the same group is maintained uniform and that tubes do not cross under or over one another at any point. Changes in direction of tubing is done by the use of tube bends and not tube fittings.

f) Compression tube fittings are used in low pressure process systems. Socket weld tube fittings are used in high pressure process systems. Refer to the instrument tubing line specifications for the design criteria for the use of compression fittings verses socket weld fittings.

g) A single blow down valve or double blow down valves (if the process root valves are doubled) shall be installed to the sensing lines of all pressure transmitters that are tapped off liquid or steam process systems. These valves shall be located at the instrument and may be brought together to the header.

h) The maximum process temperature for all transmitters shall be limited to 80°C. To dissipate the excess heat, a maximum of 1 meter of tubing for each 30°C of excess heat shall be installed to isolate the process media from the instrument. An additional isolation valve shall be used at the instrument for isolation on those instruments without valve manifolds.

1.03.00 INSTRUMENT AIR LINES

a) Instrument air lines shall be of SS.

b) Minimum bending radius of instrument air line tubing is 3 times the tube diameter.

c) All branch lines from the instrument air line header are made from the top of the air header and shall not be smaller than 1/2 inch. Branch lines have a root valve at the process connection.

d) In areas with multiple air users, an instrument air manifold is used. The branch from the air header to manifold is 1 inch, with a 1-inch

isolation valve at the manifold. The manifold consists of a 3-inch pipe with caps, 3/8 inch air takeoff connections with 3/8 inch shutoff valves, and a 1/2" drain valve. A six and eight air user, manifold design, will be used.

1.04.00 INSTRUMENT MOUNTING

a) Instrument mounting shall be in accordance to standard hook-up details and mounting details.

b) Spacing between multiple instruments mounted on the same support shall be sufficient to allow ample clearance area in order to perform service, maintenance, calibration and testing.

1.05.00 INSTRUMENT WIRING

1.06.00 GENERAL

The two-wire system shall be employed for transmission of signals from electronic transmitting instruments. Electronic instrument wiring shall be done as per manufacturer's standards and multicore cables shall be used wherever practical. Special, screened/ shielded or co-axial cables shall be used as required and as such, these special cables shall be supplied by the Contractor. For high temperature areas (eg. Turbine) Teflon(PTFE) cables shall be used.from instrument to junction box.

1.07.00 CONDUIT

Compensating and screened cable shall be installed in perforated cable tray/ rigid conduit. Remote bus/communication bus shall be installed in rigid conduit. All special cable including compensating cables required for the plant shall be included in Contractor's scope. From instrument to Junction Box, cable shall run through flexible metal conduit.

1.08.00 TERMINAL BOX

Except for thermocouple cables terminal/junction boxes shall be used for the interconnection of control wiring and instrument signal wiring. Terminal boxes of a type approved for area classification shall be provided for terminating multicore control wiring. NEMA-3 standard type of better enclosures shall be used for junction boxes.

1.09.00 WIRING PRACTICES

1.09.01 The signal cable shield shall not be used as a signal conductor. The signal cable shall not be spliced. The cable shield shall be maintained at a fixed potential with respect to the circuit being protected.

1.09.02 Low level signal cable shall be terminated with short untwisted length of wire which should have as minimum area as practicable to be exposed for inductive pick-up. Low level signal cables should be separated (isolated) from noisy & power circuits by practicable large distance.

Signal cables should not cross each others, if at all required, crossing shall be at right angles, and at a large practical distance.

1.09.03 Instrument cubicle/panel wiring shall be such that minimum crossing of signal cables are encountered. Instrument/device located in left (and right) hand side of panel/cubicle should be terminated in left (& right) side terminal block respectively so as to minimize intercrossing of wires in panel/cubicles.

1.09.04 Unused shielded conductors in a low level signal cable shall be single end grounded at the opposite end.

1.09.05 Earthing plate for all electronic instruments shall be away from common electrical earthing point. A signal circuit shall be grounded either at the transmitter end or at the instrument end.

1.09.06 All Cables to be terminated in Junction Box/Panel shall be through cable glands.

1.09.07 All instrument cables like signal cable, communication cable, supply cable should have separate color code and cables should be distinguished from electrical cables. Signal cables and control cables should be put in cable trays separate from that of power cables

1.09.08 All cables should have trace ability from field to JB and JB to DCS/Panel with PVC plate identification. The cabling should be documented properly so that it can be useful for future maintenance.

2.00.00 ERECTION PROCEDURE - INSTRUMENTS

2.01.00 This section provides the general guidelines to be followed for the testing, erection, pre commissioning checks and commissioning of various types of instruments and accessories under the scope of the specification.

2.02.00 Equipment manufactures recommendation, where furnished, shall prevail over the guidelines furnished in this section in case of any contradiction between the stipulations of this section and the recommendation of the manufacturer, the latter shall be followed.

2.03.00 For special instruments the specification furnished in this section are of general nature only and manufacturer's recommendation shall be strictly followed for such instruments as guidelines for erection and commissioning.

2.04.00 The instrument hook-up drawing shall be submitted for approval and contractor is required to erect the instrument in accordance with the approved drawing.

2.05.00 <u>FIELD MOUNTED INSTRUMENTS</u>

2.05.01 Before erection all instruments shall be subjected to calibration test and other tests as per manufacturer's standard at Contractor's site laboratory in presence of Purchaser's authorised representative. The details and modalities of such test shall be jointly decided by Purchaser and Contractor.

2.05.02 All calibration and special instruments, tools and tackles calibration kits are to be supplied by contractor.

2.05.03 All instruments shall be tagged with engraved aluminium tag plates and shall be secured to the instrument with metallic wire fasteners. CONTRACTOR can use hard PVC plates for instrument tagging. However,the same shall be subject to Owner's approval during erection.

2.05.04 Minor repairs, adjustments of the instruments shall be performed by Contractor under the supervision of the Purchaser's authorized representative, once the instrument has been successfully repaired it shall be subjected to test as specified elsewhere.

2.05.05 A record of such repairs and adjustments shall be systematically maintained by the Contractor and brought to the notice of the Purchaser.

2.05.06 For instruments where the extent of damage is such that the same can not be repaired at site it shall be brought to the notice of the Purchaser by the Contractor as early as possible for appropriate action.

2.05.07 A failure report for such damaged instruments shall be generated by the Contractor, enumerating the nature of fault/damage.

2.05.08 Cases where the damages are only superficial viz cover paints peeling etc., the decision whether such instruments are fit for erection shall solely lie with the Purchaser. Contractor shall seek written clearance from the Purchaser in such cases mentioning the details of the damage before the erection is performed.

2.05.09 Deleted.

2.05.10 Field mounted instruments which are outside the building or shed shall be provided with protective cover canopy to provide effective protection against dust, rain etc. The cover shall be provided by the contractor immediately after the instrument-mounting job is over. For each type of the instrument design of the cover shall be developed by the Contractor and the sample shall be approved by Purchaser's engineer before contractor starts bulk fabrication of the same. These cover shall be made of 3 mm thick MS sheet and painted with two coats of metal primer and two coats of final paint. CONTROCTOR shall provide canopy for instruments mounted in outdoor area.

2.05.11 All clamps, supports, stands required for installation and erection of instruments and their accessories, shall be painted. Paint shall be

procured by contractor at his own cost. Painting shall be done after proper surface treatment with two coats of metal primer and two coats of final paint.

2.06.00 PRESSURE/DP TRANSMITTERS/LEVEL TRANSMITTERS

2.06.01 Pressure & DP transmitters shall be mounted locally on fabricated structures.

2.06.02 Manifolds/ valves shall be mounted on transmitter at the Contractor's workshop and the assembly shall be leakage tested after completion of the plumbing at site. The leak test shall be performed with compressed air and soap solution at pressure not exceeding the maximum overload pressure of the transmitter. Wherever practicable the height of the transmitter from its mounting floor/ platform shall be between 1200-1600 mm.

2.06.03 C & I Sub-contractor's erection terminal point shall normally be the root valves or first/second take-off valve on the main equipment vessel or pipeline. Maximum impulse tube/ pipe length allowed is 15 Mtrs. Wherever this exceeds, the contractor shall obtain prior approval from Purchaser

2.06.04 For transmitters, to be mounted on stanchions, brackets etc., fabrication of such supporting structures shall also be envisaged upon the Contractor.

2.06.05 During installation of level instruments on vessels, if the flanged nozzles provided on vessels are found to be out of alignment, necessary modification, addition of spool pieces required for proper installation of instruments shall be carried out by the contractor.

2.07.00 TEMPERATURE INSTRUMENTS/THERMOWELLS

2.07.01 C & I Sub-contractor's scope of erection of temperature instruments shall comprise mounting of the temperature instruments on thermowells, bolting thermowells onto tapping flange, and cabling work, as applicable .

2.07.02 Alf thermowells shall be thoroughly cleaned with air jet and wire brush before installation of temperature gauge/element.

2.07.03 Zero checking shall be performed on all temperature gauges with ice bath.

2.07.04 Temperature gauges shall be calibrated at least 4 points of the scale (25%, 50%, 75% and 100%) with temperature controller bath.

2.97.05 Repeatability and hysteresis check of temperature switches shall be performed at 4 points in the manner stated above.

2.07.06 The dial of rigid stem type temperature gauges and switches shall be oriented properly so that the scale can be read/set point can be adjusted unassisted from the approach floor/platform.

2.07.07 Capillary type instruments shall be mounted on appropriate support structure with clamp bolts etc. Fabrication of such support structure will be in contractor's scope.

2.07.08 Contractor shall fabricate, where not available already, structure for routing, strapping and protecting the capillary tubes. Capillaries shall be clamped at intervals not more than 0.5 M. The supports shall protect the capillaries from mechanical damage.

2.07.09 Wherever practicable, the height of the capillary type instrument shall be 1200-1600 mm from approach floor/platform.

2.07.10 All mounting accessories, U-clamps, nuts & bolts shall be accessible for removal by means of spanner.

2.07.11 Between erection and cabling work all cable entry points shall be kept plugged with PVC caps to be procured by the Contractor.

2.07.12 Both the elements of the duplex type Thermo couple shall be terminated at the same junction boxes.

2.07.13 All compensating cables shall be terminated with proper polarity.

2.07.14 All cables shall be identified with ferrules at both the junction box and element head end.

2.08.00 <u>PRESSURE GAUGE/SWITCHES, DIFFERENTIAL PRESSURE GAUGES/SWITCHES</u>

2.08.01 Local pressure gauge/switches and differential pressure gauges/ switches shall either be directly mounted or shall be mounted on local brackets or gauge boards depending on accessibility and maintainability.

2.08.02 C & I Sub-contractor's erection terminal point shall normally be the root valve/s or first/second take-off valve on the main equipment, vessel or pipeline.

2.08.03 For gauges and switches, the erection activity shall normally include mounting of the instrument with its manifold/valve assembly etc. on appropriate support structure with clamps, bolts etc., all pipe connections from process to the instrument, piping from instrument to additional drain/vent valve, if any; supporting and clamping of additional valve to drain pot/drain header nearest system drain, cabling from switches to field junction box termination of the cable, mounting and connecting of settling chambers/damper pots/Syphon/seal pots etc.

2.08.04 For instruments to be mounted on stanchions/brackets/gauge boards, fabrication of supporting structures shall also be envisaged upon the contractor scope of work.

2.08.05 The supporting structures shall be designed, fabricated & installed to support all instrument accessories.

2.08.06 Necessary sub-trays wherever required, shall be erected by the Contractor for proper routing of the cables.

2.08.07 The indicating scales shall be oriented properly, so that the scale can be read unassisted from the approach floor/platform.

2.08.08 The mounting U-clamp nuts shall be accessible for removal by means of spanner.

2.08.09 No pressure switch, DP switch shall be installed in areas prone to vibration.

2.08.10 Before installation the pressure gauges/DP gauges shall be subjected to calibration check with dead weight tester, monometer etc. as applicable.

2.08.11 Calibration should be checked at minimum 4-points (0%, 25%, 50%, 100% of full span).

2.08.12 Repeatability and hysterisis of pressure/differential pressure switches shall be checked at 4-points as described above.

2.09.00 LEVEL GAUGES / SWITCHES

2.09.01 Before starting the actual erection, the Contractors should check that the centerlines of the tap-off valves are in plumb.

2.09.02 In case of External cage type, level switches, installation of the cage, including welding (if required) of extension nipples are in the Contractor's scope. Float and switches mechanism is integral with the level switch itself.. Necessary support structure, if required, shall be fabricated by the Contractor.

2.09.03 The erection activity of level gauges/switches shall normally include mounting of the instrument with necessary piping, nipples, and drain vent valves. Connection of drains to nearest system drain and cabling upto junction box.

2.09.04 The indicating side of the gauge glass shall be properly oriented for easy reading by the operator.

3.00.00 ERECTION PROCEDURE - MISCELLANEOUS HARDWARE

3.01.00 JUNCTION BOXES

3.01.01 Contractor's scope of erection of junction boxes shall include mounting of junction boxes in appropriate locations indicated in the JB schedule, fabrication of necessary pedestals, brackets, frameworks fittings of cable glands etc. for erection and final painting of the structures and the junction boxes.

3.01.02 The junction boxes shall be fixed to the nearest available structures as far as possible. In certain cases special pedestals may have to be fabricated and grouted/bolted to nearest available structure.

3.01.03 Before installation, junction boxes may have to be prepared, if necessary by fixing terminal blocks, mounting rail etc. Any other connected job shall be considered as a part of the junction box installation.

3.01.04 Supply and fitting of cable glands for junction boxes shall be included in the Contractor scope of work.

3.01.05 All the glands shall be sealed with sealing compound so as to make them thoroughly dust and moisture entry proof. Supply of sealing compound is included in contractor's scope of supply. Sealing compound will be decided during detailed engineering.

3.01.06 Spare Cable entries in the junction boxes shall be left plugged to prevent dust and moisture entry.

3.01.07 All necessary nuts, bolts, screws, foundation bolts etc. for mounting the junction boxes and their supporting structure shall be supplied by the Contractor. All necessary civil works viz chipping, grouting etc. shall also be envisaged upon the Contractor.

3.01.08 Identification tags for the cables made of plastic tags for the cables with printed cable numbers shall be provided inside the junction boxes panels close to the gladding point.

3.01.09 Junction box mounting shall include the fabrication of steel supporting structures as well as other connected jobs.

3.01.10 The Contractor shall arrange to repaint junction box if the paint is damaged due to bad handling. Wherever required, the contractor shall arrange to do retouching of paint on the junction boxes. Proper identification labels shall be fixed on the junction boxes for ease of identification. Necessary paints as per purchaser's approved quality shall be arranged by the contractor.

3.01.11 Deleted..

3.02.00 PANELS, GAUGE BOARDS ENCLOSURES AND STRUCTURES

3.02.01 C & I Sub-contractor's scope of work shall include installation of panels, gauge boards, mounting brackets and frames, drain headers etc. with associated painting and civil work.

3.02.02 Contractor shall arrange to transport all the panels from Purchaser's warehouse or storage yard to appropriate locations for erection.

3.02.03 Contractor shall erect panels/enclosures etc. only after ensuring availability of work front.

3.02.04 If the panels are supplied in packed condition, the same will be properly slinged for lifting. When lifting unpacked panels eye- bolts shall be used. Unpacking should be done at Contractor's store or installation site only.

3.02.05 During slinging or lifting of the panel care shall be taken not be damage the structure or any instrument/equipment mounted on the panel.

3.02.06 Prior to the installation of panels the foundation shall be inspected by the contractor to find out the presence of foreign matter and existence of possible defects or damage.

3.02.07 The Contractor shall arrange to provide suitable protective coverings for the panels since unpacking and after erection to avoid any damage due to movement of men and materials in the vicinity.

3.02.08 The Contractor shall carry out retouching of painted surface of panels wherever required. Repainting of the panels shall be carried out by the contractor at his own cost in case off damage to painted surfaces due to bad handling by the contractor during installation. The paint for this purpose shall be provided by the contractor. The Contractor must get the paint approved by Purchaser before using the same.

3.02.09 Any damage during transit or installation shall be made right by the Contractor at his own cost to Purchaser's satisfaction within shortest duration and without affecting project schedule.

3.03.00 <u>STANCHIONS, SITE STRUCTURES AND MOUNTING FRAMES</u>

3.03.01 Contractor's scope of work shall also include fabricating and installing of mounting frames, pedestals, canopies, protective enclosures for mounting of field instruments, local panels and Junction boxes. Contractor's scope shall also include mounting of the instruments in the local stanchions/pedestals/gauge boards with all necessary piping, painting cabling upto local junction box and any other associated civil work like chipping, grouting etc.

3.03.02 The design of stanchions, supporting frames and stands shall be developed by the Contractor and the sample shall be approved by

Purchaser's engineer before contractor starts bulk fabrication. This shall be decided during detail engineering.

3.03.03 All steel items shall be decaled and degreased by suitable solvent cleaning.

3.03.04 All structures shall be welded throughout.

3.03.05 All floor/platform mounted structures shall be self-supporting and free standing type. They should not depend on supports derived from nearby columns/structures/pipelines etc. for rigidity and mounting.

3.03.06 After erection, all site fabricated structures shall be painted with two coats of Primer followed by two coats of enamel paint purchaser approved finished paints of 2.0 mil/coat DFT. Sags, cracks, blisters, pear drops fat edges of paint shall render the structures unacceptable.

3.03.07 Instruments shall be mounted according to approved layout. All instruments shall be mounted as per the recommendation of the manufacturer's.

3.03.08 Contractor shall fabricate 3 mm M.S(mild steel)./Aluminium canopies for shielding of instrument from direct hit by rain, where instruments are mounted in outdoor areas.

3.04.00 <u>CABLING, INTERCONNECTION, TERMINATION, INSTALLATION, ROUTING & LAYING</u>

3.04.01 CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY:

3.04.01.01 C & I Sub-contractor's scope of cabling and interconnection activity shall include cabling work between local switches, resistance temperature detectors, transmitters, converters, limit switches, position transmitters, torque switches, solenoid valves etc. upto local junction boxes; thermocouples upto local junction boxes, or control room panels; junction boxes, analyzers, panels to control room marshalling racks or cabinets. In short all the cables laid by the Contractor shall be terminated/glanded at both ends.

3.04.01.02 The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used.

3.04.01.03 Normally 10% spare cores shall be provided when the number of pairs of cables are more than four pairs.

3.04.01.04 For analog signals, individual pair shielding & overall shielding & for binary signals, only overall shielding of instrumentation cables shall be provided.

3.04.01.05 Cables shall be laid in cable trays/conduits in all areas. Cable tray will be covered on top layer only.

3.04.01.06 All cablings shall be as per cable schedule. All cables shall be laid only along the route specified in the cable schedule until and unless changes are necessary. Whenever such changes are required the laying routes shall be decided by the Contractor in consultation with the Purchaser.

3.04.02 CABLE INSTALLATION AND ROUTING:

3.04.02.01 All cables assigned to a particular duct/ conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Owner.

3.04.02.02 Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows :

From 11 kV/6.6 kV/3.3 kV tray system	-	900 mm
From 415V tray system	-	600 mm
From control cable tray system	-	300 mm

The separation distance in vertically stacked cable tray is between bottom to bottom of tray.

3.04.02.03 Cable shall terminate in the enclosures through cable glands. All cable glands shall be properly gasketed. Fire proof sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Double Compression cable glands shall be provided

3.04.02.04 All the cable runs shall be properly identified by engraved PVC number tag plates, in owner's approved format, fastened to the cable with steel wires, which shall be provided at both field ends junction box ends and at Control room equipment ends and at every 25m length of the cable. CONTRACTOR will provide cable tags on both the ends of cables(start point and end terminal)

3.04.02.05 Line voltage drop due to high resistance splices, terminal contacts, insulation resistance at terminal block, very long transmission line etc. shall be reduced as far as practicable.

3.04.02.06 The cables emanating from redundant equipment/ devices shall be routed through different routes. The above segregation of cables & wiring for redundant equipments/ devices shall be in accordance with IEEE-Std-422.

3.04.03 CABLE LAYING AND ACCESSORIES:

3.04.03.01 CABLE LAYING

1 Cables shall be laid strictly in line with cable schedule.

2 Identification tags for cables.

Indelible tags to be provided on both the ends of cables(start point and end terminal)

3 Cable tray numbering and marking: To be provided at every 40m and at each end of cable way & branch connection

4 Joints are not permitted.

5 Buried cable protection: With concrete slabs; Route markers at every 20 Meters along the route & at every bend. As the case may be.

6 Road Crossings:

Cables to pass through buried GI Steel pipes encased in PCC. At least 300 mm clearance shall be provided between

- HT power & LT power cables,
- LT power & LT control/instrumentation cables,

Spacing between cables of same voltage grade shall be in accordance with the derating criteria adopted for cable sizing.

7 Segregation (physical isolation to prevent fire jumping):

a All cable associated with one module shall be segregated from cables of other modules.

b Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire.

8 Cable clamping

All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray by suitable steel wires. For cables in trefoil formation, trefoil clamps shall be provided.

The clamps required for fixing of cable shall be supplied by the Contractor.

The Cable shall be clamped to the trays with GI/Aluminium clamps at not more than 0.5 metre intervals for horizontal runs and vertical runs.

9 Optical fibre cables Inside conduit shall be laid on cable trays wherever available and feasible. buried in separate trench approx.1metre depth, to be laid in 2" gi/rodent proof HDPE conduits covered with sand, brick and soil along the pipe line route; While crossing roads - to be laid in GI/ rodent proof HDPE conduits with sand filling at bottom and sand, soil filling at top with cement concrete;
While crossing canals/ river- to be laid in GI/ rodent proof HDPE conduits within hume pipe. As the case may be.

3.04.03.02 In case of single piece straight multicore/ multipair cable run, no joint in the cable shall be provided in between.

3.04.03.03 Cable glands and other openings in the junction boxes shall be properly sealed by means of sealing compound supplied by the contractor at his own cost to make them thoroughly dust vermin and moisture proof. Sealing compound will be decided during detail enginerring.

3.04.03.04 The Contractor shall take full care while laying/ installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends.The cables laid shall not be subjected to excessive tension so as to cause damage to the conductors.

3.04.03.05 At the bend where excessive partial stress may concentrate or where there is any danger of damaging the insulation, extreme care shall be taken while laying the cables to avoid any possible damage to the cables. Sharp bends of cables are not permitted.

3.04.03.06 A sufficient length of multipair/multicore cables shall be left extra in the form of loop at either end.

3.04.03.07 In general RTD/Thermocouple will be duplex type and both the elements shall be terminated by the contractor upto the field junction box.

3.04.03.08 All cable shields shall be individually terminated and jumpered together at the terminal blocks. Earthing of the shields shall, however, be performed at the control panel end. Individual cable shield shall be terminated at local JB. Overall shield of cable shall be terminated at cabinet.

3.04.03.09 If at any time during progress of work, the Contractor finds the trays which appear inadequate to accommodate the assigned cable, Contractor shall discontinue laying of the cable until advised as to how he shall proceed.

3.04.03.10 All cable shall be carefully laid or pulled in trays or trench so that neither cable nor the trays are damaged. Cable shall be cut sufficiently long to conform to the contour of the trays, especially for vertical inside bends.

All excessive slack shall be removed from the cable so that it lies parallel to the sides of the trays. For all buried cables, sand filling shall be in contractor's scope.

3.04.03.11 All exposed conductor surfaces shall be taped with all weather proof vinyl plastic electrical tape.

3.04.03.12 Contractor after laying the cable shall solder cable cores and screen ends to connector pins/plug-in crimped ends of the cable to the connector plug socket/crimp-in special connectors for coupling the cable to the plug socket/wire wrap the ends to connector pins, as the case may be. Contractor shall ensure properness of end connection before embarking upon the termination. As the case may be.

3.04.03.13 No splices shall be made in conductors for instrument and control circuits..

3.04.03.14 Contractor shall supply and install all cable accessories and fittings like Light Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.

3.04.03.15 Contractor shall furnish two completely new sets of cable termination kits like Crimping tools, maxi-termi/ wire-wrap tools etc., which are required for maintenance of the system as per the type of termination used.

3.04.03.16 Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.

3.04.03.17 The Contractor shall be responsible for proper grounding of all equipment under C&I package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests. All the cables etc. required for grounding of all equipments supplied under this package are to be supplied by the Contractor.

3.04.03.18 All instrumentation cable trays shall be galvanized aluminium perforated type. Top cable tray shall be covered. Instrumentation cable tray shall be perforated type. Control and other cable tray shall be ladder type.

3.04.03.19 All necessary connectors, lugs, ferrules, tags etc. for termination of cables shall be supplied by the contractor except where special connectors may be required.

3.04.04 TERMINAL BLOCKS

3.04.04.01 All terminal blocks shall be rail mounted/ post mounted, cage clamp type/ maxi-termi type (MTP) with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, CJC boxes, instrument enclosures/ racks, etc., shall be suitable for cage clamp/ MTP connections. The terminal blocks in Control Equipment Room logic/ termination/ marshalling cubicles shall be suitable for post mounted maxi-termi/ cage clamp connection at the field input end. The terminal blocks for DCS input/output connections from/to SWGR/ MCC, Actuators with Integral Starter (for coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT & VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the Contractor and the technical details of the same including width etc. shall be subject to Owner's approval. Ring/Fork type terminal blacks shall be provided for control and signal cables. For any specific case where Ring/Fork terminal blocks can not used, CONTRACTOR shall furnish the technical reasons and the special terminal block which shall be proposed will be submitted for OWNER's approval.

3.04.04.02 All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc.

3.04.04.03 The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 15% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.

3.04.04.04 Terminal blocks shall be provided for terminating process actuated switches, drive actuators, control valves, RTD, etc. in Local Junction Boxes, HT drives, LT drives, Electrical drives etc.

3.04.04.05 The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.

3.04.04.06 For ensuring proper connections, Contractor shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to Owner's approval without any cost repercussions.

3.04.04.07 Internal wiring in factory prewired electronic equipment cabinets may be installed according to the Contractor's standard as to wire size and method of termination or internal equipment. Terminal blocks for

connection of external circuits into factory prewired electronic equipment cabinets shall meet all the requirements as specified above.

3.05.00 TRAYS/SUB-TRAYS/SUPPORTS

3.05.01 Contractor's scope of erection of trays/sub-trays/supports shall normally include sub-tray sections upto the specified main tray. However, in some areas where main trays are not available, Contractor shall have to lay tray sections upto the master junction boxes/local panels/cable spreader areas. Contractor's scope of work shall include laying and supporting of trays, fabrication of trays wherever required, painting of trays and supports and associated erection work including minor civil work wherever required.

3.05.02 Supply of sub-tray and tray supports are in the Contractor's scope of work.

3.05.03 This shall include fabrication, welding and installation of Branch trays including supports from structurals.

3.05.04 The supports shall be welded to the main structures, grouted in the walls or welded to the plate inserts. Welding of supports to main equipment/piping shall never be allowed. Welding of trays shall not be allowed. In special cases if trays are welded the same shall be painted by anti rust paint.

3.05.05 The contractor shall arrange to provide hangers, rigs, inserts and other fixtures on the walls, ceilings, structures and permanent scaffolding etc. for fixing trays. Fabrication and fixing of necessary jigs, hangers, insert and other fixtures as per need will be considered as a part of erection of structural steel and nothing extra on this account shall be paid to the contractor.

3.05.06 The trays shall be properly finished and laid to give neat appearance.

3.05.07 Before taking-up erection of trays in a particular area, written work front clearance shall be obtained from the Site-in-charge. If any erected tray or its supporting structures are found by the Purchaser to be vulnerable to damage or to be fouling/interfering with progress of other activities in the area the same shall be dismantled and re-erected not withstanding the clearance received for the job.

3.06.00 EARTHING

3.06.01 Contractor's scope of work shall include Earthing of all instruments/Junction boxes/panels which are to be installed by him. Necessary wires, lugs, ferrules, etc. shall be supplied by the Contractor. In addition to the general guidelines given below, the Contractor shall remain responsible to follow the instrument/equipment manufacturer's grounding recommendation.

3.06.02 Screen of all instrument cables between instruments to local junction box shall be terminated by individual terminal blocks. The other end of the screen shall be left disconnected and taped with adhesive vinyl tape. All screen terminal blocks at JB end shall be shorted with shorting links.

3.06.03 Compensating cable screens shall be terminated at independent terminal block in control room end only. This terminal block shall, however, be wired upto insulated screen bus bar integrate to the panel.

3.06.04 All junction boxes, stands, stanchions, local panels, cubicles etc. as installed by the Contractor must be connected to the nearest riser of electrical earth mat by SWG 10 MS wire. CONTRACTOR shall provide copper flat(as per manufacturer standard) in the cabinet.

3.06.05 For terminating grounding wires only ring-tongue typelugs shall be used and the wires ; shall be ferruled at both ends.

3.07.00 FITTINGS & TUBINGS

3.07.01 Contractor's scope of work shall include erection of all piping/tubing necessary fittings required for erection of field instruments, control valves, analyzers etc.

3.07.02 Normally, C & I Sub-contractor's terminal point for erection of primary impulse piping shall be the first or the second take-offs are permitted within 15 mtr.length of impulse tubing. .(C&I Sub-contractor means C&I erection contractor)

3.07.03 Welding of steam piping and high pressure piping shall be carried out by duly certified welders only. The certificates of such welder must be presented to the engineer for scrutiny on demand. Such jobs done by uncertified welders shall be rejected.

3.07.04 Pipes installed but not connected, shall have ends closed with taps or plugs to prevent the entry of foreign material. All reasonable precautions shall be taken to prevent the entry of foreign materials in pipelines before and during erection. All drain points, after installation shall be sealed with caps.

3.07.05 All instrument impulse pipe fittings and accessories which shall include but not limited to brackets, supports, clamps, angle irons/flats shall also to be painted as per the Purchaser's approved color code. Color code will be detailed during detailed engineering.

3.07.06 For differential pressure instruments, wherever applicable the seal pots/condensate pots shall be brought to the same level.

3.07.07 For differential pressure instrument both impulse lines shall run in parallel and shall be as close as possible.

3.07.08 All impulse pipes shall be subjected to hydraulic test at 1.5 times the maximum working pressure and leakage test at site after erection.

3.07.09 After hydraulic testing of impulse lines, the same shall be completely drained out and air shall be blown through the pipes to dry the pipes completely.

3.07.10 Impulse tubing from first isolation valve upto the pressure/DP instrument shall be as per the hookup diagrams. Single lengths of SS tubes shall be 6 meters. Fittings like male/female connectors, unions, tee, plug etc. shall be 1Cr18Ni9Ti. All connectors shall be NPT standard and threaded as per ANSI B2.1. The pressure rating of all fittings shall be 3000 lbs and size shall be ½". OWNER will review the hookup drawings during detailed engineering.

3.07.11 The pipes and fittings for instrument air sub headers shall be galvanized carbon steel.

3.07.12 The air distribution to individual consumer shall be done by means of 1Cr18Ni9Ti pipe.

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SCHEDULE II

TECHNICAL SPECIFICATION

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Owner's Consultants		DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI
Contractor	SEPCO	SEPCO Electric Power Construction Corporation, China

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SCHEDULE II

TECHNICAL SPECIFICATION

VOLUME # 6

(OTHER ENCLOSURES)

Project	6 x 600 MW THERMAL POWER PLANT PROJECT AT NARIYARA, CHATTISGARH, INDIA	
Owner	KSK Power from knowledge	**Wardha Power Company Private Limited, India**
Owner's Consultants		**DEVELOPMENT CONSULTANTS PVT. LTD. MUMBAI**
E P C Contractor	SEPCO	**SEPCO Electric Power Construction Corporation, China**

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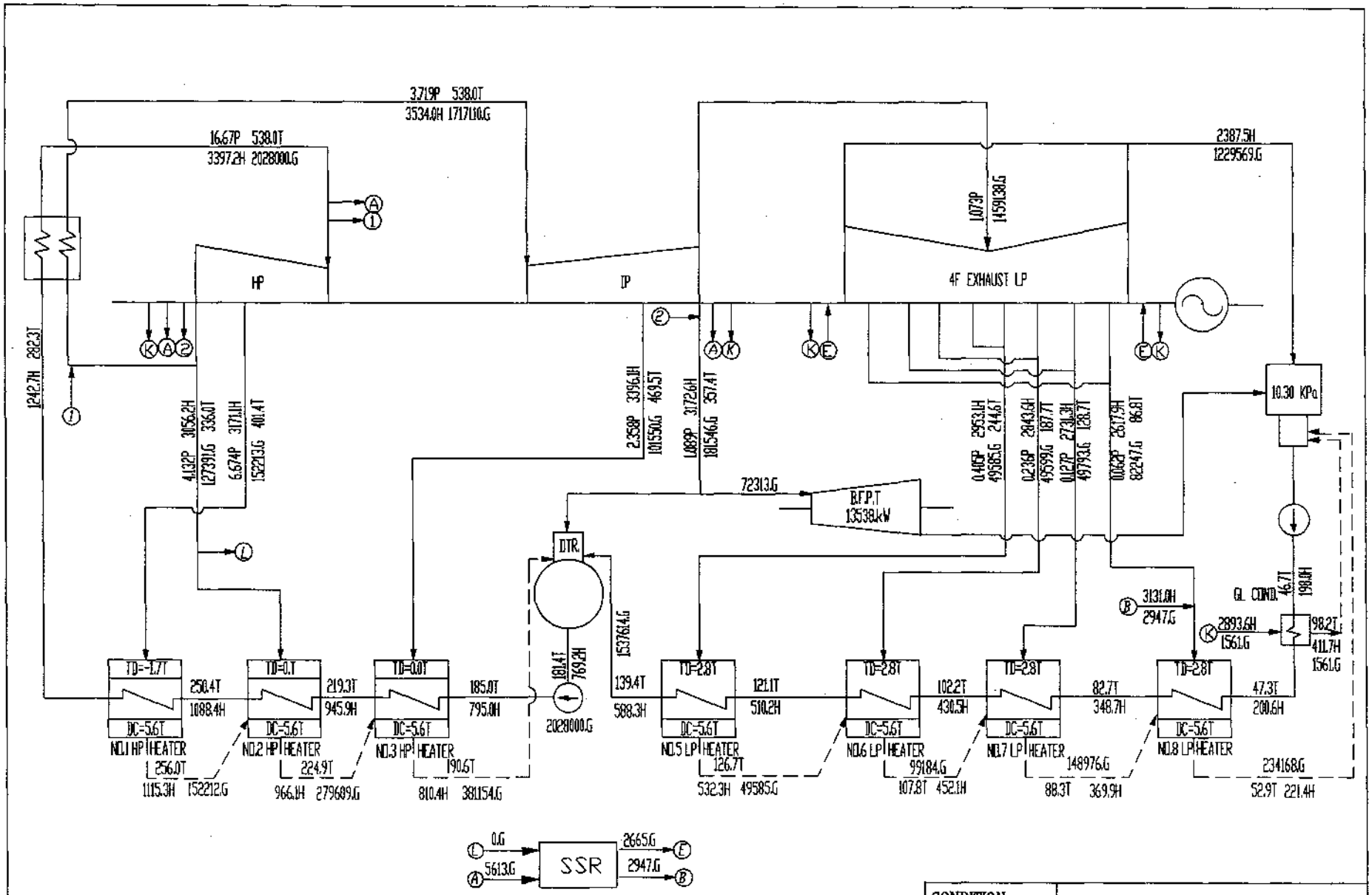
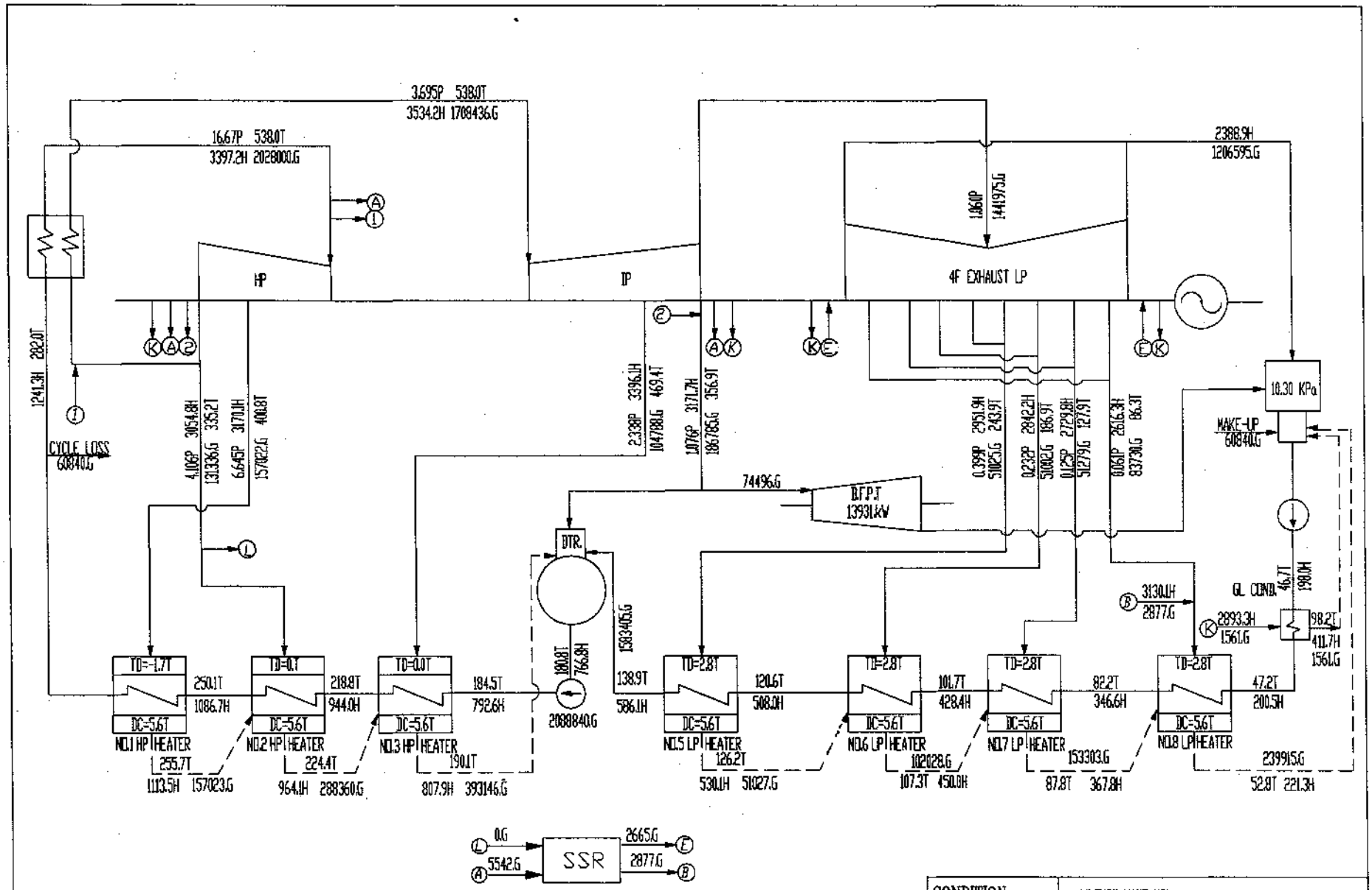


FLOW	G	kg/h
PRESSURE	P	MPa
TEMPERATURE	T	'c
ENTHALPY	H	kJ/kg

CONDITION	V W O		
LOAD	637516. kW	STEAM RATE	3.181 kg/kW.h
HEAT RATE	8141. kJ/kW.h	S.N.	
THROTTLE FLOW	2028000. kg/h		



FLOW	G	kg/h
PRESSURE	P	MPa
TEMPERATURE	T	℃
ENTHALPY	H	kJ/kg

CONDITION	VWO(3% MAKE UP)		
LOAD	632743. kW	STEAM RATE	3.205 kg/kW.h
HEAT RATE	8098. kJ/kW.h	S.N.	
THROTTLE FLOW	2028000. kg/h		

Wardha Power Company Private Limited, Hyderabad
(6x 600 MW Power Project)

Minutes of Meeting Between WPCPL and SEPCO dated 25-03-09

Following were present

WPCPL	SEPCO
Mr. G. P. Rao	Mr. Zhang Jianping General Manager – Procurement and
Mr. S.S. Lakshmanan	Logistics
Mr. Ajay Kumar Jajoo	Mr. Wang Hai Feng

Following points are discussed and decided

1. WPCPL requested SEPCO to submit detailed procedure for the following before signing the contract but SEPCO agreed to submit the same within TWO (2) months time from the date of signing the contract. These procedures (Sr. No. a to e) should be better/improved than the procedure submitted by SEPCO during this meeting.

   Further SEPCO shall address in Procedures regarding the issues related to what kind of storage, protection and preservation will be ensured if material is lying at port for longer time. How they will avoid mixing of WPCPL material with other company's material. The Lorry Receipt (LR) prepared for transportation of material from port to site must contain the exact description of material what is mentioned in corresponding packing List.

   a. **Material Identification Procedure**: which includes methodology of identification, stenciling Part Number on each component, Case No./ Bundle No., etc, writing details on Case / Bundle, etc.

   b. **Packing Procedure** : It should cover Different type of packing, methodology for deciding which type of packing to be used for each category of material, markings on the packing, where the packing list will be kept/pasted and properly secured, etc. What are all the details that will be covered in Subvendor's Purchase Orders

   c. **Procedure for pre-dispatch Inspection being carried out by SEPCO at Manufacturer's workshops / factories.**

   d. **Procedure for Unloading at Site, Storage, Preservation, Protection at site.** : This shall include which items will be kept under covered storage, how to preserve the material kept in open area from Rain, dust, heat, etc. How the storage yard will be prepared? System of traceability of material, etc.

2. One set of complete dispatch documents (sample) to be shown, discussed and Finalised in consultation with WPCPL team.Following are the requirements with respect the material dispatch to WPCPL site:

   a. Format of all the dispatch documents must be discussed before effecting first shipment.

   b. Invoice should be prepared Unit wise. (If a shipment contains material for various units, the invoice should be prepared unit wise)

   c. The packing list should be prepared as General (Master) Packing List and Detailed Packing List .

   d. In addition to all other documents, All packing lists must be accompanied with dispatch documents sent for any purpose (Payment or information)

   e. All dispatch documents should be properly linked with each other by writing B/L No. on all the documents. While preparing B/L, it must be ensured that the General (Master) Packing List No is mentioned. SEPCO informed that this is not their normal practice. However, SEPCO agreed to check up with the Shipping Company and revert back within two months time from the date of contract signing.

   f. Page No. and total No. of pages should be written on each page even it is a single page document.

   g. All "Bill of Entry" in Original shall be submitted to WPCPL immediately after the shipment is cleared by the Customs House at Indian Port.

   h. After every shipment, updated Billing Schedule / Adjusted Billing Schedule must be sent as a soft copy before the physical copy of Dispatch Documents reach to Hyderabad office.

2. Quantity and Packing Inspection will be carried out by WPCPL or Agency appointed by WPCPL at WPCPL discretion.

3. SEPCO and WPCPL shall jointly finalize the CHA for handling of material at Indian Port and transportation of Material to site.

4. Each Unit wise and for every equipment package or system (for ex. Boiler, Turbine, BFP, etc.) total material shall be distributed in to few categories. BOQ (Bill of Quantity) for each such category shall be furnished to WPCPL 15 days before dispatching the first item of such category.

5. English Version Copy of Standard being followed by SEPCO for Export Job packing should be submitted by SEPCOI within 60 days of contract finalisation.

6. Organisation Chart of Purchase Department and Quality Department should be submitted to WPCPL for their reference. Name, position, Responsibility and Contact details should be clearly mentioned in the chart.

7. Storage facilities at site (As agreed) shall be made ready at site 15 days before receipt of the material at site. Otherwise material shall not be received inside the site except the construction equipment / machinery and material required for creating storage facility.

WPCPL	**SEPCO**
Ajay Kumar Tajoo	

WPCPL – 3600 MW, Chhattisgarh, India

VENDOR LIST

Bidder to confirm following points with respect to vendor selection/finalization.

1. All the vendors offered in the bid shall be manufacturer of equipments of proven design of similar size and model which shall be in satisfactory operation in at least two installations under similar operating conditions at PLF of 89% and above for a period not less than two (2) years as on the date of submission of the bid. Bidder to produce certificate for the same.
2. Vendors for all the six units for a particular item shall be same (except for Civil works). For Ex. If Vendor 'A', 'B' & 'C' is approved under Vendor list. Then, six boilers in any ratio can not be split between three vendors. All the boilers shall be provided from either Vendor 'A', Vendor 'B' or Vendor 'C'. This limitation will be applicable to all the items even for small items for which vendors are not mentioned under this list.
3. Further, Boilers, Turbines & Generators shall be from same manufacturer.
4. Bidder to provide credentials* of the manufacturer for owner's approval, guarantees and erection tie-up for the following equipment/works before finalization of order.
   - Boiler Package
   - TG Package
   - ESP (+ Fabric Filter)
   - Coal Handling Plant
   - Ash Handling Package
   - Civil work for complete plant
   - Switchyard
   - Electrical Package
   - DCS
   - C&I Package
   - Water treatment package

* – Experience details in respect to the product being supplied
– Quality track record & system
– Export experience

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5. Bidder to submit their Vendor evaluation procedure for all the equipment and works to be carried out under this project. This will be approved from the Owner before placement of order.
6. Bidder to confirm that all the contract along with data sheets of sub-vendors will be sent for approval to the owner before ordering.
7. EPC contract along with necessary details shall be handed over to the sub-vendor before placement of order.
8. Approved Vendor list for complete Instrumentation package is attached herewith. Any Vendor outside this list will not be entertained.
9. Approved Vendors for some of the electrical items are indicated in the following items which shall binding for that particular equipment.
10. Any deviation from approved drawings or vendor shall be taken prior approval. With out drawing approval, equipments shall not be shifted to the site or dispatched. In case, Bidder proceeds with such deviation for ordering, such equipment or vendors will be rejected outright.
11. Regarding the various other sub-vendors which are not covered here under, the list would be submitted within six (6) months of placement of order. These vendors shall be mutually discussed and agreed to.

Minutes of Meeting dated 23-03-2009 Between WPCPL, Hyderabad and SEPCO
For 6 x 600 MW Power Project

Sub : Vendor List

Following were present

WPCPL	SEPCO
Mr. Ajay Kumar Jajoo Mr. Kiran Kumar Panda	Mr. Zhang Jianping General Manager – Procurement and Logistics Mr. Wang Hai Feng

Following points are discussed and decided.

1. Vendor List is finalized for the following equipments and the detailed vendor list is enclosed herewith.
   i. Boiler
   ii. Turbine
   iii. Generator
   iv. LP & HP Heater
   v. Condenser and Deaerator
   vi. Condensate Extraction Pump
   vii. Boiler Feed Pump
   viii. Circulating Water Pump
   ix. Air Compressors
   x. FD, ID and PA Fans
   xi. ESP + FF
   xii. Coal Mill and feeder
   xiii. Generating Transformer, Station Transformer and Unit Aux. Transformer
   xiv. Bus Duct.
   xv. Numerical Relays(400 KV) and control and relay panel.
   xvi. BATTERY
   xvii. CT 400 KV
   xviii. PT 400 KV
   xix. 400kV Circuit Breaker
   xx. 400kV CVT
   xxi. PLCC
2. For Balance Equipment, WPCPL requested SEPCO to keep the best 4-5 vendors in the list and remove all other vendors and submit the same for approval. SEPCO agreed to submit the same after contract finalization within two month time. WPCPL shall complete vendor evaluation within two months after receiving the updated list from SEPCO and inform SEPCO about the results of vendor evaluation.
3. Vendor List total 44 pages is enclosed with this minutes.

WPCPL

Ajay Kumar Jajoo

SEPCO

Zhang Jianping

12. Bidders shall give preference to those parties who have technical collaboration with reputed international manufacturers.
13. Inspection & Testing shall be carried out as per approved Quality Plan. 'Inspection Release Note' issued by owner / owner's representative shall be attached along with dispatch documents required for payment

Item 13: To be finalized with commercial. 2 C
addressed in commercial document payment terms.

Yes – Vendor is acceptable
No – Vendor is not acceptable
-- - Details required

LIST OF VENDORS – MECHANICAL-BTG

SL. NO.	Equipments/ Services	SL. NO.	Sub-Contractors Name	WPCPL Comments	SEPCO Reply
1	Steam Generator (Boiler)		Dongfang Boiler Group Co.,Ltd	Yes	
			Shanghai Electric Power Generation Group	Yes	
			Harbin Boiler Co.,Ltd	yes	
2	Steam Turbine		Dongfang Steam Turbine Works	Yes	
			Shanghai Electric Power Generation Group	Yes	
			Harbin Turbine Co. Ltd	yes	
				No	
3	Generator		Shanghai Electric Power Generation Group	Yes	
			Harbin Eletric Machinery Co,Ltd	Yes	
			Dongfang Eletric Machinery Co,Ltd	yes	
4	HP Heaters / LP Heaters	HP	Shanghai Electric Power Generation Group	Yes	
			Harbin Boiler Co.,Ltd	Yes	
			Dongfang Boiler Group Co.,Ltd	yes	

			Hangzhou Boiler Group Co.,Ltd	--	It is well qualified
			Dalian Hitachi Machinery & Equipment Co.,LTD.	--	It is well qualified
		LP	Shanghai Electric Power Generation Group	Yes	
			Harbin Turbine Co. Ltd	Yes	
			Dongfang Steam Turbine Works	yes	
			Dalian Hitachi Machinery & Equipment Co.,LTD.	--	It is well qualified
5	Condenser / Deaerator	Condenser	Shanghai Electric Power Generation Group	Yes	
			Harbin Turbine Co. Ltd	Yes	
			Dongfang Steam Turbine Works	yes	
			Dalian Hitachi Machinery & Equipment Co.,LTD	--	It is well qualified
			Hangzhou Boiler Group Co.,Ltd	--	It is well qualified
		Deaerator	Shanghai Electric Power Generation Group	Yes	
			Harbin Boiler Co.,Ltd	Yes	
			Dongfang Boiler Group Co.,Ltd	Yes	
			Hangzhou Boiler Group Co.,Ltd	--	It is well qualified
			Dalian Hitachi Machinery & Equipment Co.,LTD	--	It is well qualified
6	a) Condensate Extraction Pumps	Condensate Extraction Pump	KSB Shanghai Pumb CO., Ltd	yes	

		s	Changsha Pumb CO., Ltd	--	
			Ebara Boshan Pumps Co., Ltd	--	It is well qualified
			Shanghai Pump Factory Co,.Ltd	---	Add, It is well qualified
	b) Boiler Feed Pumps	Boiler Feed Pumps	KSB Shanghai Pumb CO., Ltd	Yes	
			Shanghai Power Equipment Manufactur & Repair Co,.Ltd	Yes	SPEM
			hitachi-pump (wuxi)	No	It is well qualified
			Ebara Boshan Pumps Co., Ltd	--	
7	Circulating Water Pumps		KSB Shanghai Pumb CO., Ltd	Yes	
			Changsha Pumb CO., Ltd	--	
			Changsha Tiane Water Pump Co., Ltd.	--	It is well qualified
			Shenyang Blower Group CO.,LTD	No	It is well qualified
			hitachi-pump (wuxi)	No	It is well qualified
			Ebara Boshan Pumps Co., Ltd	--	It is well qualified
			Shanghai Pump Machinery Works	No	It is well qualified
8	General Service Pumps		LATER		
			Changsha Tiane Water Pump Co., Ltd.		Add
			Dalian Shuanglong Pumb Manufachure Co, Ltd		Add
			Ebara Boshan Pumps Co., Ltd		Add
			Jiangsu Huadian Machine Manufacthre Co, Ltd		Add
			Hunan Neptune Pumb Co, Ltd		Add
			Shanghai Pump Manufacture Co, Ltd		Add
			Shanghai KaiQuan Pump Group Co., Ltd		Add

			Shanghai Dongfang Pumb Group		Add
					Add
			Shanghai Shangbeng Pump Co., Ltd		Add
			Shanghai Liancheng (Group) Co., Ltd.		Add
			Only Part Of This Company ,		
9	Air Compressors		Shanghai Ingersoll-Rand Company	Yes	
			Beijing Fusheng Machinery CO,.LTD	--	It is well qualified
			Atlas Copco Group(wuxi)	Yes	
			Shanghai Feihe Industrial Group Co., Ltd	Yes	
			Kunxi Compressor CO,.LTD	No	It is well qualified
			SULLAIR USA		
			Shanghai COMPAIR		
10	FD Fan / ID Fan / PA Fan		Shanghai Blower Works LTD.	Yes	
			Shenyang Blower Group CO.,LTD	Yes	
			Chengdu Power Mechinery Works	--	It is well qualified
			Shaanxi Blower Group CO,.LTD	==	It is well qualified
11	ESP (+ Fabric Filter)		Zhejiang Feida Environmenta Science & Technology CO.,LTD	---	http://www.feida.biz/
			Fujian Lonfking Environment Conservation CO,.LTD	Yes	
			Zhejiang Sunyard Environment Project CO,.LTD	Yes	
			Zhejiang TIANJIE Group		
12	Coal Mills & Feeders	Coal Mills	Northern Heavy Shenyang Heavy Machinery Group Co., Ltd	---	http://www.china-sz.com/web/index.html
			shanghai Heavy Machinery Group Co., Ltd	---	http://www.shmp-sh.com/

			Beijing Electric Equipment Works CO,.LTD	Yes	
			Changchun ~~Electric~~ Generating Equipment CO,.LTD	---	http://www.cncge.com/
		Feeders	Shanghai Power Equipment Research Institute (SPERI),	--	
			Jiangsu Saimo Group CO,.LTD	---	http://www.saimogroup.com/
			Xuzhou Sanyuan Electric M&C Technolocy CO,.LTD	---	http://www.sanyuan-china.com/
			Beijing Electric Equipment Works CO,.LTD	Yes	
			Shenyang Stock Electric Power Equipment CO,.LTD	--	http://www.stock-sy.com/(S(dpdody45zspigg55wossyi55))/index_new.html
13 14 15	Generator Transformer Unit Auxiliary Transformer Station Service Transformer		Baoding Tianwei Baobian Electic CO., Ltd	--	It is well qualified
			Xi'an Xidian Transformer Co.,Ltd	---	It is well qualified
			Tebiandiangong Shengyang Transformer Group Co.,Ltd	No	It is well qualified
			Shandong Power Equipment Works	---	It is well qualified
			TBEA Xinjiang Transformer Factory	Yes	
16	Bus Duct		Jiangsu daqo group Corporation	Yes	
			Beijing Power Equipment Group	--	http://www.bpeg.cn/
			Alfa Standard- Shandong dachi	--	http://www.moderndachi.com.cn/
			Fuxin Enclosed Busbar Co.Ltd	--	http://www.fxfb.com/index.php
				-=-	
17	Switch Gear		Tianshui chancheng	--	http://www.chinatcs.com/
			Beijing Beikai Electric Co.Ltd	--	http://www.bbe.com.cn/
			Shandong taikaipower engineering Co.,Ltd.	--	http://www.taikai.cn/

			Beijing huadong electric Co.,Ltd.	--	http://www.huadongswitc .com/
			Ningbo tianan group	Yes	
			Jiangsu Changjiang Electric Co Ltd.	Yes	
			Shanghai Huatong Switchgear Co Ltd.	Yes	
			Jiangsu nanzi tonghua electrical group	--	http://www.nanzitonghua com/index.asp
			Hyundai heavy industries(china) electric Co.,Ltd.,	--	http://www.hhi-cn.com/
			Shandong huashuo	--	http://www.sdhsdq.com/C hina/index.htm
			Shanghai general guangdian engineering Co.,Ltd.	---	http://www.sva.com.cn/
			Shandong luyitong electric Co.,Ltd.	---	http://www.lyt-electric.cor /
18	Numerical Relays(400 KV) and control and relay panel.	a)	ABB	Yes	
		b)	AREVA	Yes	
		c)	SIEMENS	Yes	
	CONDENSATE POLISHING UNIT (Complete System)		China Huadian Engineering Co., Ltd	----	http://www.chec.com.cn/
			SUZHOU DONGFANG WATER TREATMENT CO.,LTD	----	http://www.szdfscl.com/
			Nanjing ZhongdianHuanbao Entironment Engineering CO,.LTD	----	http://www.njcec.cn/
			Xian Thermal Power Research Institute Co,.ltd	----	http://www.tpri.com.cn/
			Wuhan Kaidi Water Sevice Co,.ltd	----	http://www.china-kaidiws. com/
			Wuxi Huaguang Water Treatment Engineering Co., Ltd	----	http://www.wxhbw.com/
			Shanghai Safbon Water Treatment Engineering Co., Ltd	---	http://www.safbon.com/ho me.asp

			Beijing Zhongdian Jiamei Environment Engineering T Co., Ltd	---	Beijing Zhongdian Jiame Environment Engineering
			China Datang Technologies & Engineering Co., Ltd	---	http://www.cnbidding.com .cn/guanggao/dete.htm
			Xian Chuangyuan Water Treatment Co,.Ltd		Add
			Beijing Zhongdian Hengji Energy & Technology Co.,Ltd.		Add
			Liaoning Yingsheng Industrial CO,.ltd	---	http://www.ysgf.cn/newEb iz1/EbizPortalFG/portal/h ml/index.html
1. 2.	WATER TREATMENT PLANT				Yet to be submitted b SEPCO
		boiler water m Cooli ng water,	Jiaangsu Yangyi Water Treatment Co,.Ltd		
			Guohua EBARA Environment Co,.Ltd		
			Jiangyin Shangshi Environment Engineering Co,.Ltd		
			Liaoyang Fangxin		
			Chengdu Jingquan Technology		
			Jiangsu Luomenyang Environment Engineering		
			Suzhou FEITUO Water Technology		
			Wuxi Power Auxiliary Equipment Works		
			Wuhan Kaidi Water Technology		
			Asia Fangda Water Technology Engineering CO.,LTD.Beijing		
			Nanjing CEC Environmental Protection Co., Ltd		
			Xian Chuangyuan Water Technology co, ltd		
			China Huadian Engineering Co, ltd		

	Wuxi Huanguang Boiler Water Technology Co,.ltd		
	Shanghai Station Auxiliary Machine Co., Ltd.		
	Jiangsu Suqing Water Treatment Engineering Group		
	Qingdao Land Of State power Environment Engineering Co,.ltd		
	BANDAO (kushan) Environment Engineering Co,.ltd		
	Thermal Power Research Institute (TPRI)		
	China Datang Technologies & Engineering Co., Ltd.		
	Liaoning Yingsheng Industrial CO,.ltd		
	Qinghuatongfang Water Engineering Co,.ltd		
	Beijing Zhongdian Jiamei Environment Engineering T Co., Ltd		
raw water treatment, Effluent water treatment	Yixing SIFANG Water Treatment Co,.Ltd		
	Beijing BORIXINGFA Water Engineering & Technology Co,.ltd		
	Chengdu Perewater Technology Co,.Ltd		
	Beijing Guodian Futong Science & Technology Development Co,.ltd		
	Shanghai Safbon Water Treatment Engineering Co., Ltd		
	Jiangsu Bixin Water Treatment Co,ltd		
	Suzhou DONGFANG Water Treatment Co, ltd		
	Nanjing Ease Environment		

			Supply Co,.ltd		
			Nanjing Longyuan Environment (Engineering) Co., Ltd		
			Leeya Water Treatment And Technology Co,.ltd		
			Changchun UP water Engineering Co,.ltd		
			Haerbin Multi-phase Technology Co,.ltd		
			Chengdu Hagongda Environment Engineering Co,.ltd		
			Haerbin Industry University Environment Technology Co,.ltd		
			Shandong Omex Environmental Engineering Co,. Ltd		
			Guangzhou Asian Tec Water Treatment Limited		
			Yixing Huanfa Equipment Manufacturing Company		
			Jinshan environmental-protection Group		
			Sanxingaoke(Beijing) Technology Engineering Co,.ltd		
			Jiangsu SUMEC Complete Equipment & Engineering Co,ltd		
			Lvyuanyongfeng(beijing) Environment Technology Co,.ltd		
			Wuxi Rongda Ambient Technology Co,.ltd		
			Yixing Runyang Water-industries Co., Ltd.		
2. 3.	COAL HANDLING PLANT	d) Crush	Shanxi Power Equipment Works	No	It is well qualified

	a) Crushers	ers crush ers	Shandong Huiying Machinery Plant Co,.ltd	--	http://huiyingjx.my.sme.c /index.jsp
	b) Screens		Shenyang Electric Power Machinery Genral Factory	--	http://www.sepm.com.cn/
	c) Vibro Feeders		Mudanjiang Beifang Power Equipment Co,.ltd	--	http://www.chmbd.com/
			Shenyang Huaneng Electric Power Machinery Genral Factory	--	
		Vibro Feed ers	Shanxi Power Equipment Works		http://www.shxepc.com/
			Jiangsu Saimo group	--	http://www.saimogroup.c m/
			Xuzhou Sanyuan Electic M £ C Technology Co,.ltd	--	http://www.sanyuan-china .com/
			Xinxiang Weiyuan Machinery CO,.LTD	--	http://www.zgmk.com.cn/ ompany/12/about.asp?id= 640
			Haerbin Hetai Electicr Equipment CO,.LTD	--	http://www.hetaiec.com/
			Wuhan Xinhuayuan Electicr Equipment CO,.LTD	--	http://www.whxhy.com/
			Shanxi Pulande Technology Co,.ltd	--	http://www.pldpld.com/
			Henan Winner Vibrating Equipment Co., Ltd		
			Jilin Shuanglong Power Station Equipment Co,.ltd	No	It is well qualified
		Scree ns	Henan Winner Vibrating Equipment Co., Ltd	--	http://www.weimeng.com. cn/
			Xinxiang Gaofu Sievine Machine CO,.LTD	--	http://www.gfzds.com/
			Xinxiang Weiyuan Machinery CO,.LTD	--	http://www.zgmk.com.cn/ ompany/12/about.asp?id= 640
			Shanxi Power Equipment Works		
			Shenyang Eletric Power Machinery Genral Factory		
			Mudanjiang Beifang Power Equipment Co, ltd		

			Mudanjiang Longjiang Power Equipment Co,.ltd		
			Mudanjiang Hengtian Generating Equipment Plant		
3. 6.	ASH HANDLING PLANT		Clyde Bergemann Materials Handing CO,.LTD, Shanghai	--	http://www.cbh.net.cn/
			Shanghai SINOFINN Electric Company	Yes	
			Alstom Sizhou Electric Power Equipment (Qingdao) Co., Ltd.	--	http://sizhou.cepee.com/
			Zhejiang Feida Environmenta Science & Technology CO.,LTD	yes	
			Fujian Lonfking Environment Conservation CO,.LTD		
			Zhenjiang Pnuplan Pneumatic Co.Ltd		
	High Concentration Slurry Disposal Pump		GEHO, Netherland		
4. 7.	Fuel OIL HANDLING PLANT				Clarify the scope
5. 8.	MILL REJECT HANDLING		Wuxi Huayuan Power Plant CO,.LTD		
			Jiangsu Haifeng Electric Eqipment Co,.Ltd		
			Zhejian Electric Eqipment Co,.Ltd		
			Qingdao Sizhou Boiler Eqipment CO,.LTD		
			Beiiing Guodian Futong Science and Technology Development Co.Ltd. is		
			Zhejiang Huaguang Electric Equipment Co,.Ltd		
			Shanghai SINOFINN Electic Engineering CO,.LTD		
6. 9.	VERTICAL TURBINE				Clarify the scope

	PUMPS				
7. 10.	HORIZONTAL CENTRIFUGAL PUMPS		~~LATER~~		
			Shanghai KSB	Yes	
			Changsha Water Pump	Yes	
			Shanghai Power Equipment Manufacture and repair Co	Yes	
			Changsha Tiane Water Pump Co., Ltd.		add
			Shenyang Blower Group CO.,LTD	No	add
			Dalian Shuanglong Pumb Manufachure Co,.Ltd		add
			Shandong BOSHAN Pump Science And Technology CO,.LTD		add
			Jiangsu Huadian Machine Manufacthre Co,.Ltd		add
			Hunan Neptune Pumb Co,.Ltd		add
			Shanghai Pump Manufacture Co,.Ltd		add
			Shanghai KaiQuan Pump Group Co., Ltd		add
			Shanghai Dongfang Pumb Group		add
			Shanghai Hualian Pump Co., Ltd	No	add
			Shanghai Shangbeng Pump Co., Ltd		add
			Shanghai Liancheng (Group) Co., Ltd.		add
8. 11.	METERING/ DOSING PUMPS				
			Milton Roy	yes	
			PULSAFEEDER		add
			BENXI LAUREL		http://www.bxlaurel.com/index.html
9. 12.	SUMP PUMPS		Shanghai KSB		Add

			Changsha Water Pump		Add
			Shanghai Power Equipment Manufacture and repair Co		Add
			Changsha Tiane Water Pump Co., Ltd.		Add
			Shenyang Blower Group CO.,LTD		Add
			Dalian Shuanglong Pumb Manufachure Co,.Ltd		Add
			Shandong BOSHAN Pump Science And Technology CO,.LTD		Add
			Jiangsu Huadian Machine Manufacthre Co,.Ltd		Add
			Hunan Neptune Pumb Co,.Ltd		Add
			Shanghai Pump Manufacture Co,.Ltd		Add
			Shanghai KaiQuan Pump Group Co., Ltd		Add
			Shanghai Dongfang Pumb Group		Add
			Shanghai Shangbeng Pump Co., Ltd		Add
			Shanghai Liancheng (Group) Co., Ltd.		Add
10.	13.	FUEL OIL PUMPS	Sichuan Zigong Shengda CO,.LTD	Yes	
			Sichuan Fine Purication Equipment CO,.LTD	Yes	
			Beijing Haishengda Pump CO,.LTD	Yes	
			Zigong Dongfang Strainer Mahine Manufacture CO,.LTD	Yes	
			Tianjin Pump Machinery Group	Yes	
			Dalian Deep Blue Pump Co,.Ltd		add
			Shenyang Factory Pump		Add
11.	14.	AIR BLOWER (LOBE TYPE)	Shandong Zhangqiu Blower Co., Ltd		
			Changsha Blower Co., Ltd		

			Zhenjiang Power Station Auxiliaiy Machinery Plant		
			Tianjin Blower Co., Ltd		
			B-Tohin(Jiangsu) Machine Co., Ltd.		
12. 15.	Carbon Steel PIPES - ERW				
13. 16.	Carbon Steel / Alloy Steel PIPES - SEAMLESS				
14. 17.	CAST IRON PIPES		qualified Vendors with good reputation		
15. 18.	CS PIPES (SPIRAL WELDED/ LONGITUDINAL WELDED)				
16. 19.	BUTTERFLY VALVES (MANUAL/PNEUMATIC)		Jinan Jinzhao Valve Shandong Huanqiu Valve Suzhou High & Medium Pressure Valve Factory Shandong Gaoneng Valve Shanghai High Valve Shanghai Power Station Valve		
17. 20.	DIAPHRAGM VALVES (MANUAL/ PNEUMATIC)		Shandong zhengguan Valve、 Henan Kaifeng Hp Valve Jinan Yidu Valve Xiamen Freet SAMSHIN MOON VALVE YANTAI CO.,LTD		
18. 21.	PLUG VALVE		Dalian Xingfeng Haizhou Equipment		

			Tianjin Jingtong Control Instroment Technologiies CO,.LTD		
19. 22.	CAST IRON GATE / GLOBE / CHECK VALVE		Shanghai General Vacuum Valve Equipment Co,.Ltd'Na.5 Valve Factory Shanghai No.2 Valve CO,.LTD (jinzhou), Shanghai Dacheng Instrument Factory Zhejiang Sanfang Group Shanghai yongsheng Instrument Co,Ltd Beijing Chenyuan Chuangxin		
20. 23.	CAST STEEL VALVES		ANDAC Engineering Co,.Ltd Shandong Sanneng Shandong Electric Power International Corporation Shandong Finehope South Valve Manufacturing Co,.Ltd Nengfa Weiye Tieling Valve Joint-Stock Co. Ltd		
21. 24.	FORGED STEEL VALVE (UPTO 50NB SIZE)		Watts Valve(Changsha) Co. Ltd Nantong High and Medium Pressure Valve Factory Zhejiang High and Medium Pressure Valve Factory Shanghai Valve Factory Co.Ltd		
22. 5.	BALL VALVES		Dresser Crosby Fisher/Copes-Vulcan/Valtek Sempell/Volk/Velan/KSB/HV Parker/Marwin/Swagelok And other qualified vendors with good reputaion		
23.	RO SYSYTEM				
	a) RO Membrane		BANDAO Environment Engineering Co,.ltd		
	b) UF Membrane		OMEX Environment Engineering CO,.LTD		

			Membrance Equipment (beijing) ,Ltd Nanjing CEC Environmental Protection Co., Ltd China Huadian Engineering Group Beijing Guodian Futong Science & Technology Development Co,.ltd		
	c) HP Pumps		HP Pumps : only Grundfoss		
24. 26.	WASTE WATER TREATMENT PLANT		Refer to 18. 1.2		
25. 27.	FLANGES & FITTINGS		qualified Vendors with good reputation		
26. 28.	GUN METAL /BRASS / BRONZE VALVE		Refer to 12.15		
27. 29.	SAFETY RELIEF VALVE		Dresser Crosby And other qualified Vendors with good reputation		
28. e	STRAINERS		Zigong Vacuum Strainer Equipment CO,.ltd Zigong Chuanlv Mahine Manufacture CO,.LTD Zigong Dongfang Strainer Mahine Manufacture CO,.LTD Qingdao Huatai Electric Equipment Co.,Ltd Sichuan Fine Purication Equipment CO,.LTD		
29. 29.	AIR DRYING UNIT(Refrigerant Type)		Hangzhou Shanli Purify Co,.Ltd Jialong Air equipments limited company		

			Hangzhou Chaolu Purification Equipment Co., Ltd		
			Wuxi Pneumatech Air/Gas Purity Equipment Co,.Ltd		
			Xian UnionFilter Co,.Ltd		
			Wuxi Shengda Air/Gas Purity Equipment Co,.Ltd		
30. 30.	ELEVATOR		Shanghai Xunda elevator co,.ltd	Yes	
			Xizi otis elevator co,.ltd	Yes	
			Changzhou Elevator Factory Co., Ltd.	Yes	
			Shanghai Building Equipment Co.,Ltd.	Yes	
			Hitachi Elevator (China) Co.,Ltd.	Yes	
			Shanghai Mitsubishi Elevator Co.,Ltd.	Yes	
31A.	EOT CAN E (More than 100 Ton)		Shandong Finehope Group CO,,LTD		
31B.	EOT CRANE (Less than 100 T)		Nanjing Hoisting Machinery General works co.,Ltd Hubei Yinlun Puqi Machine Co., Ltd. Zibo Shengjian Group Shandong Huatong Machinery Co,.Ltd Shandong Tianli Hoisting Machinery Co,.Ltd Henan Weihua Group Xinxiang Hoisting Transport Machinery Co,.Ltd Xinxiang Mining Hoisting Machinery Co,.LTD Jiangxi Hoisting Machinery Co,.LTD		
32	MANUAL HOIST & CHAIN PULLEY BLOCK				
33	ELECTRICAL HOIST				

34	PAINTS		qualified Vendors with good reputation		
35	GEAR BOX		qualified Vendors with good reputation		
36	PRESSURE REDUCING VALVE		Refer to 12.15		
37	OIL / STEAM HOSES		qualified Vendors with good reputation		
38	FLAME ARRESTER		qualified Vendors with good reputation		
39	STEAM TRAP		qualified Vendors with good reputation		
40	FLUID COUPLING (SCOOP TYPE)	a)	VOITH, Germany		
			EBARA		add
			SPEM		add
			Shanghai Jiaotong University		
			Dalian Fluid Couplings Machinery Factory		
41	FLUID COUPLING (TRACTION TYPE)		qualified Vendors with good reputation		
42	FLEXIBLE COUPLING		qualified Vendors with good reputation		
43	INSULATION		LLOYD INSULATIONS		

			(INDIA) LTD		
			DAMODHARTECH INTERNATIONAL PVT.LTD		
			KURUP ENGINEERING COMPANY PVT.LTD		
46	HYDRAULIC ACTUATOR / CYLINDER		Refer to CONTROL & INSTRUMENTATION		
45	PNEUMATIC ACTUATOR / CYLINDER		Refer to CONTROL & INSTRUMENTATION		
46	POWER PACK				Clarify the scope
47	**FIRE FIGHTING EQUIPMENT**		**- complete system from TYCO/ Vijay Fire/ Tecnofab / Newfire / Techno Fire**		
A	PUMPS		Mather & Platt		
			Kirloskar Brothers Limited		
			Worthington Pumps India Limited		
			Flowmore		
B	HIGH VELOCITY NOZZLES				Owner recommend
C	MEDIUM VELOCITY NOZZLES				Owner recommend
D	DELUGE VALVE		Shah Bhogilal		
			Technico(I) Pvt Ltd		
			HD FIRE		

			KIDDE		
			FIRETECH		
E	FIRE HOSE		NEWAGE		
			CHHATARIYA RUBBER & CHEMICAL INDUSTRIES		
			EVERSAFE		
F	DETECTORS (IONISATION)		Kiddie		
			Tyco		
G	DETECTOR PHOTO ELECTRIC				Owner recommend
H	HEAT DETECTOR (Fire Sensor)		SIEMENS		
I.	WATER MONITORS		SHAH BOGILAL		
			H.D. FIRE.		
			NEW AGE		
J.	BRANCH PIPES & NOZZLES		SUKAN		
			SHAH BHOGILAL		
			WINCO		
			VENUS		

K.	FIRE FIGHTING SYSTEM		Mather & Platt		
			Kirloskar Brothers Limited		
			Worthington Pumps India Limited		
			Flowmore		
			Mather & Platt		
L.	L.D. PIPING				Owner recommend
48	**COAL HANDLING EQUIPMENT**				
A	STACKER RECLAIMER		Shangshai Heavy Machinery Manufacturing Co,.Ltd	Yes	
			Haerbin Zhongxin Heavy Machinery Manufacturing Co,.Ltd		
			DHI·DCW Group Co., Ltd.	Yes	
			Changchun Generating Equipment Co,.Ltd		
			Shanghai Electric Power Environmental Equipment Works co., Ltd (SEPEE)		
B	INTEGRAL WEIGH BRIDGE		Jinan Jinzhong		
			Changzhou TOLEDO		
			Gansu Tianshui TOLEDO		
C	APRON FEEDER		Shandong Shankuang Machinery CO, LTD		
			Tangshan Mining & Metallurgical Machinery Plant		
			Northern Heavy Shenyang Mining Machinery Group Co.,Ltd		

			Hengyang Conveying Machinery CO,.LTD		
			Shanghai Mining & Metallurgical Machinery Plant		
D	IMPACTOR / CRUSHER				
			Shanxi Electric Equipment Works		
			Shenyang Electric Power Machinery Genral Factory		
			Mudanjiang Beifang Electric EquipmentCo,.Ltd		
			Shenyang Huaneng Electric Power Machinery Genral Factory		
E	MAGNETIC SEPARATOR		Fushun Longji Electiromagnetic Separators Factory CO,.LTD		
			Shandong Huate Electiromagnetic Separators Factory CO,.LTD		
			Zhenjiang Electiromagnetic Separators Factory CO,.LTD		
			Zhenjiang Jiangnan Electromechanical Mining Equipment Co., Ltd		
			Zhenjiang Hongxing Magnetic Plant CO,.LTD		
F	ELECTRIC BELT WEIGHER		Xuzhou Sanyuan Electric M& C Technology CO,.LTD		
			Zhejiang Hangzhou Drilling Machine Manufactory CO,.LTD		
			Beijing TONYTECH Science CO,.LTD		
			Jiangsu Saimo Group		
			Jinan Jinzhong Electronic Scale Co., Ltd.		
G	CONVEYOR BELT (Fire resistant)		Shandong Shankuang Machinery CO,.LTD		
			Tangshan Mining & Metallurgical Machinery Plant	Yes	

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			Northern Heavy Shenyang Mining Machinery Group Co.,Ltd	Yes	
			Hengyang Conveying Machinery CO,.LTD	Yes	
H	IDLERS				
			Ningbo Henghui Machinery Manufacturing Co,.Ltd		
			Mudanjiang Hengtian Generating Equipment Plant		
			Xiangshan Fangzheng Machinery Co,.Ltd		
			Ningbo Tansuo Machinery Manufacturing Co,.Ltd		
			Ningbo Huadian Coal Handing Equipment Manufacturing Co,.Ltd		
I	PULLEYS		Match With Body Equipment		
J	WOBBLER FEEDER		NA		
K	PADDLE FEEDER				
			Shenyang Electric Power Machinery Genral Factory		
			Mudanjiang Beifang Electric EquipmentCo,.Ltd		
			Hunan Wantong Technology Co,.Ltd		
			Haerbin Hetal Electric Power Equipment Co,.Ltd		
L	FLAP GATE		qualified Vendors with good reputation		
M	a) DUST EXTRACTION SYSTEM b)DUST		Zhangjiagang Changli Machinery Co,.Ltd		
			Zhangjiagang Kedi Machinery Co,.Ltd		
			Zhangjiagang Xinzhong		

	SUPPRESSION SYSTEM		Environment Protecting Co,.Ltd		
			Jiangsu Jiangping Air Conditioning Purification		
			Jiangsu Zhiyu		
			Wuxi Huguang Generating Equipment Co		
			Chengdu Shuangfeng Environment Protection Co		
			Haerbin Environment Protection Hydrogen Manufacting Co		
N	DRY FOG DS SYSTEM		Beijing Longyuandongfang Technology Developing Co,.Ltd		
			Henan Qinyang Keling Environment Protecting Co,.Ltd		
			Nibo Xiangtai Machinery Co,.Ltd		
			Changzhou Sunan Environment Protecting Co,.Ltd		
			Beijing Jianzhao Technology Developing Co,.Ltd		
O	WATER MONITORS		Match With Body Equipment		
P	ULTRASONIC BUNKER LEVEL INDICATOR		Match With Body Equipment		
Q	METAL DETECTOR		Fushun Longji Electiromagnetic Separators Factory CO,.LTD		

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			Shandong Huate Electiromagnetic Separators Factory CO,.LTD		
			Zhenjiang Electiromagnetic Separators Factory CO,.LTD		
			Zhenjiang Jiangnan Electromechanical Mining Equipment Co., Ltd		
			Zhenjiang Hongxing Magnetic Plant CO,.LTD		
R	BELT CLEANER		Match With Body Equipment		
S	HOLD BACK		Match With Body Equipment		
T	BEARINGS		Match With Body Equipment		
U	IMPACT PADS		Match With Body Equipment		
V	HYDRAULIC MOTORS & POWER PACK		Match With Body Equipment		
W	BELT SCRAPERS		Match With Body Equipment		

LIST OF VENDORS – MECHANICAL-BOP

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49	**ASH HANDLING PLANT EQUIPMENT**				
A	CASTABLE REFRACTORY			--	http://www.cbh.net.cn/ http://www.sinofinn.net/
B	POROUS TILES		Clyde Bergmann Huatong Materials Handing Company Limited Shanghai SINOFINN Electic Engineering CO,.LTD Tianjin ASM Machinery Equipment Production CO,.Ltd Alstom Sizhou Power Equipment (qingdao) Co., Ltd. Zhenjiang Pnuplan Pneumatic Co.Ltd		
C	KNIFE GATE VALVES (CHUTE ISOLATION)				
D	KNIFE GATE VALVES (SLURRY DUTY)				
E	PLUG VALVE (SLURRY DUTY) (FULL BORE, REGULAR PATTERN)				
F	CONVEYING COMPRESSOR		Atlas Capco Shanghai Feihe Industrial group Co Ltd	Yes Yes	

			Shandong Zhangqiu Blower Co., Ltd		Add
			Changsha Blower Co., Ltd		Add
G	FLUIDISING BLOWER		Zhenjiang Power Station Auxiliaiy Machinery Plant		Add
			Tianjin Blower Co., Ltd		Add
			B-Tohin Machine Co., Ltd		
H	a) TUBE SETTLER				
	b) PLATE SETTLER		Clyde Bergmann Huatong Materials Handing Company Limited		
I	BASALT LINED FITTING AND PIPING.		Shanghai SINOFINN Electic Engineering CO,.LTD		
	DRC LINING		Tianjin ASM Machinery Equipment Production CO,.Ltd		
			Alstom Sizhou Power Equipment (qingdao) Co., Ltd.		
J	METALLIC EXPANSION BELOWS		Zhenjiang Pnuplan Pneumatic Co.Ltd		
K	SLURRY PUMPS		Beijing Xinhuayuan Machine Manufacturing Co,.Ltd		
			Shijiazhuang Industrial Water Punmp Co,.Ltd		
			Shandong Boshan Slurry Punp Co.,Ltd		
			Hefei Atlas		
			Shijiazhuang Qiangda		
			Zigong Gongyebeng		
			Shanghai Kaiquan		
L	HIGH CONC. SLURRY DISPOSAL PUMPS (Piston Diaphram pumps)	A	GEHO,Netherland		
		B		--	
M	ACI FITTINGS		Zhangjiagang Changli Machinery		

	/CASINGS/LINERS	Co,.Ltd Zhangjiagang Kedi Machinery Co,.Ltd		
N	BAG FILTERS / VENT FILTER	Zhangjiagang Xinzhong Environment Protecting Co,.Ltd Jiangsu Jiangping Air Conditioning Purification Jiangsu zhiyu Wuxi Huguang Generating Equipment Co,.Ltd Chengdu Shuangfeng Environment Protection Co,.Ltd Haerbin Environment Protection Hydrogen Manufacting Co,.Ltd		
O	VACUUM PUMP	Guangdong Foushan Pump Works Hubei TFHI-TECH Pump CO,.LTD Gardner Denver Nash Machine CO,.LTD Tsurumi-Awamura(shanghai)EngineeringCo,.Ltd		http://www.kenflo.com/ http://templet.pinsou.com http://www.gdnash.com.cn/
P	AIR HEATER	Wuxi Taihu Electric Power Complete Plant Co., Ltd. Hankou Generating Equipment Works SPER Wuxi Huatong Generating Equipment Works Haerbin North General MEC And ELE Equipment Engineering Co,.Ltd		
Q	CONVENTIONAL TYPE CLARIFIER	AlstomSizhouElectricPowerEquipment(Qingdao)Co.,Ltd Qingdao Songling Electric Environmental Protection Equipment Co., Ltd. Wuxi Huayuan Power Station Ash Removal Equipment Co., Ltd. Jiangsu Haifeng Generating Machinery Co,.Ltd Qingdao Dishipu Generating Machinery Co,.Ltd Wuxi Huadian Generating Machinery Co,.Ltd		

50	AIR CONDITIONING/ VENTILATION EQUIPMENT			
A.	VENTILATION SYSTEM	Zhejiang Shangfeng Industrial Holdings Co., Ltd	----	http://www.shenling.com/
	(add B, C, D, E rows as was there in earlier Vendor list)	Shandong Shuangyi Group		
		Nantong Jinghai	---	http://www.jiangping.com/
		Jiangsu Zhiyu	---	http://www.yatai.cc/
		Guangdong Shenling Air-Conditiong CO,.LTD	--	http://www.jirong.com/
		Jiangsu Jiangping AC purification equipment Ltd.	--	http://www.dzln.cn/
		Dezhou Yatai Group		
		Guangdong Jirong Air-Conditioning Equipment Co.,LTD	--	http://www.wuzhou-ref.cn/
		Shandong Zhongda Air-Conditioning Equipment Co.,LTD	---	
B	i) REFRIGERATION RECIPROCATING COMPRESSOR	Shanghai King Industry Co., Ltd		
		Nanjing Wuzhou Refrigeration Group Co., Ltd	---	
	ii) VAPOUR ABSORPTION CHILLER		--	http://www.dzfrp.com/
			--	http://www.kwell.com.cn/
			--	http://www.lianfeng.com/
			---	http://www.seagull-ct.com/

C	CONDENSER & CHILLER		---	

D	COOLING COILS
E	AIR HANDLING UNITS
F	CONDENSER CHILLED WATER PUMPS
G	FRESH AIR BLOWERS / FANS
H	AIR FILTER

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I	COLD INSULATION MATERIAL		
J	FAN COIL UNITS		
K	BEARINGS		
L	V. BELTS & PULLEY		
M	FALSE CEILING MATERIAL		
N	MOTORISED DAMPERS		
O	COOLING TOWERS	Jiangsu Shuangyi Group Changzhou Kwell Cooling Equipment Co., Ltd Zhejiang Lianfeng Stock Co., Ltd Jiangsu Seagull Cooling Tower Co., LTD Zhejiang Shangyu Jintai	
P	FIRE DAMPER	Guangdong Shenling Air-Conditiong CO,.LTD Jiangsu Jiangping AC purification equipment Ltd.	
Q	MIXING VALVES	Dezhou Yatai Group Guangdong Jirong Air-Conditioning Equipment	

			Co.,LTD		
R	MODULATING MOTORS		Shandong Zhongda Air-Conditioning Equipment Co.,LTD Shanghai King Industry Co., Ltd		
S	MODULATING THERMOSTAT		Nanjing Wuzhou Refrigeration Group Co., Ltd		
51	CONDENSER ON-LINE TUBE CLEANING SYSTEM AND DEBRIS FILTER				

LIST OF VENDORS – ELECTRICAL

SL. NO.	ITEMS	VENDORS		WPCPL Comments Yes	SEPCO Reply
1	MOTOR ACTUATORS	a	ROTORK		
		b	AUMA	Yes	
		c	LIMITORQUE	Yes	
			Yangzhou Electric Power Equipment Repair & Manufacture Factory	--	http://www.yepef.com/
			EMG	--	
			SIPOS	--	
			Shanghai Automation Instrumentation Co.Ltd	--	http://www.saic.sh.cn/ziyi/
			Chongqing Chuanyi Instrument Complex Co. Ltd.	--	http://www.sicc.com.cn/
			Yangzhou hengchun	--	http://www.chinahengchun.com/main.asp
			Changzhou power station auxiliary equipment works Ltd.	--	http://www.czcdf.cn/

			Wenzhou ruiji	--	http://www.raga.com.cn/
			Yangzhou Lianggong	--	
			Tianjin Jinda	--	http://www.jdzxq.com/
			Shanghaoi Autork	--	http://www.autork.cc/
2	DRY TYPE TRANSFORMERS		Shandong luneng mount.tai electric equipment CO.,LTD.	--	http://www.ltds.com.cn/
			Jiangsu daqo group Corporation	--	http://www.daqo.com/
			Hainan jinpan electric	--	http://www.jst.com.cn/
			CEEG	--	
			Shandong jinmanke electric	--	http://www.chinajmc.com.cn/
			TBEA tianjinshi transformer group CO.,LTD	yes	
3	OIL FILLED POWER TRANSFORMER		Baoding Tianwei Baobian Electic CO., Ltd	--	http://www.btwgroup.com/
			Xi'an Xidian Transformer Co.,Ltd	yes	
			Tebiandiangong Shengyang Transformer Group Co.,Ltd	--	http://www.tbea.com.cn/
			TBEA Xinjiang Transformer Factory	yes	
			Shandong Power Equipment Works	yes	
4	MOTOR 415 V, , 11 Kv		Shanghai Electric Co.	yes	
			Shenyang Electric Co.		
			Xiangtan Electric Co.		
			Lanzhou Electric Co.		
			佳木斯电机厂		

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5	LT POWER AND CONTROL CABLES		Shandong Yanggu Cable Group		
			Dodge		
			Far East Cable		
			Jiangsu Shangshang Cable		
			Baoji Technology		
			Shandong Luneng Mount Tai Cable		
6	HT POWER CABLE		Shengyang Cable		
			Jiangsu Zhongchao Cable		
			Changzhou Bayi Cable		
			Anhui Xinke Cable		
			Jiangsu Sd-electric		
			Jiangsu Chenyang Cable		
			Shanghai Shenghua Cable		
			Changzhou Shenlan Specail Cable		
			Anhui Cable		
			Wuxi Huan Cable		
			Anhui Jingfeng Cable Group		
			Jiangsu Saite Electric LTD		
			Jiangsu Jingtong Cable		
7	VFD (LT / HT)		ABB	Yes	
			L & T	--	
			Siemens	--	
			Emerson		
			GE		
8	TRANSDUCER		Shenzhen Zhineng		
			Guodian Nanjing Aoutomation Co,.Ltd		
9. a	Isolated Phase Bus Duct		Jiangsui daqo group Corporation	---	http://www.daqo.com/
			Beijing Power Equipment Group	---	http://www.daqo.com/
			Alfa Standard- Shandong dachi	=--	http://www.moderndachi.com.cn/
			Fuxin Enclosed Busbar Co.Ltd	---	http://www.fxfb.com

			Huapeng Group Corp.	---	http://www.huapeng.com/
9. b	LT Bus Duct		Jiangsui daqo group Corporation	Yes	
			Beijing Power Equipment Group	--	http://www.daqo.com/
			Alfa Standard- Shandong dachi	--	http://www.moderndachi.com.cn/
			Fuxin Enclosed Busbar Co.Ltd	--	http://www.fxfb.com
			Huapeng Group Corp.	--	http://www.huapeng.com/
			Tianshui chancheng		
			Beijing Beikai Electric Co.Ltd		
			Shandong taikaipower engineering Co.,Ltd.		
			Beijing huadong electric Co.,Ltd.		
			Ningbo tianan group		
			Jiangsu Changjiang Electric Co Ltd.		
			Shanghai Huatong Switchgear Co Ltd.		
			Jiangsu nanzi tonghua electrical group		
			Hyundai heavy industries(china) electric Co.,Ltd.,		
			Shandong huashuo		
			Shanghai general guangdian engineering Co.,Ltd.		
			Shandong luyitong electric Co.,Ltd.		
10	BATTERY		HBL,EXIDE,. (Indian vendor only)		
11	BATTERY CHARGER		Haerbin jiuzhou electric co.,ltd.		
			Shangong luneng intelligence technology co.,ltd.		
			Guodian Nanjing automatism company limited; Co. Ltd.		
			Xj international engineering corporation		
	PROTECTION		ABB	Yes	

12	RELAYS FOR SWITCHGEAR		ALSTOM	Yes	
			AREVA	Yes	
			SIEMENS	Yes	
			Dongda jinzhi	--	http://www.wiscom.com.cn/
			Nanjing nanri-relays engineering technology CO.,LTD.	--	http://www.nari-relays.com/
			Sifang electric(group)CO.,LTD.		
			Guodian Nanjing automatism company limited; Co. Ltd.	--	http://www.sac-china.com/
			GE		
13	THERMAL O/L RELAYS		Match with body Equipment	--	
14	a) TARIFF METER	a	Securemeter, India	--	
	b) INDICATING METER	b	Enercon, India	--	
			Automatic Electric India	--	
15	CT 400 KV		ABB, China	--	
			Siemens, China	--	
			Areva, China	--	
16	PT 400 KV		ABB, China	--	
			Siemens, China	--	
			Areva, China	--	
17	POWER SWITCH		Match with body Equipment		
18	SELECTOR SWITCH		Salezer, India	--	Match with body Equipment
			Match with body Equipment		

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19	TIMERS		Match with body Equipment		
20	FUSES		Match with body Equipment		
21	MCCB		ABB		
			SCHNEIDER		
			Changshu Switchgear MFG Co,.Ltd		
			Shanghai people electric		
			CHINT		
22	MCB		ABB		
			SCHNEIDER		
			BEIJING PEOPLE		
			Changshu Switchgear MFG Co,.Ltd		
			Shanghai people electric		
			CHINT		
23	NUMERIC RELAY FOR LT SWTICHGEAR		LATER		
24	NUMERIC RELAY FOR 11 kv		LATER		
25	LIGHTING FIXTURES		Bajaj, SIEMENS, philips		
26	DIESEL GENERATOR		Cummins	---	
			Stanford	---	
			Perkins	---	
			Volvo	---	
			DEUTZ	--	
			VERYPOWER	--	
			KOHLER	--	

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27	LT PCC & MCC		Beijing Beikai Electric Co.Ltd	--	http://www.bbe.com.cn/
			Shandong taikaipower engineering Co.,Ltd.	--	http://www.taikai.cn/
			Beijing huadong electric Co.,Ltd.	--	http://www.huadongswitch.com
			Ningbo tianan group	Yes	
			Jiangsu Changjiang Electric Co. Ltd	Yes	
			Shanghai HuatongSwitchgear Co Ltd.	--	http://www.shhtkgcyxgs.com.cn/
			Jiangsu nanzi tonghua electrical group	--	http://www.shhtkgcyxgs.com.cn/
			Hyundai heavy industries(china) electric Co.,Ltd.	--	http://www.hhi-cn.com/
			Shandong huashuo	--	
			Shanghai general guangdian engineering Co.,Ltd.	--	http://www.sva.com.cn/
			Shanghai power transmission&distribution CO.,LTD.	--	
			Shandong luyitong electric Co.,Ltd.	--	http://www.lyt-electric.com/
28	UPS system		Acpower	--	
			Cnc group	--	
			Gutor	--	
			LDC power	--	
			Emerson	--	
			PCM	--	
29	400kV Circuit Breaker		ABB	---	
			AREVA	--	
			SIEMENS	--	
				--	http://www.skdianqi.com/cn/
				--	http://www.pinggao.com/

				yes	
30	400kV Disconnecting Switch		New Northeast Electric(Shenyang)High voltage Switchgear Co.,Ltd.		
			Henan pinggao electric sales ltd.		
			Shandong taikai electric group		
			Xian xd high voltage apparatus CO.,LTD.		
31	400kV Current Transformer		LATER Refer Sr. No. 15		
32	400kV Voltage Transformer		LATER Refer Sr. No. 16		
33	400kV Insulator		Dalian Insulatou Co., Ltd. Xian high voltage porcelain insulator Co,.Ltd Suzhou Porcelain Insulator Works Co.,Ltd(SPIW) Shandong Porcelain Insulator Co,.Ltd Inner Mongolia Jingcheng High Voltage Insulator Co., Ltd Hunan Liling Huoju Insulatoe Co,.Ltd Fushun Porcelain Insulato Manufacting Co,.Ltd Zibo Taiguang Electrical Equipment Factory		
35	400kV Lightning Arrester		Xian xd Lightning Arrester CO.,LTD.		
			Fushun electric porlelain manufacturing CO.,LTD.		
			Nanyang Jinguan Electric Co., Ltd.		
40	400kV CVT		ABB	--	

			Siemens Areva		
41	Switchyard SCADA		Dongda jinzhi		
			Nanjing nanri-relays engineering technology CO.,LTD.		
			Zhuhai tuopu		
			Nanjing zhongde		
			Guodian Nanjing automatism company limited; Co. Ltd.		
42	PLCC		ABB Model ETL 41 0r 42	--	Match with body Equipment
43	400kV Wave Trap		Jiangsu hiteker company Jiangsu himark tech.co.,ltd.		

LIST OF VENDORS – CONTROL & INSTRUMENTATION

Sr. No.	Item		Sub-vendor		
1.	DCS		ABB(china), WESTINGHOUSE(china), FOXBORO(china) Siemens Toshiba GE	Yes Yes Yes No No NO	It is well qualified It is well qualified It is well qualified
2.	PLC		ALLEN BRADLEY, SIEMENS, SCHNEIDER, MODICON		
3.	Pressure/DP transmitter		ROSEMOUNT, HONEYWELL, ABB, YOKOGAWA,siemens		
4.	Level transmitter		E & H, SOR, MOBREY, MAGNETROL Rosemount, EJA , Yokogowa , Honeywell, Shanghai Automation Instrumentation Co Ltd		

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5.	Temperature/pressure gauge		WIKA, GLUCK, BOURDAN, ASHCROFT/CHINESE MAKE,ASHCROFT Shanghai Automation Instrumentation Co.Ltd Chongqing Chuanyi Instrument Complex Co. Ltd. Toshiba xingyi control system(xi`an) Co. Ltd.		
6.	Temperature element		DEGUSSA, OMEGA/CHINESE MAKE Shanghai Automation Instrumentation Co.Ltd Chongqing Chuanyi Instrument Complex Co. Ltd. Anhui Tiankang Group Co.Ltd Toshiba xingyi control system(xi`an) Co. Ltd. Jiangsu hongguang instrument factory		
7.	DP/Flow/Level switch		MAGNETROL, E & H, SOR, UE		
8.	Temperature/Pressure switch		SOR, UE,Georgin,Danfoss ASHCROFT, INVENSYS,SIEMENS		
9.	Control valve		A)FISHER, MASONEILAN,COPES-VULCAN, ,CCI,HOPKINSON B) Non-Critical applications: CHINESE MAKE(OWNER APPROVAL IS REQUIRED)		
10.	Solenoid valve		ASCO, HERION , SMC Rexroth , Herion		
11.	Mass flowmeter		ROSEMOUNT, E & H, KROHNE, YOKOGAWA		
12.	Magnetic/Vortex flowmeter		ROSEMOUNT, E & H, KROHNE, YOKOGAWA		
13.	Tank gauging		E&H,SAAB,ENRAF/CHINESE MAKE SIAC, E&H, Emersion		

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			Shanghai Automation Instrumentation Co.Ltd Chongqing Chuanyi Instrument Complex Co. Ltd. Toshiba xingyi control system(xi`an) Co. Ltd.		
14.	Analyzer		Ametek, Rosemount, Polymetron, Landy,E+H		
15.	Electric actuator		ROTORK		
			AUMA		
			LIMITORQUE		
			HARTRMANN&BRAUN, Germany		
16.	EWLI		Hydrastep,Keystone, Yarway Changchun Boiler Instrument Co.Ltd Tieling tieguang instrument limitde liability Co.Ltd Tieling instrument work		
17.	CEMS		AMETEK H&B, SICK,ABB,DURAG		
18.	TSI -Vibration monitoring & Analysis		BENTLEY NEVADA, BNC-3500 & SYSTEM-1		
19.	EPABX / PA system		Siemens, Gytronics		
20.	SWAS		POLYMETRON, EMERSON		
21.	Flow Nozzle / Orifice / Aerofoil		Shanghai Automation Instrumentation Co.Ltd Chongqing Chuanyi Instrument Complex Co. Ltd. Toshiba xingyi control system(xi`an) Co. Ltd.		
22.	Anubar / Pitot tube		Shanghai Automation Instrumentation Co.Ltd Chongqing Chuanyi Instrument Complex Co. Ltd. Toshiba xingyi control system(xi`an) Co. Ltd.		
23.	CC TV		Shanghai Automation Instrumentation Co.Ltd Chongqing Chuanyi Instrument		

			Complex Co. Ltd. Toshiba xingyi control system(xi`an) Co. Ltd.		
24.	Turbine Bypass System		CCI,BTG		
25.	PRDS		CCI, BTG		
26.	Gravimetric Feeders		Later		
27.	Panels / Cabinets		Rittal		Match With Body Equipment
28.	Ambient Environment Monitoring System		Chemetrol, Emerson, Forbes – Marshall		
29	AVR		ABB		

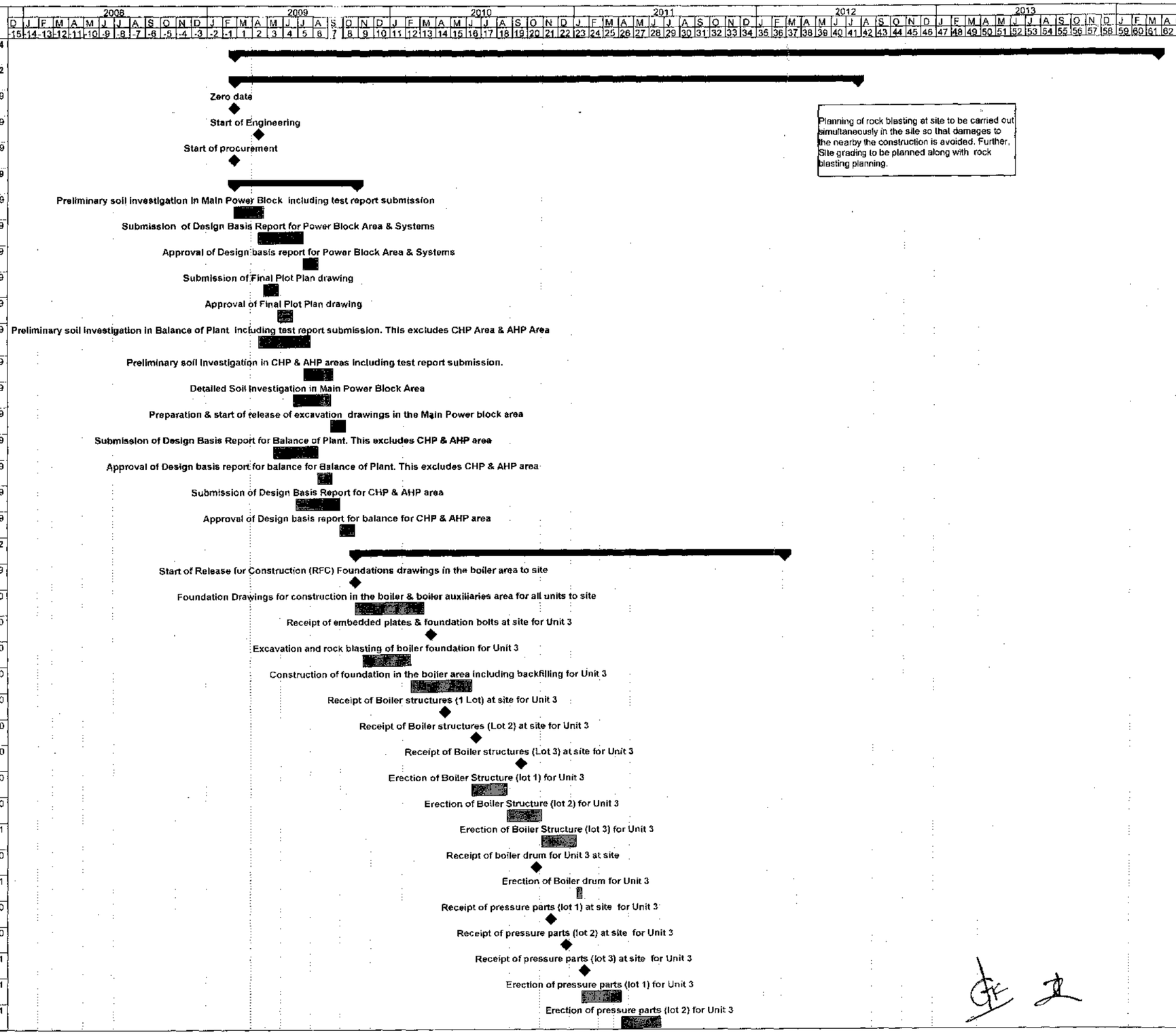
ANNEXURE-1

WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1	**WPCPL 3600 MW coal based power project**	**1854 d**	**Thu 2/26/09**	**Tue 3/25/14**
2	**Schedule for unit 3**	**1246 d**	**Thu 2/26/09**	**Wed 7/25/12**
3	Zero date	0 d	Thu 2/26/09	Thu 2/26/09
4	Start of Engineering	0 d	Wed 4/15/09	Wed 4/15/09
5	Start of procurement	0 d	Thu 2/26/09	Thu 2/26/09
6	**Soil Investigation in Main Power Block & Balance Of Power Plant**	**247 d**	**Thu 2/26/09**	**Fri 10/30/09**
7	Preliminary soil investigation in Main Power Block including test report submission	60 d	Thu 2/26/09	Sun 4/26/09
8	Submission of Design Basis Report for Power Block Area & Systems	91 d	Thu 4/16/09	Wed 7/15/09
9	Approval of Design basis report for Power Block Area & Systems	31 d	Thu 7/16/09	Sat 8/15/09
10	Submission of Final Plot Plan drawing	30 d	Mon 4/27/09	Tue 5/26/09
11	Approval of Final Plot Plan drawing	30 d	Wed 5/27/09	Thu 6/25/09
12	Preliminary soil investigation in Balance of Plant including test report submission. This excludes CHP Area & AHP Area	105 d	Sat 4/18/09	Fri 7/31/09
13	Preliminary soil investigation in CHP & AHP areas including test report submission.	60 d	Sat 7/18/09	Tue 9/15/09
14	Detailed Soil Investigation in Main Power Block Area	77 d	Fri 6/26/09	Thu 9/10/09
15	Preparation & start of release of excavation drawings in the Main Power block area	30 d	Fri 9/11/09	Sat 10/10/09
16	Submission of Design Basis Report for Balance of Plant. This excludes CHP & AHP area	90 d	Mon 5/18/09	Sat 8/15/09
17	Approval of Design basis report for balance for Balance of Plant. This excludes CHP & AHP area	30 d	Sun 8/16/09	Mon 9/14/09
18	Submission of Design Basis Report for CHP & AHP area	90 d	Fri 7/3/09	Wed 9/30/09
19	Approval of Design basis report for balance for CHP & AHP area	30 d	Thu 10/1/09	Fri 10/30/09
20	**Boiler & Boiler Auxiliaries for Unit 3**	**855 d**	**Sat 10/31/09**	**Sun 3/4/12**
21	Start of Release for Construction (RFC) Foundations drawings in the boiler area to site	0 d	Sat 10/31/09	Sat 10/31/09
22	Foundation Drawings for construction in the boiler & boiler auxiliaries area for all units to site	135 d	Sun 11/1/09	Mon 3/15/10
23	Receipt of embedded plates & foundation bolts at site for Unit 3	0 d	Sun 3/28/10	Sun 3/28/10
24	Excavation and rock blasting of boiler foundation for Unit 3	94 d	Mon 11/16/09	Wed 2/17/10
25	Construction of foundation in the boiler area including backfilling for Unit 3	120 d	Thu 2/18/10	Thu 6/17/10
26	Receipt of Boiler structures (1 Lot) at site for Unit 3	0 d	Sun 4/25/10	Sun 4/25/10
27	Receipt of Boiler structures (Lot 2) at site for Unit 3	0 d	Fri 6/25/10	Fri 6/25/10
28	Receipt of Boiler structures (Lot 3) at site for Unit 3	0 d	Thu 9/23/10	Thu 9/23/10
29	Erection of Boiler Structure (lot 1) for Unit 3	70 d	Fri 6/18/10	Thu 8/26/10
30	Erection of Boiler Structure (lot 2) for Unit 3	70 d	Fri 8/27/10	Thu 11/4/10
31	Erection of Boiler Structure (lot 3) for Unit 3	70 d	Fri 11/5/10	Thu 1/13/11
32	Receipt of boiler drum for Unit 3 at site	0 d	Mon 10/25/10	Mon 10/25/10
33	Erection of Boiler drum for Unit 3	10 d	Sun 1/16/11	Tue 1/25/11
34	Receipt of pressure parts (lot 1) at site for Unit 3	0 d	Wed 11/24/10	Wed 11/24/10
35	Receipt of pressure parts (lot 2) at site for Unit 3	0 d	Sat 12/25/10	Sat 12/25/10
36	Receipt of pressure parts (lot 3) at site for Unit 3	0 d	Mon 1/31/11	Mon 1/31/11
37	Erection of pressure parts (lot 1) for Unit 3	80 d	Wed 1/26/11	Fri 4/15/11
38	Erection of pressure parts (lot 2) for Unit 3	80 d	Sat 4/16/11	Mon 7/4/11

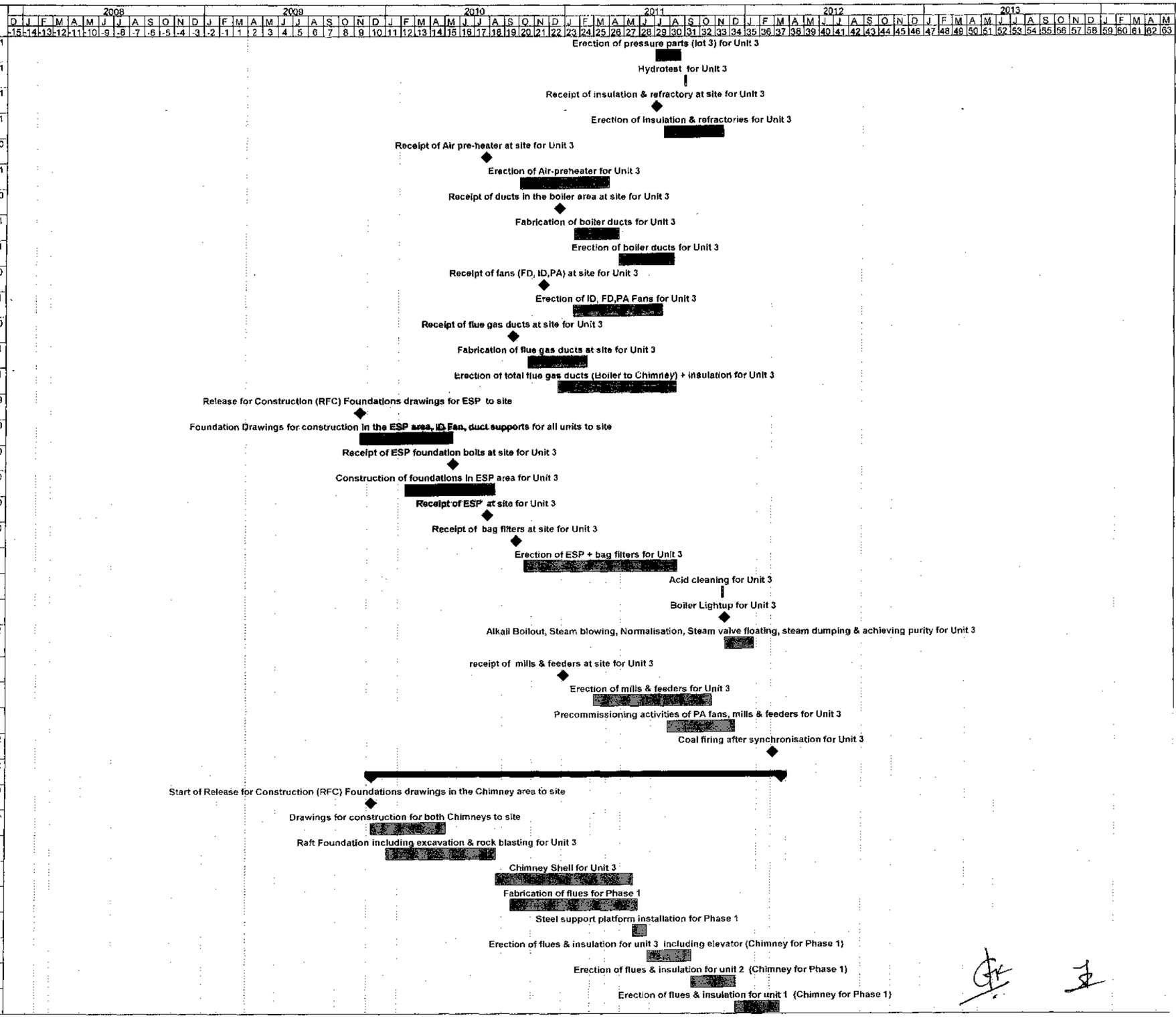


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
39	Erection of pressure parts (lot 3) for Unit 3	50 d	Tue 7/5/11	Tue 8/23/11
40	Hydrotest for Unit 3	4 d	Fri 9/2/11	Mon 9/5/11
41	Receipt of insulation & refractory at site for Unit 3	0 d	Wed 7/6/11	Wed 7/6/11
42	Erection of insulation & refractories for Unit 3	122 d	Fri 7/22/11	Sun 11/20/11
43	Receipt of Air pre-heater at site for Unit 3	0 d	Tue 7/27/10	Tue 7/27/10
44	Erection of Air-preheater for Unit 3	180 d	Wed 10/6/10	Sun 4/3/11
45	Receipt of ducts in the boiler area at site for Unit 3	0 d	Sat 12/25/10	Sat 12/25/10
46	Fabrication of boiler ducts for Unit 3	90 d	Tue 1/25/11	Sun 4/24/11
47	Erection of boiler ducts for Unit 3	112 d	Mon 4/25/11	Sun 8/14/11
48	Receipt of fans (FD, ID,PA) at site for Unit 3	0 d	Wed 11/24/10	Wed 11/24/10
49	Erection of ID, FD,PA Fans for Unit 3	180 d	Mon 1/24/11	Fri 7/22/11
50	Receipt of flue gas ducts at site for Unit 3	0 d	Thu 9/23/10	Thu 9/23/10
51	Fabrication of flue gas ducts at site for Unit 3	120 d	Sun 10/24/10	Sun 2/20/11
52	Erection of total flue gas ducts (Boiler to Chimney) + insulation for Unit 3	240 d	Thu 12/23/10	Fri 8/19/11
53	Release for Construction (RFC) Foundations drawings for ESP to site	0 d	Mon 11/16/09	Mon 11/16/09
54	Foundation Drawings for construction in the ESP area, ID Fan, duct supports for all units to site	186 d	Tue 11/17/09	Fri 5/21/10
55	Receipt of ESP foundation bolts at site for Unit 3	0 d	Sat 5/22/10	Sat 5/22/10
56	Construction of foundations in ESP area for Unit 3	184 d	Mon 2/15/10	Tue 8/17/10
57	Receipt of ESP at site for Unit 3	0 d	Sun 8/1/10	Sun 8/1/10
58	Receipt of bag filters at site for Unit 3	0 d	Thu 9/30/10	Thu 9/30/10
59	Erection of ESP + bag filters for Unit 3	310 d	Sun 10/17/10	Mon 8/22/11
60	Acid cleaning for Unit 3	5 d	Mon 11/21/11	Fri 11/25/11
61	Boiler Lightup for Unit 3	0 d	Sun 11/27/11	Sun 11/27/11
62	Alkali Boilout, Steam blowing, Normalisation, Steam valve floating, steam dumping & achieving purity for Unit 3	60 d	Mon 11/28/11	Thu 1/26/12
63	receipt of mills & feeders at site for Unit 3	0 d	Tue 1/4/11	Tue 1/4/11
64	Erection of mills & feeders for Unit 3	240 d	Sun 3/6/11	Mon 10/31/11
65	Precommissioning activities of PA fans, mills & feeders for Unit 3	138 d	Wed 8/3/11	Sun 12/18/11
66	Coal firing after synchronisation for Unit 3	0 d	Sun 3/4/12	Sun 3/4/12
67	**Chnimney for Phase 1**	833 d	Wed 12/9/09	Wed 3/21/12
68	Start of Release for Construction (RFC) Foundations drawings in the Chimney area to site	0 d	Wed 12/9/09	Wed 12/9/09
69	Drawings for construction for both Chimneys to site	150 d	Thu 12/10/09	Sat 5/8/10
70	Raft Foundation including excavation & rock blasting for Unit 3	223 d	Sat 1/9/10	Thu 8/19/10
71	Chimney Shell for Unit 3	280 d	Fri 8/20/10	Thu 5/26/11
72	Fabrication of flues for Phase 1	260 d	Sun 9/19/10	Sun 6/5/11
73	Steel support platform installation for Phase 1	30 d	Fri 5/27/11	Sat 6/25/11
74	Erection of flues & insulation for unit 3 including elevator (Chimney for Phase 1)	90 d	Sun 6/26/11	Fri 9/23/11
75	Erection of flues & insulation for unit 2 (Chimney for Phase 1)	90 d	Sat 9/24/11	Thu 12/22/11
76	Erection of flues & insulation for unit 1 (Chimney for Phase 1)	90 d	Fri 12/23/11	Wed 3/21/12

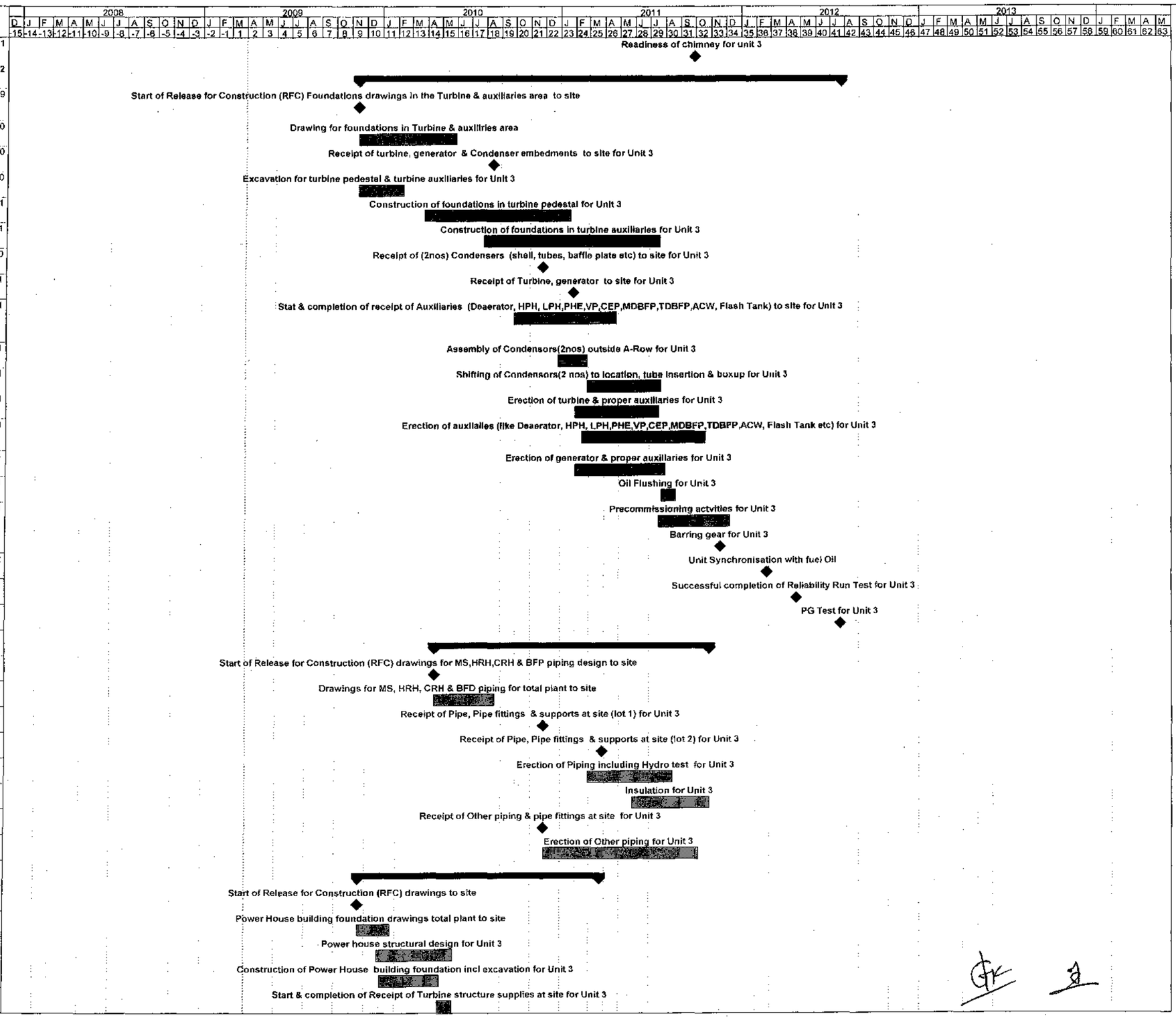


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
77	Readiness of chimney for unit 3	0 d	Thu 9/29/11	Thu 9/29/11
78	**Turbine (unit 3)**	**983 d**	**Sun 11/15/09**	**Wed 7/25/12**
79	Start of Release for Construction (RFC) Foundations drawings in the Turbine & auxiliaries area to site	0 d	Sun 11/15/09	Sun 11/15/09
80	Drawing for foundations in Turbine & auxilries area	196 d	Mon 11/16/09	Sun 5/30/10
81	Receipt of turbine, generator & Condenser embedments to site for Unit 3	0 d	Sun 8/15/10	Sun 8/15/10
82	Excavation for turbine pedestal & turbine auxillaries for Unit 3	90 d	Mon 11/16/09	Sat 2/13/10
83	Construction of foundations in turbine pedestal for Unit 3	300 d	Sun 3/28/10	Fri 1/21/11
84	Construction of foundations in turbine auxiliaries for Unit 3	360 d	Wed 7/28/10	Fri 7/22/11
85	Receipt of (2nos) Condensers (shell, tubes, baffle plate etc) to site for Unit 3	0 d	Sat 11/27/10	Sat 11/27/10
86	Receipt of Turbine, generator to site for Unit 3	0 d	Fri 1/28/11	Fri 1/28/11
87	Stat & completion of receipt of Auxiliaries (Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank) to site for Unit 3	210 d	Wed 9/29/10	Tue 4/26/11
88	Assembly of Condensors(2nos) outside A-Row for Unit 3	60 d	Tue 12/28/10	Fri 2/25/11
89	Shifting of Condensors(2 nos) to location, tube insertion & boxup for Unit 3	150 d	Sat 2/26/11	Mon 7/25/11
90	Erection of turbine & proper auxillaries for Unit 3	170 d	Tue 2/1/11	Wed 7/20/11
91	Erection of auxliaries (like Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank etc) for Unit 3	250 d	Mon 2/14/11	Fri 10/21/11
92	Erection of generator & proper auxillaries for Unit 3	183 d	Tue 2/1/11	Tue 8/2/11
93	Oil Flushing for Unit 3	30 d	Tue 7/26/11	Wed 8/24/11
94	Precommissioning actvities for Unit 3	144 d	Thu 7/21/11	Sun 12/11/11
95	Barring gear for Unit 3	0 d	Tue 11/22/11	Tue 11/22/11
96	Unit Synchronisation with fuel Oil	0 d	Sat 2/25/12	Sat 2/25/12
97	Successful completion of Reliability Run Test for Unit 3	0 d	Wed 4/25/12	Wed 4/25/12
98	PG Test for Unit 3	0 d	Wed 7/25/12	Wed 7/25/12
99	**Power Cycle Piping (unit 3)**	**560 d**	**Sun 4/18/10**	**Sun 10/30/11**
100	Start of Release for Construction (RFC) drawings for MS,HRH,CRH & BFP piping design to site	0 d	Sun 4/18/10	Sun 4/18/10
101	Drawings for MS, HRH, CRH & BFD piping for total plant to site	123 d	Mon 4/19/10	Thu 8/19/10
102	Receipt of Pipe, Pipe fittings & supports at site (lot 1) for Unit 3	0 d	Sat 11/27/10	Sat 11/27/10
103	Receipt of Pipe, Pipe fittings & supports at site (lot 2) for Unit 3	0 d	Sun 3/27/11	Sun 3/27/11
104	Erection of Piping including Hydro test for Unit 3	172 d	Sat 2/26/11	Tue 8/16/11
105	Insulation for Unit 3	155 d	Sun 5/29/11	Sun 10/30/11
106	Receipt of Other piping & pipe fittings at site for Unit 3	0 d	Sat 11/27/10	Sat 11/27/10
107	Erection of Other piping for Unit 3	315 d	Sun 11/28/10	Sat 10/8/11
108	**Power House building for unit 3**	**490 d**	**Tue 11/17/09**	**Tue 3/22/11**
109	Start of Release for Construction (RFC) drawings to site	0 d	Tue 11/17/09	Tue 11/17/09
110	Power House building foundation drawings total plant to site	65 d	Wed 11/18/09	Thu 1/21/10
111	Power house structural design for Unit 3	152 d	Sun 12/27/09	Thu 5/27/10
112	Construction of Power House building foundation incl excavation for Unit 3	120 d	Fri 1/1/10	Fri 4/30/10
113	Start & completion of Receipt of Turbine structure supplies at site for Unit 3	30 d	Tue 4/27/10	Wed 5/26/10

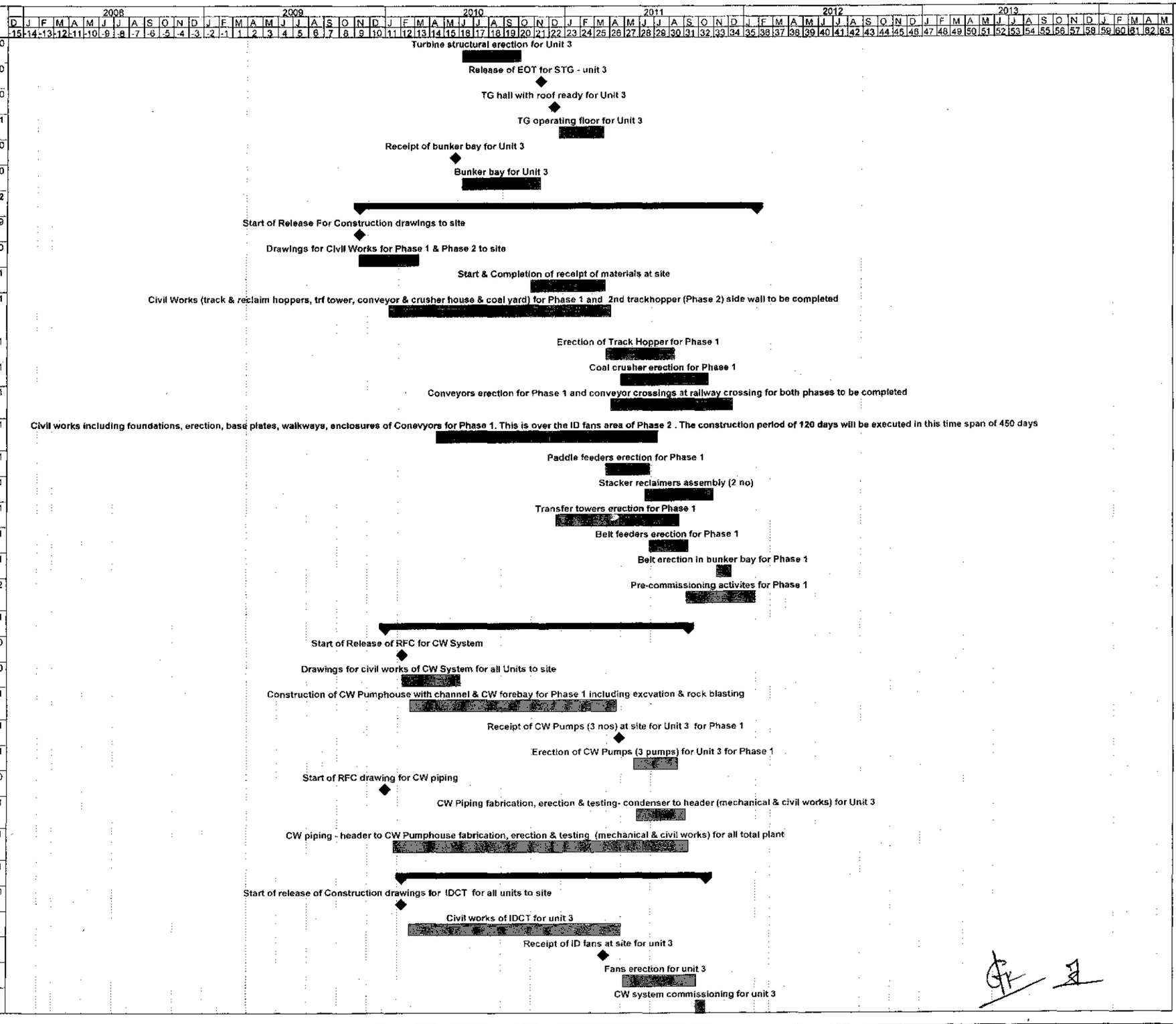


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
114	Turbine structural erection for Unit 3	120 d	Thu 6/10/10	Thu 10/7/10
115	Release of EOT for STG - unit 3	0 d	Tue 11/16/10	Tue 11/16/10
116	TG hall with roof ready for Unit 3	0 d	Mon 12/13/10	Mon 12/13/10
117	TG operating floor for Unit 3	90 d	Thu 12/23/10	Tue 3/22/11
118	Receipt of bunker bay for Unit 3	0 d	Wed 5/26/10	Wed 5/26/10
119	Bunker bay for Unit 3	160 d	Thu 6/10/10	Tue 11/16/10
120	**Coal Handling for Phase 1**	**808 d**	**Fri 11/13/09**	**Mon 1/30/12**
121	Start of Release For Construction drawings to site	0 d	Fri 11/13/09	Fri 11/13/09
122	Drawings for Civil Works for Phase 1 & Phase 2 to site	120 d	Sat 11/14/09	Sat 3/13/10
123	Start & Completion of receipt of materials at site	150 d	Fri 10/29/10	Sun 3/27/11
124	Civil Works (track & reclaim hoppers, trf tower, conveyor & crusher house & coal yard) for Phase 1 and 2nd trackhopper (Phase 2) side wall to be completed	450 d	Wed 1/13/10	Thu 4/7/11
125	Erection of Track Hopper for Phase 1	140 d	Wed 3/30/11	Tue 8/16/11
126	Coal crusher erection for Phase 1	180 d	Fri 4/29/11	Tue 10/25/11
127	Conveyors erection for Phase 1 and conveyor crossings at railway crossing for both phases to be completed	250 d	Fri 4/8/11	Tue 12/13/11
128	Civil works including foundations, erection, base plates, walkways, enclosures of Conevyors for Phase 1. This is over the ID fans area of Phase 2 .	450 d	Mon 4/19/10	Tue 7/12/11
129	Paddle feeders erection for Phase 1	90 d	Wed 3/30/11	Mon 6/27/11
130	Stacker reclaimers assembly (2 no)	140 d	Sat 6/18/11	Fri 11/4/11
131	Transfer towers erection for Phase 1	250 d	Mon 12/20/10	Fri 8/26/11
132	Belt feeders erection for Phase 1	80 d	Tue 6/28/11	Thu 9/15/11
133	Belt erection in bunker bay for Phase 1	30 d	Sun 11/13/11	Mon 12/12/11
134	Pre-commissioning activites for Phase 1	141 d	Mon 9/12/11	Mon 1/30/12
135	**CW system for Unit 3**	**617 d**	**Wed 1/6/10**	**Thu 9/15/11**
136	Start of Release of RFC for CW System	0 d	Tue 2/9/10	Tue 2/9/10
137	Drawings for civil works of CW System for all Units to site	120 d	Wed 2/10/10	Wed 6/9/10
138	Construction of CW Pumphouse with channel & CW forebay for Phase 1 including excvation & rock blasting	420 d	Thu 2/25/10	Wed 4/20/11
139	Receipt of CW Pumps (3 nos) at site for Unit 3 for Phase 1	0 d	Tue 4/26/11	Tue 4/26/11
140	Erection of CW Pumps (3 pumps) for Unit 3 for Phase 1	90 d	Fri 5/27/11	Wed 8/24/11
141	Start of RFC drawing for CW piping	0 d	Wed 1/6/10	Wed 1/6/10
142	CW Piping fabrication, erection & testing- condenser to header (mechanical & civil works) for Unit 3	100 d	Thu 6/2/11	Fri 9/9/11
143	CW piping - header to CW Pumphouse fabrication, erection & testing (mechanical & civil works) for all total plant	600 d	Sun 1/24/10	Thu 9/15/11
144	**IDCT Construction for unit 3**	**620 d**	**Tue 2/9/10**	**Sat 10/22/11**
145	Start of release of Construction drawings for IDCT for all units to site	0 d	Tue 2/9/10	Tue 2/9/10
146	Civil works of IDCT for unit 3	430 d	Thu 2/25/10	Sat 4/30/11
147	Receipt of ID fans at site for unit 3	0 d	Sun 3/27/11	Sun 3/27/11
148	Fans erection for unit 3	150 d	Fri 5/6/11	Sun 10/2/11
149	CW system commissioning for unit 3	20 d	Mon 10/3/11	Sat 10/22/11

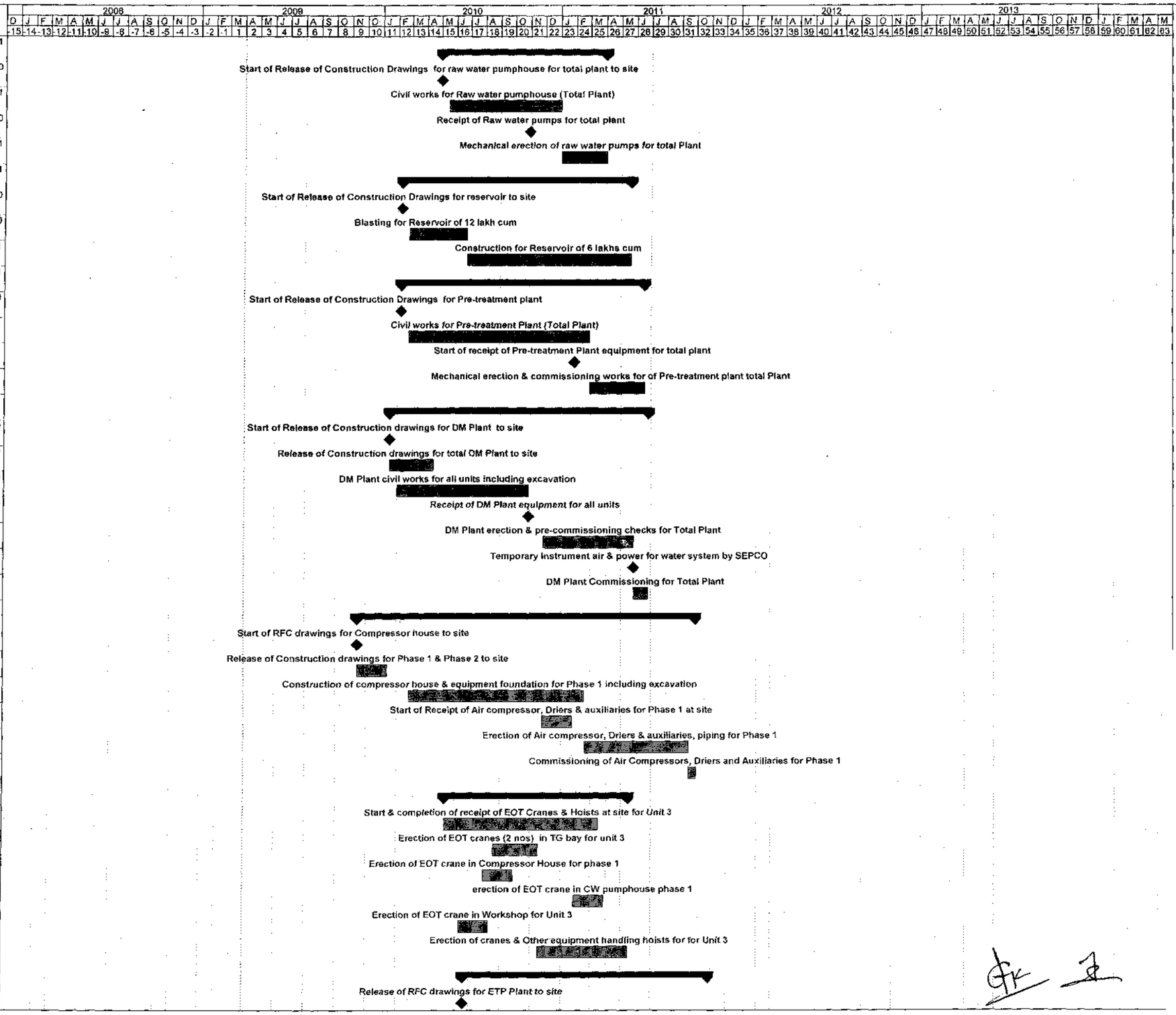


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
150	**Raw water system for total plant**	**335 d**	**Sat 5/1/10**	**Fri 4/1/11**
151	Start of Release of Construction Drawings for raw water pumphouse for total plant to site	0 d	Sat 5/1/10	Sat 5/1/10
152	Civil works for Raw water pumphouse (Total Plant)	230 d	Mon 5/17/10	Sat 1/1/11
153	Receipt of Raw water pumps for total plant	0 d	Sat 10/30/10	Sat 10/30/10
154	Mechanical erection of raw water pumps for total Plant	90 d	Sun 1/2/11	Fri 4/1/11
155	**Raw Water Reservoir**	**485 d**	**Tue 2/9/10**	**Fri 5/20/11**
156	Start of Release of Construction Drawings for reservoir to site	0 d	Tue 2/9/10	Tue 2/9/10
157	Blasting for Reservoir of 12 lakh cum	120 d	Thu 2/25/10	Thu 6/24/10
158	Construction for Reservoir of 6 lakhs cum	330 d	Fri 6/25/10	Fri 5/20/11
159	**Pre-treatment Plant for total plant**	**494 d**	**Mon 2/8/10**	**Fri 6/17/11**
160	Start of Release of Construction Drawings for Pre-treatment plant	0 d	Mon 2/8/10	Mon 2/8/10
161	Civil works for Pre-treatment Plant (Total Plant)	369 d	Wed 2/24/10	Sun 2/27/11
162	Start of receipt of Pre-treatment Plant equipment for total plant	0 d	Fri 1/28/11	Fri 1/28/11
163	Mechanical erection & commissioning works for of Pre-treatment plant total Plant	110 d	Mon 2/28/11	Fri 6/17/11
164	**DM Plant for Total Plant**	**525 d**	**Sat 1/16/10**	**Sat 6/25/11**
165	Start of Release of Construction drawings for DM Plant to site	0 d	Sat 1/16/10	Sat 1/16/10
166	Release of Construction drawings for total DM Plant to site	90 d	Sun 1/17/10	Fri 4/16/10
167	DM Plant civil works for all units including excavation	270 d	Mon 2/1/10	Thu 10/28/10
168	Receipt of DM Plant equipment for all units	0 d	Thu 10/28/10	Thu 10/28/10
169	DM Plant erection & pre-commissioning checks for Total Plant	180 d	Sun 11/28/10	Thu 5/26/11
170	Temporary Instrument air & power for water system by SEPCO	0 d	Thu 5/26/11	Thu 5/26/11
171	DM Plant Commissioning for Total Plant	30 d	Fri 5/27/11	Sat 6/25/11
172	**Air Compressors, Driers and Auxiliaries for Phase 1**	**686 d**	**Fri 11/13/09**	**Fri 9/30/11**
173	Start of RFC drawings for Compressor house to site	0 d	Fri 11/13/09	Fri 11/13/09
174	Release of Construction drawings for Phase 1 & Phase 2 to site	60 d	Sat 11/14/09	Tue 1/12/10
175	Construction of compressor house & equipment foundation for Phase 1 including excavation	355 d	Sat 2/27/10	Wed 2/16/11
176	Start of Receipt of Air compressor, Driers & auxiliaries for Phase 1 at site	60 d	Thu 11/25/10	Sun 1/23/11
177	Erection of Air compressor, Driers & auxiliaries, piping for Phase 1	210 d	Fri 2/18/11	Thu 9/15/11
178	Commissioning of Air Compressors, Driers and Auxiliaries for Phase 1	15 d	Fri 9/16/11	Fri 9/30/11
179	**Cranes & Hoists for Unit 3**	**370 d**	**Tue 5/11/10**	**Sun 5/15/11**
180	Start & completion of receipt of EOT Cranes & Hoists at site for Unit 3	310 d	Tue 5/11/10	Wed 3/16/11
181	Erection of EOT cranes (2 nos) in TG bay for unit 3	90 d	Thu 8/19/10	Tue 11/16/10
182	Erection of EOT crane in Compressor House for phase 1	60 d	Fri 7/30/10	Mon 9/27/10
183	erection of EOT crane in CW pumphouse phase 1	60 d	Thu 1/27/11	Sun 3/27/11
184	Erection of EOT crane in Workshop for Unit 3	60 d	Fri 6/11/10	Mon 8/9/10
185	Erection of cranes & Other equipment handling hoists for for Unit 3	180 d	Wed 11/17/10	Sun 5/15/11
186	**Effluent Treatment Plant for total plant**	**495 d**	**Fri 6/18/10**	**Wed 10/26/11**
187	Release of RFC drawings for ETP Plant to site	0 d	Fri 6/18/10	Fri 6/18/10



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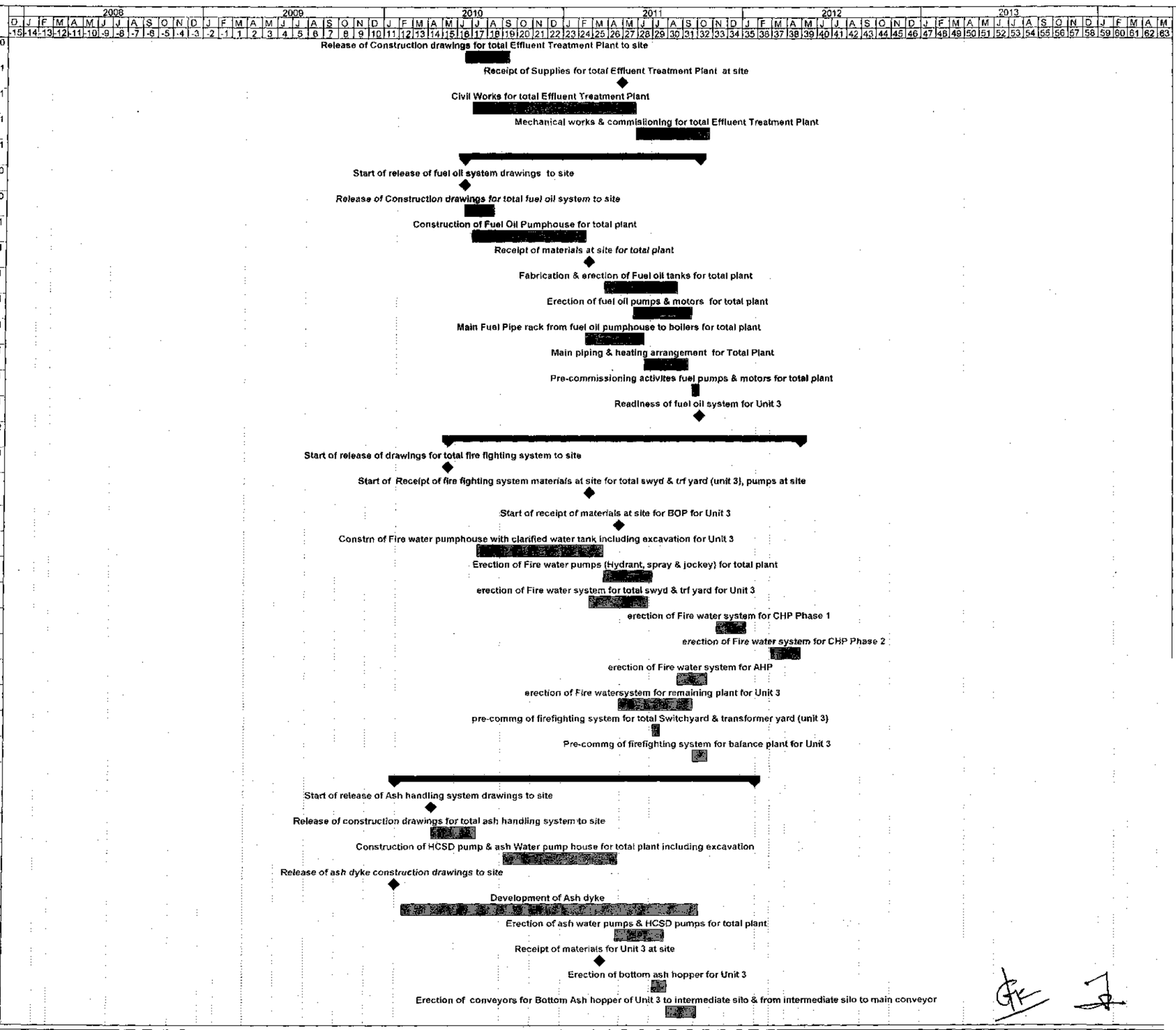
L1 SCHEDULE

ID	Task description	Duration	Start	Finished
188	Release of Construction drawings for total Effluent Treatment Plant to site	90 d	Sat 6/19/10	Thu 9/16/10
189	Receipt of Supplies for total Effluent Treatment Plant at site	0 d	Sat 4/30/11	Sat 4/30/11
190	Civil Works for total Effluent Treatment Plant	330 d	Sun 7/4/10	Sun 5/29/11
191	Mechanical works & commisioning for total Effluent Treatment Plant	150 d	Mon 5/30/11	Wed 10/26/11
192	**Fuel Oil system for total plant**	**477 d**	**Fri 6/18/10**	**Sat 10/8/11**
193	Start of release of fuel oil system drawings to site	0 d	Fri 6/18/10	Fri 6/18/10
194	Release of Construction drawings for total fuel oil system to site	60 d	Sat 6/19/10	Tue 8/17/10
195	Construction of Fuel Oil Pumphouse for total plant	230 d	Sun 7/4/10	Fri 2/18/11
196	Receipt of materials at site for total plant	0 d	Fri 2/25/11	Fri 2/25/11
197	Fabrication & erection of Fuel oil tanks for total plant	150 d	Tue 3/29/11	Thu 8/25/11
198	Erection of fuel oil pumps & motors for total plant	120 d	Fri 5/27/11	Fri 9/23/11
199	Main Fuel Pipe rack from fuel oil pumphouse to boilers for total plant	120 d	Sat 2/19/11	Sat 6/18/11
200	Main piping & heating arrangement for Total Plant	90 d	Sun 6/19/11	Fri 9/16/11
201	Pre-commissioning activites fuel pumps & motors for total plant	15 d	Sat 9/24/11	Sat 10/8/11
202	Readiness of fuel oil system for Unit 3	0 d	Sat 10/8/11	Sat 10/8/11
203	**Fire Fighting System for Unit 3**	**716 d**	**Mon 5/17/10**	**Wed 5/2/12**
204	Start of release of drawings for total fire fighting system to site	0 d	Mon 5/17/10	Mon 5/17/10
205	Start of Receipt of fire fighting system materials at site for total swyd & trf yard (unit 3), pumps at site	0 d	Sun 2/27/11	Sun 2/27/11
206	Start of receipt of materials at site for BOP for Unit 3	0 d	Thu 4/28/11	Thu 4/28/11
207	Constrn of Fire water pumphouse with clarified water tank including excavation for Unit 3	255 d	Sat 7/17/10	Mon 3/28/11
208	Erection of Fire water pumps (Hydrant, spray & jockey) for total plant	100 d	Tue 3/29/11	Wed 7/6/11
209	erection of Fire water system for total swyd & trf yard for Unit 3	120 d	Mon 2/28/11	Mon 6/27/11
210	erection of Fire water system for CHP Phase 1	60 d	Mon 11/14/11	Thu 1/12/12
211	erection of Fire water system for CHP Phase 2	60 d	Sun 3/4/12	Wed 5/2/12
212	erection of Fire water system for AHP	60 d	Sat 8/27/11	Tue 10/25/11
213	erection of Fire watersystem for remaining plant for Unit 3	150 d	Fri 4/29/11	Sun 9/25/11
214	pre-commg of firefighting system for total Switchyard & transformer yard (unit 3)	15 d	Thu 7/7/11	Thu 7/21/11
215	Pre-commg of firefighting system for balance plant for Unit 3	30 d	Mon 9/26/11	Tue 10/25/11
216	**Ash Handling for Unit 3**	**729 d**	**Sun 1/31/10**	**Mon 1/30/12**
217	Start of release of Ash handling system drawings to site	0 d	Thu 4/15/10	Thu 4/15/10
218	Release of construction drawings for total ash handling system to site	90 d	Fri 4/16/10	Wed 7/14/10
219	Construction of HCSD pump & ash Water pump house for total plant including excavation	230 d	Thu 9/9/10	Tue 4/26/11
220	Release of ash dyke construction drawings to site	0 d	Sun 1/31/10	Sun 1/31/10
221	Development of Ash dyke	600 d	Tue 2/16/10	Sat 10/8/11
222	Erection of ash water pumps & HCSD pumps for total plant	100 d	Sat 4/23/11	Sun 7/31/11
223	Receipt of materials for Unit 3 at site	0 d	Wed 3/23/11	Wed 3/23/11
224	Erection of bottom ash hopper for Unit 3	30 d	Fri 7/8/11	Sat 8/6/11
225	Erection of conveyors for Bottom Ash hopper of Unit 3 to intermediate silo & from intermediate silo to main conveyor	60 d	Sun 8/7/11	Wed 10/5/11



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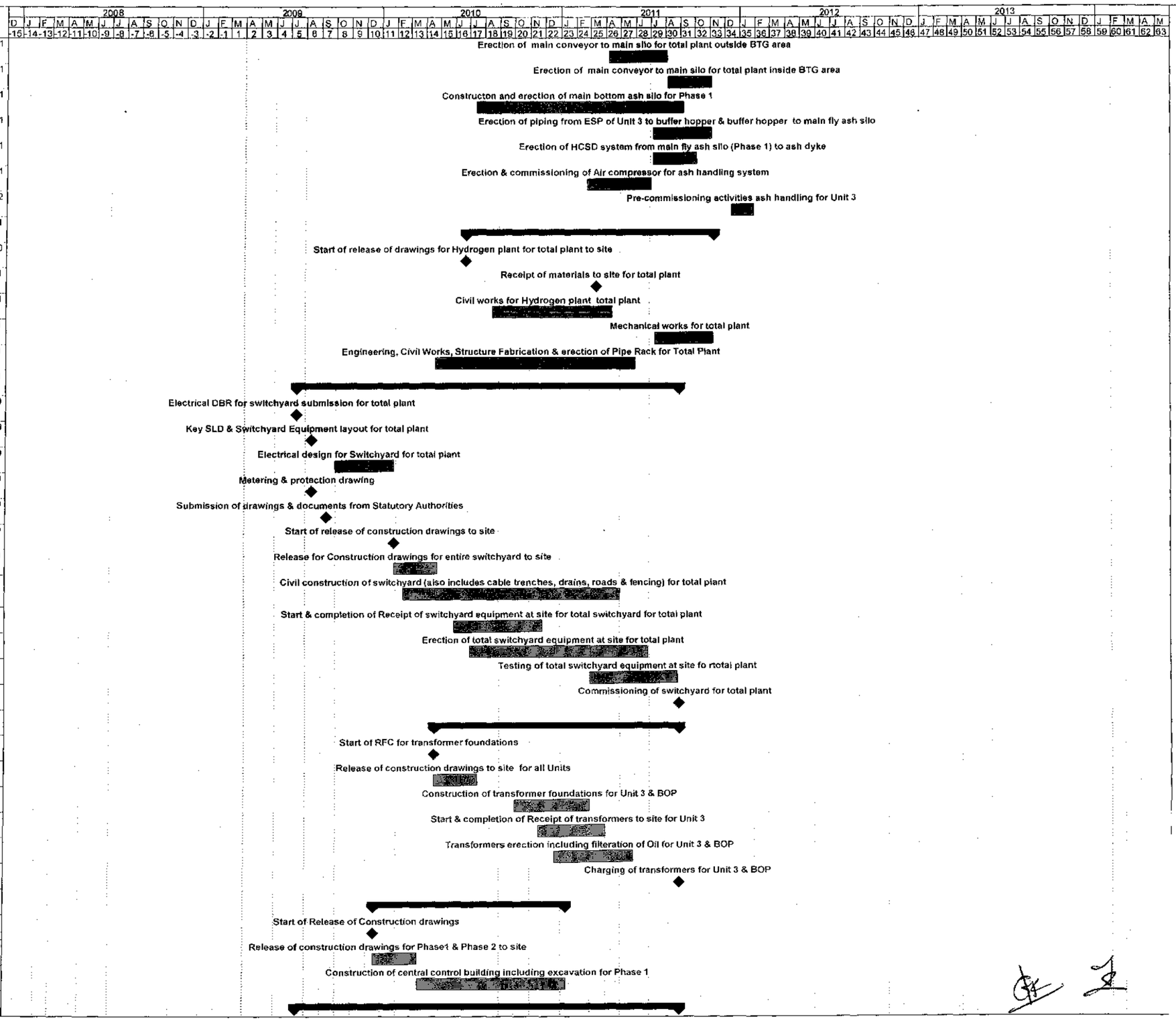
3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
226	Erection of main conveyor to main silo for total plant outside BTG area	120 d	Fri 4/8/11	Fri 8/5/11
227	Erection of main conveyor to main silo for total plant inside BTG area	90 d	Sun 8/7/11	Fri 11/4/11
228	Construcion and erection of main bottom ash silo for Phase 1	420 d	Thu 7/15/10	Wed 9/7/11
229	Erection of piping from ESP of Unit 3 to buffer hopper & buffer hopper to main fly ash silo	120 d	Fri 7/8/11	Fri 11/4/11
230	Erection of HCSD system from main fly ash silo (Phase 1) to ash dyke	90 d	Fri 7/8/11	Wed 10/5/11
231	Erection & commissioning of Air compressor for ash handling system	130 d	Wed 2/23/11	Sat 7/2/11
232	Pre-commissioning activities ash handling for Unit 3	45 d	Sat 12/17/11	Mon 1/30/12
233	**Hydrogen plant for total plant**	**503 d**	**Thu 6/24/10**	**Wed 11/9/11**
234	Start of release of drawings for Hydrogen plant for total plant to site	0 d	Thu 6/24/10	Thu 6/24/10
235	Receipt of materials to site for total plant	0 d	Mon 3/14/11	Mon 3/14/11
236	Civil works for Hydrogen plant total plant	240 d	Wed 8/18/10	Thu 4/14/11
237	Mechanical works for total plant	120 d	Wed 7/13/11	Wed 11/9/11
238	Engineering, Civil Works, Structure Fabrication & erection of Pipe Rack for Total Plant	405 d	Thu 4/22/10	Tue 5/31/11
239	**Switchyard for Total power plant**	**778 d**	**Tue 7/14/09**	**Wed 8/31/11**
240	Electrical DBR for switchyard submission for total plant	0 d	Tue 7/14/09	Tue 7/14/09
241	Key SLD & Switchyard Equipment layout for total plant	0 d	Thu 8/13/09	Thu 8/13/09
242	Electrical design for Switchyard for total plant	120 d	Wed 9/30/09	Wed 1/27/10
243	Metering & protection drawing	0 d	Thu 8/13/09	Thu 8/13/09
244	Submission of drawings & documents from Statutory Authorities	0 d	Sat 9/12/09	Sat 9/12/09
245	Start of release of construction drawings to site	0 d	Wed 1/27/10	Wed 1/27/10
246	Release for Construction drawings for entire switchyard to site	90 d	Thu 1/28/10	Tue 4/27/10
247	Civil construction of switchyard (also includes cable trenches, drains, roads & fencing) for total plant	440 d	Mon 2/15/10	Sat 4/30/11
248	Start & completion of Receipt of switchyard equipment at site for total switchyard for total plant	180 d	Tue 6/1/10	Sat 11/27/10
249	Erection of total switchyard equipment at site for total plant	360 d	Sat 7/3/10	Mon 6/27/11
250	Testing of total switchyard equipment at site fo rtotal plant	180 d	Wed 3/2/11	Sun 8/28/11
251	Commissioning of switchyard for total plant	0 d	Wed 8/31/11	Wed 8/31/11
252	**Transformers (ST-1,GT-1,UAT-2,Service transformers) for unit 3 & BOP**	**499 d**	**Mon 4/19/10**	**Wed 8/31/11**
253	Start of RFC for transformer foundations	0 d	Mon 4/19/10	Mon 4/19/10
254	Release of construction drawings to site for all Units	90 d	Tue 4/20/10	Sun 7/18/10
255	Construction of transformer foundations for Unit 3 & BOP	150 d	Sat 10/2/10	Mon 2/28/11
256	Start & completion of Receipt of transformers to site for Unit 3	135 d	Thu 11/18/10	Fri 4/1/11
257	Transformers erection including filteration of Oil for Unit 3 & BOP	160 d	Mon 12/20/10	Sat 5/28/11
258	Charging of transformers for Unit 3 & BOP	0 d	Wed 8/31/11	Wed 8/31/11
259	**Control House for Phase 1**	**390 d**	**Wed 12/16/09**	**Mon 1/10/11**
260	Start of Release of Construction drawings	0 d	Wed 12/16/09	Wed 12/16/09
261	Release of construction drawings for Phase1 & Phase 2 to site	90 d	Thu 12/17/09	Tue 3/16/10
262	Construction of central control building including excavation for Phase 1	300 d	Wed 3/17/10	Mon 1/10/11
263	**Switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 3 & BOP**	**778 d**	**Tue 7/14/09**	**Wed 8/31/11**

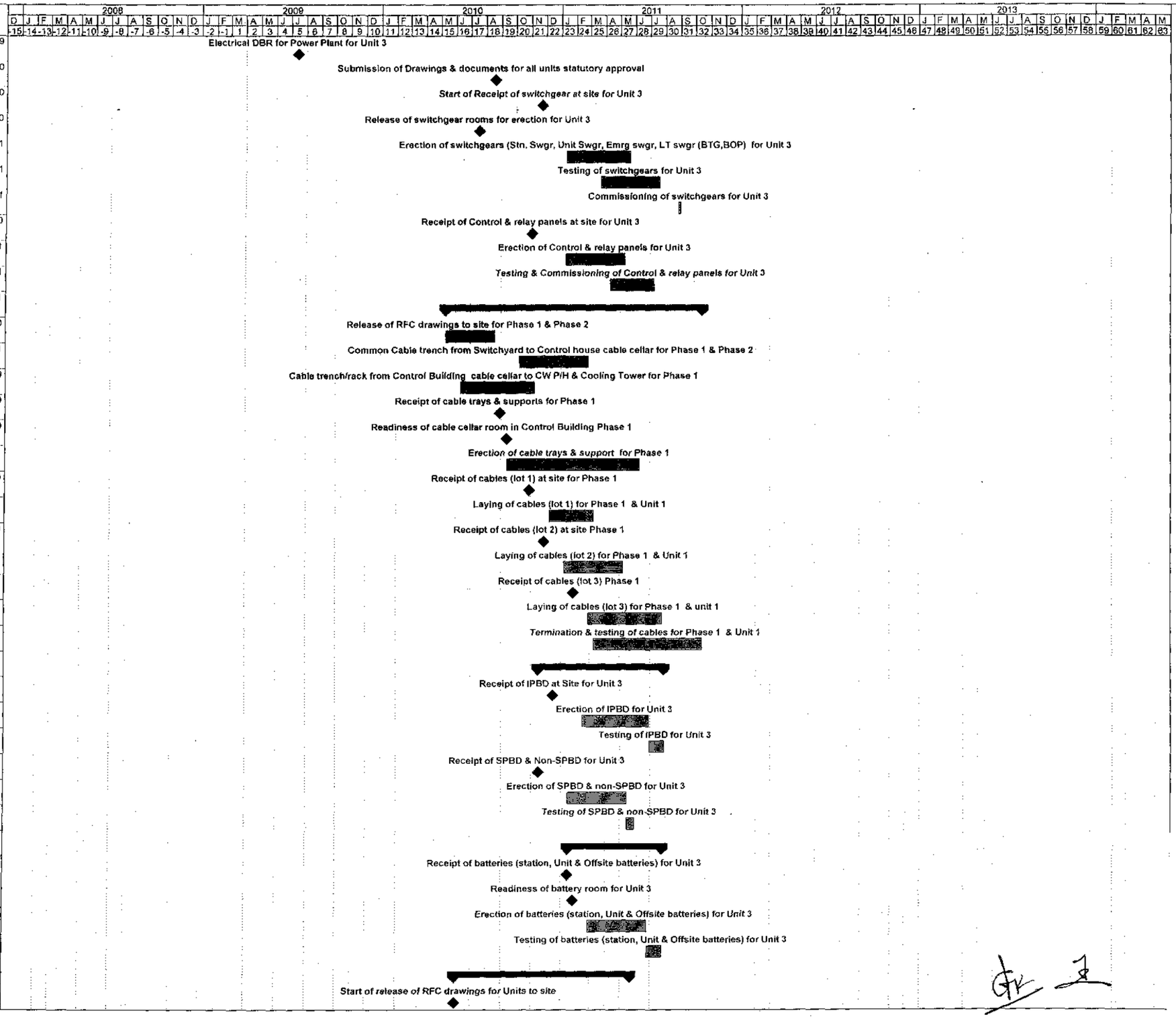


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
264	Electrical DBR for Power Plant for Unit 3	0 d	Tue 7/14/09	Tue 7/14/09
265	Submission of Drawings & documents for all units statutory approval	0 d	Thu 8/19/10	Thu 8/19/10
266	Start of Receipt of switchgear at site for Unit 3	0 d	Mon 11/22/10	Mon 11/22/10
267	Release of switchgear rooms for erection for Unit 3	0 d	Sat 7/17/10	Sat 7/17/10
268	Erection of switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 3	130 d	Tue 1/11/11	Fri 5/20/11
269	Testing of switchgears for Unit 3	120 d	Tue 3/22/11	Tue 7/19/11
270	Commissioning of switchgears for Unit 3	5 d	Sat 8/27/11	Wed 8/31/11
271	Receipt of Control & relay panels at site for Unit 3	0 d	Tue 11/2/10	Tue 11/2/10
272	Erection of Control & relay panels for Unit 3	120 d	Tue 1/11/11	Tue 5/10/11
273	Testing & Commissioning of Control & relay panels for Unit 3	90 d	Mon 4/11/11	Sat 7/9/11
274	**Cable trays & Cable for Phase 1**	**521 d**	**Wed 5/12/10**	**Fri 10/14/11**
275	Release of RFC drawings to site for Phase 1 & Phase 2	100 d	Wed 5/12/10	Thu 8/19/10
276	Common Cable trench from Switchyard to Control house cable cellar for Phase 1 & Phase 2	140 d	Sat 10/9/10	Fri 2/25/11
277	Cable trench/rack from Control Building cable cellar to CW P/H & Cooling Tower for Phase 1	150 d	Fri 6/11/10	Sun 11/7/10
278	Receipt of cable trays & supports for Phase 1	0 d	Sun 8/29/10	Sun 8/29/10
279	Readiness of cable cellar room in Control Building Phase 1	0 d	Mon 9/13/10	Mon 9/13/10
280	Erection of cable trays & support for Phase 1	270 d	Mon 9/13/10	Thu 6/9/11
281	Receipt of cables (lot 1) at site for Phase 1	0 d	Thu 10/28/10	Thu 10/28/10
282	Laying of cables (lot 1) for Phase 1 & Unit 1	90 d	Thu 12/9/10	Tue 3/8/11
283	Receipt of cables (lot 2) at site Phase 1	0 d	Sat 11/27/10	Sat 11/27/10
284	Laying of cables (lot 2) for Phase 1 & Unit 1	120 d	Sat 1/8/11	Sat 5/7/11
285	Receipt of cables (lot 3) Phase 1	0 d	Wed 1/26/11	Wed 1/26/11
286	Laying of cables (lot 3) for Phase 1 & unit 1	150 d	Sat 2/26/11	Mon 7/25/11
287	Termination & testing of cables for Phase 1 & Unit 1	220 d	Wed 3/9/11	Fri 10/14/11
288	**IPBD, SPBD & Non-SPBD for Unit 3**	**255 d**	**Mon 11/15/10**	**Thu 7/28/11**
289	Receipt of IPBD at Site for Unit 3	0 d	Wed 12/15/10	Wed 12/15/10
290	Erection of IPBD for Unit 3	135 d	Mon 2/14/11	Tue 6/28/11
291	Testing of IPBD for Unit 3	30 d	Wed 6/29/11	Thu 7/28/11
292	Receipt of SPBD & Non-SPBD for Unit 3	0 d	Mon 11/15/10	Mon 11/15/10
293	Erection of SPBD & non-SPBD for Unit 3	120 d	Sat 1/15/11	Sat 5/14/11
294	Testing of SPBD & non-SPBD for Unit 3	15 d	Sun 5/15/11	Sun 5/29/11
295	**Battery (station, Unit & Offsite batteries) for Unit 3**	**191 d**	**Fri 1/14/11**	**Sun 7/24/11**
296	Receipt of batteries (station, Unit & Offsite batteries) for Unit 3	0 d	Fri 1/14/11	Fri 1/14/11
297	Readiness of battery room for Unit 3	0 d	Tue 1/25/11	Tue 1/25/11
298	Erection of batteries (station, Unit & Offsite batteries) for Unit 3	120 d	Fri 2/25/11	Fri 6/24/11
299	Testing of batteries (station, Unit & Offsite batteries) for Unit 3	30 d	Sat 6/25/11	Sun 7/24/11
300	**Emergency Dgset for Unit-3**	**356 d**	**Sun 5/30/10**	**Sat 5/21/11**
301	Start of release of RFC drawings for Units to site	0 d	Sun 5/30/10	Sun 5/30/10

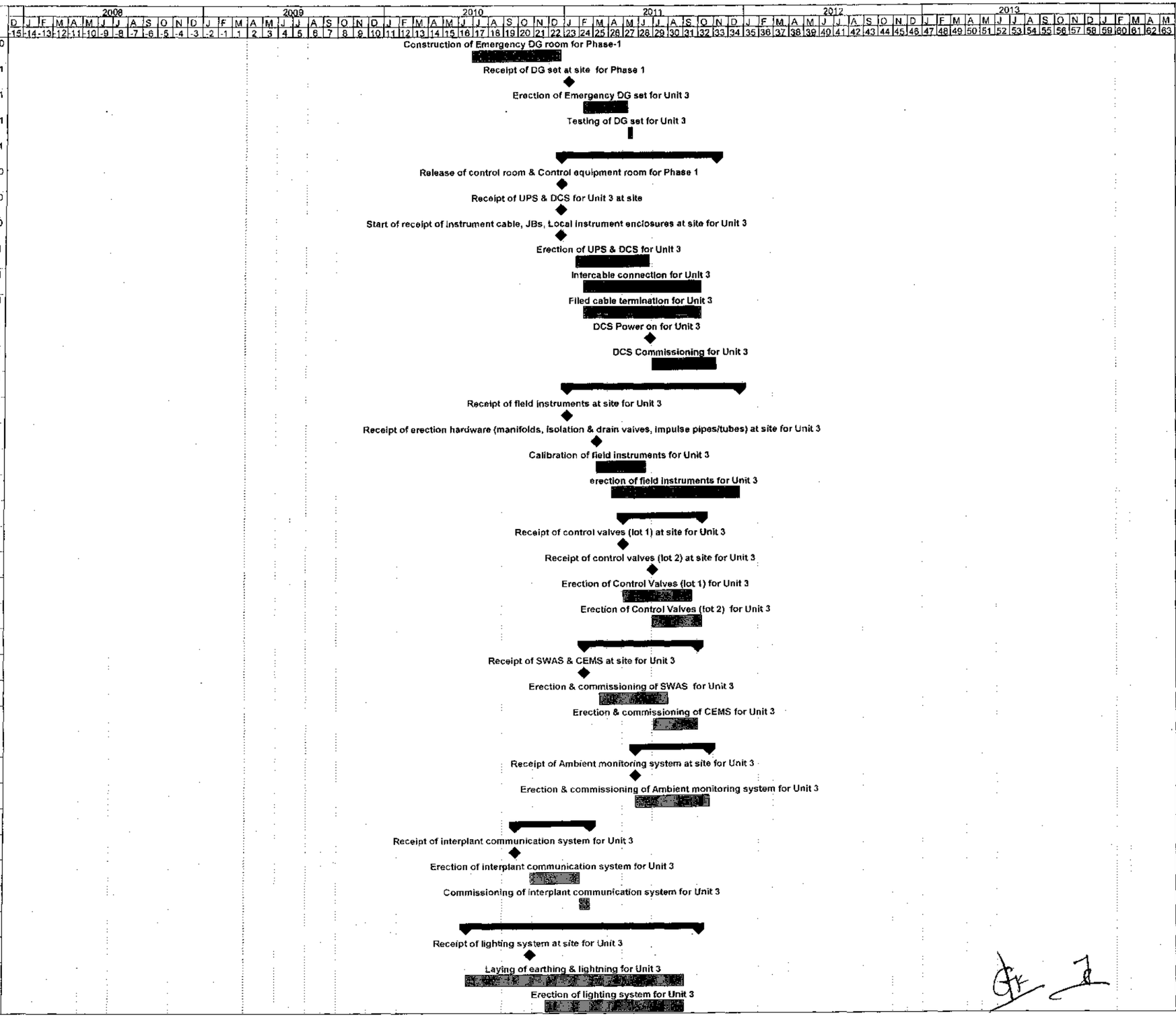


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
302	Construction of Emergency DG room for Phase-1	180 d	Wed 6/30/10	Sun 12/26/10
303	Receipt of DG set at site for Phase 1	0 d	Tue 1/11/11	Tue 1/11/11
304	Erection of Emergency DG set for Unit 3	90 d	Fri 2/11/11	Wed 5/11/11
305	Testing of DG set for Unit 3	10 d	Thu 5/12/11	Sat 5/21/11
306	**DCS, UPS, cables for Unit 3**	**316 d**	**Mon 12/27/10**	**Tue 11/8/11**
307	Release of control room & Control equipment room for Phase 1	0 d	Tue 12/28/10	Tue 12/28/10
308	Receipt of UPS & DCS for Unit 3 at site	0 d	Mon 12/27/10	Mon 12/27/10
309	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 3	0 d	Mon 12/27/10	Mon 12/27/10
310	Erection of UPS & DCS for Unit 3	150 d	Fri 1/28/11	Sun 6/26/11
311	intercable connection for Unit 3	240 d	Sat 2/12/11	Sun 10/9/11
312	Filed cable termination for Unit 3	240 d	Sat 2/12/11	Sun 10/9/11
313	DCS Power on for Unit 3	0 d	Tue 6/28/11	Tue 6/28/11
314	DCS Commissioning for Unit 3	130 d	Sat 7/2/11	Tue 11/8/11
315	**Field Instruments for Unit 3**	**350 d**	**Sun 1/9/11**	**Sun 12/25/11**
316	Receipt of field instruments at site for Unit 3	0 d	Sun 1/9/11	Sun 1/9/11
317	Receipt of erection hardware (manifolds, isolation & drain valves, impulse pipes/tubes) at site for Unit 3	0 d	Thu 3/10/11	Thu 3/10/11
318	Calibration of field instruments for Unit 3	100 d	Fri 3/11/11	Sat 6/18/11
319	erection of field instruments for Unit 3	260 d	Sun 4/10/11	Sun 12/25/11
320	**Control valves for Unit 3**	**160 d**	**Tue 5/3/11**	**Mon 10/10/11**
321	Receipt of control valves (lot 1) at site for Unit 3	0 d	Tue 5/3/11	Tue 5/3/11
322	Receipt of control valves (lot 2) at site for Unit 3	0 d	Sat 7/2/11	Sat 7/2/11
323	Erection of Control Valves (lot 1) for Unit 3	140 d	Wed 5/4/11	Tue 9/20/11
324	Erection of Control Valves (lot 2) for Unit 3	100 d	Sun 7/3/11	Mon 10/10/11
325	**CEMS & SWAS for Unit 3**	**230 d**	**Sun 2/13/11**	**Sat 10/1/11**
326	Receipt of SWAS & CEMS at site for Unit 3	0 d	Sun 2/13/11	Sun 2/13/11
327	Erection & commissioning of SWAS for Unit 3	140 d	Wed 3/16/11	Tue 8/2/11
328	Erection & commissioning of CEMS for Unit 3	90 d	Mon 7/4/11	Sat 10/1/11
329	**Ambient air monitoring system for Unit 3**	**150 d**	**Fri 5/27/11**	**Mon 10/24/11**
330	Receipt of Ambient monitoring system at site for Unit 3	0 d	Fri 5/27/11	Fri 5/27/11
331	Erection & commissioning of Ambient monitoring system for Unit 3	150 d	Sat 5/28/11	Mon 10/24/11
332	**interplant communication system for Unit 3**	**150 d**	**Mon 9/27/10**	**Thu 2/24/11**
333	Receipt of interplant communication system for Unit 3	0 d	Mon 9/27/10	Mon 9/27/10
334	Erection of interplant communication system for Unit 3	100 d	Thu 10/28/10	Fri 2/4/11
335	Commissioning of interplant communication system for Unit 3	20 d	Sat 2/5/11	Thu 2/24/11
336	**lighting system for Unit 3**	**470 d**	**Sun 6/20/10**	**Sun 10/2/11**
337	Receipt of lighting system at site for Unit 3	0 d	Wed 10/27/10	Wed 10/27/10
338	Laying of earthing & lightning for Unit 3	440 d	Sun 6/20/10	Fri 9/2/11
339	Erection of lighting system for Unit 3	280 d	Sat 11/27/10	Fri 9/2/11

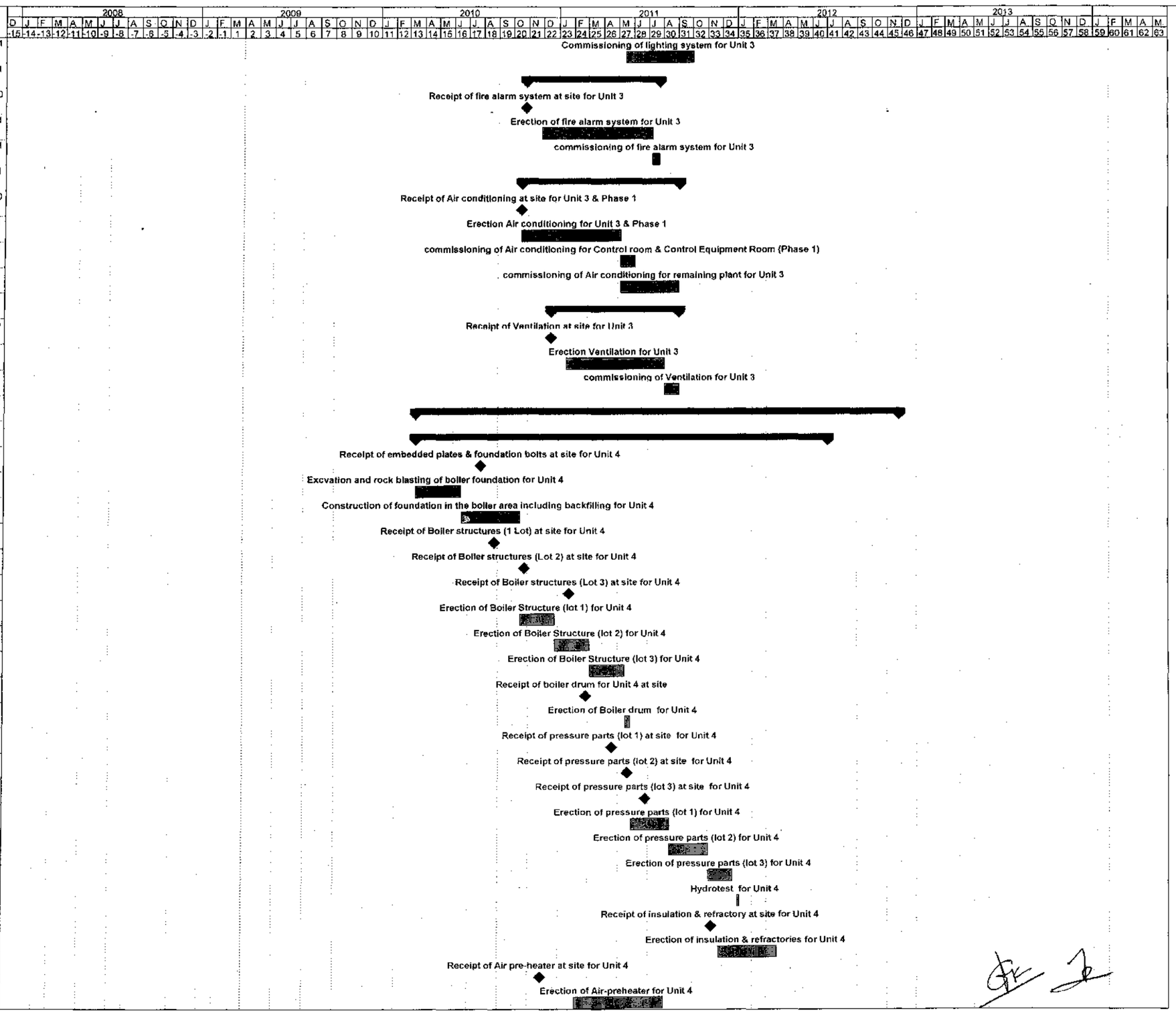


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
340	Commissioning of lighting system for Unit 3	140 d	Mon 5/16/11	Sun 10/2/11
341	**fire alarm system for Unit 3**	270 d	Wed 10/27/10	Sun 7/24/11
342	Receipt of fire alarm system at site for Unit 3	0 d	Wed 10/27/10	Wed 10/27/10
343	Erection of fire alarm system for Unit 3	225 d	Sat 11/27/10	Sat 7/9/11
344	commissioning of fire alarm system for Unit 3	15 d	Sun 7/10/11	Sun 7/24/11
345	**Air conditioning for Unit 3**	320 d	Mon 10/18/10	Sat 9/3/11
346	Receipt of Air conditioning at site for Unit 3 & Phase 1	0 d	Mon 10/18/10	Mon 10/18/10
347	Erection Air conditioning for Unit 3 & Phase 1	200 d	Tue 10/19/10	Fri 5/6/11
348	commissioning of Air conditioning for Control room & Control Equipment Room (Phase 1)	30 d	Sat 5/7/11	Sun 6/5/11
349	commissioning of Air conditioning for remaining plant for Unit 3	120 d	Sat 5/7/11	Sat 9/3/11
350	**Ventilation for Unit 3**	260 d	Fri 12/17/10	Sat 9/3/11
351	Receipt of Ventilation at site for Unit 3	0 d	Fri 12/17/10	Fri 12/17/10
352	Erection Ventilation for Unit 3	200 d	Mon 1/17/11	Thu 8/4/11
353	commissioning of Ventilation for Unit 3	30 d	Fri 8/5/11	Sat 9/3/11
354	**Schedule for Unit 4**	986 d	Tue 3/16/10	Sun 11/25/12
355	**Boiler & Boiler Auxiliaries (Unit 4)**	841 d	Tue 3/16/10	Tue 7/3/12
356	Receipt of embedded plates & foundation bolts at site for Unit 4	0 d	Tue 7/27/10	Tue 7/27/10
357	Excvation and rock blasting of boiler foundation for Unit 4	94 d	Tue 3/16/10	Thu 6/17/10
358	Construction of foundation in the boiler area including backfilling for Unit 4	120 d	Sat 6/19/10	Sat 10/16/10
359	Receipt of Boiler structures (1 Lot) at site for Unit 4	0 d	Wed 8/25/10	Wed 8/25/10
360	Receipt of Boiler structures (Lot 2) at site for Unit 4	0 d	Mon 10/25/10	Mon 10/25/10
361	Receipt of Boiler structures (Lot 3) at site for Unit 4	0 d	Sun 1/23/11	Sun 1/23/11
362	Erection of Boiler Structure (lot 1) for Unit 4	70 d	Sun 10/17/10	Sat 12/25/10
363	Erection of Boiler Structure (lot 2) for Unit 4	70 d	Sun 12/26/10	Sat 3/5/11
364	Erection of Boiler Structure (lot 3) for Unit 4	70 d	Sun 3/6/11	Sat 5/14/11
365	Receipt of boiler drum for Unit 4 at site	0 d	Fri 2/25/11	Fri 2/25/11
366	Erection of Boiler drum for Unit 4	10 d	Mon 5/16/11	Wed 5/25/11
367	Receipt of pressure parts (lot 1) at site for Unit 4	0 d	Mon 4/18/11	Mon 4/18/11
368	Receipt of pressure parts (lot 2) at site for Unit 4	0 d	Thu 5/19/11	Thu 5/19/11
369	Receipt of pressure parts (lot 3) at site for Unit 4	0 d	Sat 6/25/11	Sat 6/25/11
370	Erection of pressure parts (lot 1) for Unit 4	80 d	Fri 5/27/11	Sun 8/14/11
371	Erection of pressure parts (lot 2) for Unit 4	80 d	Mon 8/15/11	Wed 11/2/11
372	Erection of pressure parts (lot 3) for Unit 4	50 d	Thu 11/3/11	Thu 12/22/11
373	Hydrotest for Unit 4	4 d	Mon 1/2/12	Thu 1/5/12
374	Receipt of insulation & refractory at site for Unit 4	0 d	Tue 11/8/11	Tue 11/8/11
375	Erection of insulation & refractories for Unit 4	120 d	Thu 11/24/11	Thu 3/22/12
376	Receipt of Air pre-heater at site for Unit 4	0 d	Fri 11/26/10	Fri 11/26/10
377	Erection of Air-preheater for Unit 4	180 d	Fri 2/4/11	Tue 8/2/11

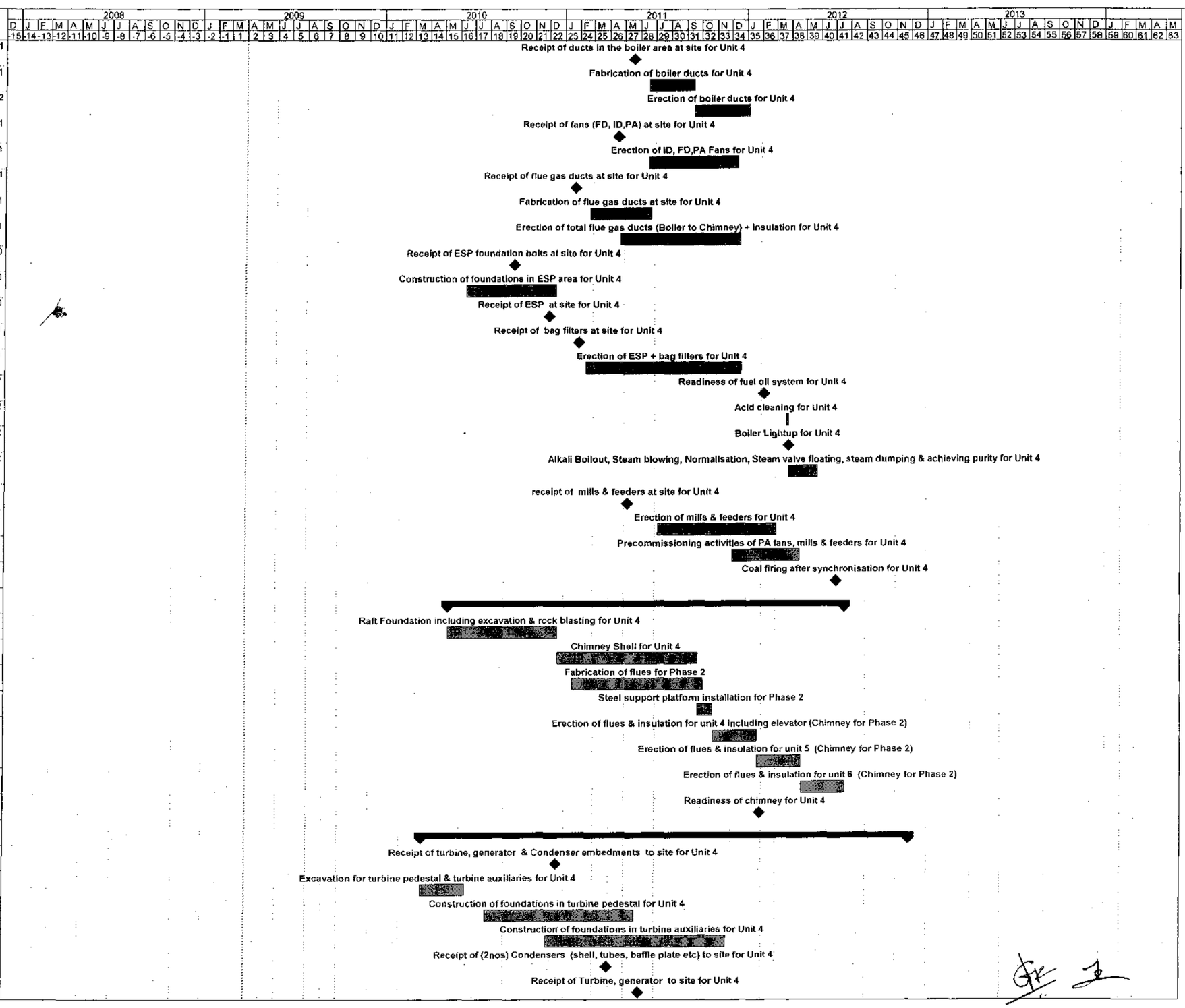


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
378	Receipt of ducts in the boiler area at site for Unit 4	0 d	Thu 5/19/11	Thu 5/19/11
379	Fabrication of boiler ducts for Unit 4	90 d	Sun 6/19/11	Fri 9/16/11
380	Erection of boiler ducts for Unit 4	112 d	Sat 9/17/11	Fri 1/6/12
381	Receipt of fans (FD, ID,PA) at site for Unit 4	0 d	Mon 4/18/11	Mon 4/18/11
382	Erection of ID, FD,PA Fans for Unit 4	180 d	Sat 6/18/11	Wed 12/14/11
383	Receipt of flue gas ducts at site for Unit 4	0 d	Sun 1/23/11	Sun 1/23/11
384	Fabrication of flue gas ducts at site for Unit 4	120 d	Wed 2/23/11	Wed 6/22/11
385	Erection of total flue gas ducts (Boiler to Chimney) + insulation for Unit 4	240 d	Sun 4/24/11	Mon 12/19/11
386	Receipt of ESP foundation bolts at site for Unit 4	0 d	Wed 9/22/10	Wed 9/22/10
387	Construction of foundations in ESP area for Unit 4	184 d	Wed 6/16/10	Thu 12/16/10
388	Receipt of ESP at site for Unit 4	0 d	Thu 12/2/10	Thu 12/2/10
389	Receipt of bag filters at site for Unit 4	0 d	Mon 1/31/11	Mon 1/31/11
390	Erection of ESP + bag filters for Unit 4	310 d	Tue 2/15/11	Wed 12/21/11
391	Readiness of fuel oil system for Unit 4	0 d	Mon 2/6/12	Mon 2/6/12
392	Acid cleaning for Unit 4	5 d	Fri 3/23/12	Tue 3/27/12
393	Boiler Lightup for Unit 4	0 d	Tue 3/27/12	Tue 3/27/12
394	Alkali Boilout, Steam blowing, Normalisation, Steam valve floating, steam dumping & achieving purity for Unit 4	60 d	Wed 3/28/12	Sat 5/26/12
395	receipt of mills & feeders at site for Unit 4	0 d	Sat 5/7/11	Sat 5/7/11
396	Erection of mills & feeders for Unit 4	240 d	Thu 7/7/11	Fri 3/2/12
397	Precommissioning activities of PA fans, mills & feeders for Unit 4	138 d	Sun 12/4/11	Thu 4/19/12
398	Coal firing after synchronisation for Unit 4	0 d	Tue 7/3/12	Tue 7/3/12
399	**Chnimney for Phase 2**	**803 d**	**Mon 5/10/10**	**Fri 7/20/12**
400	Raft Foundation including excavation & rock blasting for Unit 4	223 d	Mon 5/10/10	Sat 12/18/10
401	Chimney Shell for Unit 4	280 d	Sun 12/19/10	Sat 9/24/11
402	Fabrication of flues for Phase 2	260 d	Tue 1/18/11	Tue 10/4/11
403	Steel support platform installation for Phase 2	30 d	Sun 9/25/11	Mon 10/24/11
404	Erection of flues & insulation for unit 4 including elevator (Chimney for Phase 2)	90 d	Tue 10/25/11	Sun 1/22/12
405	Erection of flues & insulation for unit 5 (Chimney for Phase 2)	90 d	Mon 1/23/12	Sat 4/21/12
406	Erection of flues & insulation for unit 6 (Chimney for Phase 2)	90 d	Sun 4/22/12	Fri 7/20/12
407	Readiness of chimney for Unit 4	0 d	Sat 1/28/12	Sat 1/28/12
408	**Turbine (Unit 4)**	**985 d**	**Wed 3/17/10**	**Sun 11/25/12**
409	Receipt of turbine, generator & Condenser embedments to site for Unit 4	0 d	Wed 12/15/10	Wed 12/15/10
410	Excavation for turbine pedestal & turbine auxiliaries for Unit 4	90 d	Wed 3/17/10	Mon 6/14/10
411	Construction of foundations in turbine pedestal for Unit 4	300 d	Mon 7/26/10	Sat 5/21/11
412	Construction of foundations in turbine auxiliaries for Unit 4	360 d	Fri 11/26/10	Sun 11/20/11
413	Receipt of (2nos) Condensers (shell, tubes, baffle plate etc) to site for Unit 4	0 d	Tue 3/29/11	Tue 3/29/11
414	Receipt of Turbine, generator to site for Unit 4	0 d	Mon 5/30/11	Mon 5/30/11



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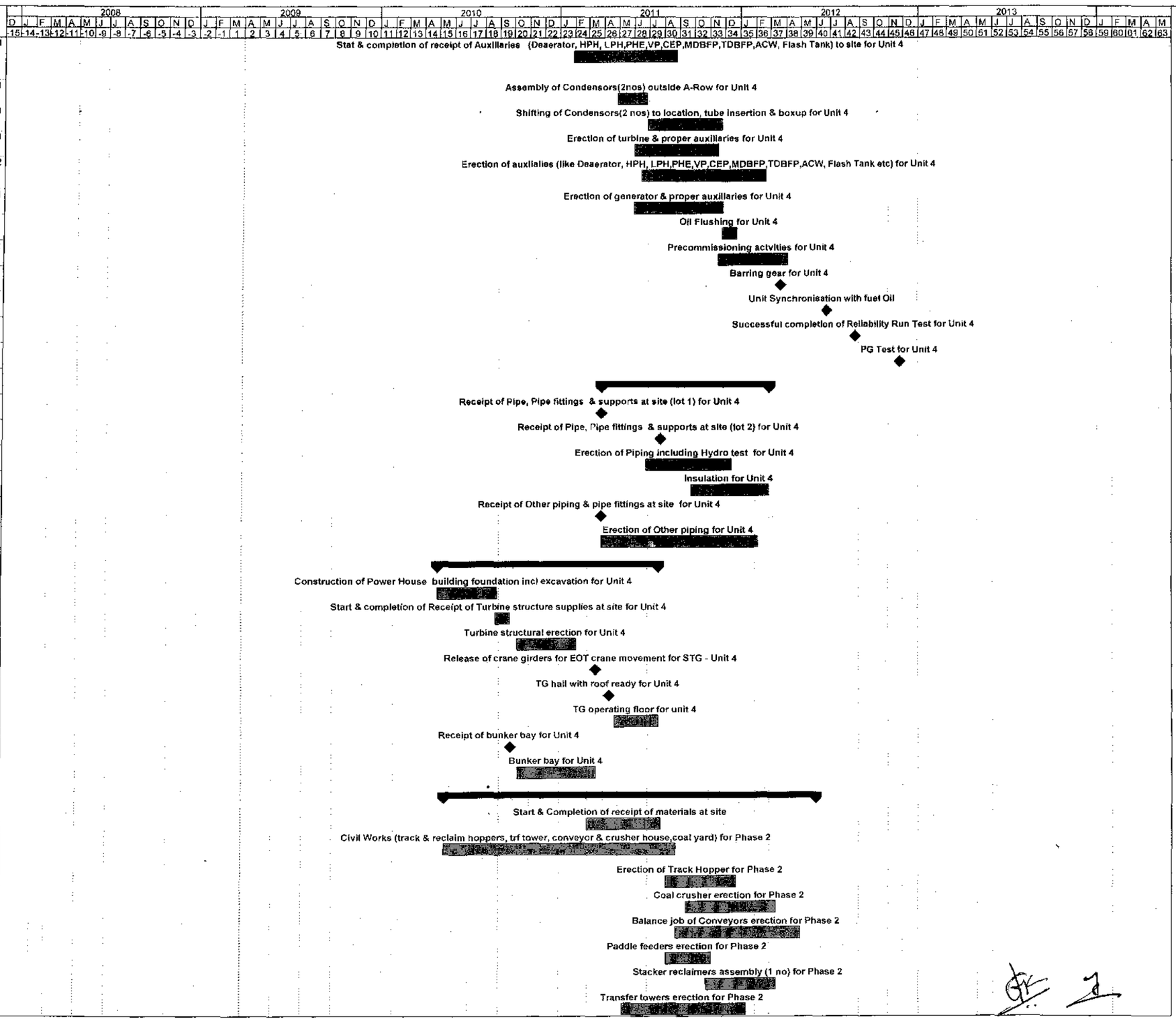
3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
415	Stat & completion of receipt of Auxiliaries (Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank) to site for Unit 4	210 d	Sat 1/29/11	Fri 8/26/11
416	Assembly of Condensors(2nos) outside A-Row for Unit 4	60 d	Thu 4/28/11	Sun 6/26/11
417	Shifting of Condensors(2 nos) to location, tube insertion & boxup for Unit 4	150 d	Wed 6/29/11	Fri 11/25/11
418	Erection of turbine & proper auxiliaries for Unit 4	170 d	Wed 6/1/11	Thu 11/17/11
419	Erection of auxlialies (like Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank etc) for Unit 4	250 d	Thu 6/16/11	Mon 2/20/12
420	Erection of generator & proper auxiliaries for Unit 4	180 d	Wed 6/1/11	Sun 11/27/11
421	Oil Flushing for Unit 4	30 d	Sat 11/26/11	Sun 12/25/11
422	Precommissioning activities for Unit 4	140 d	Sat 11/19/11	Fri 4/6/12
423	Barring gear for Unit 4	0 d	Thu 3/22/12	Thu 3/22/12
424	Unit Synchronisation with fuel Oil	0 d	Mon 6/25/12	Mon 6/25/12
425	Successful completion of Reliability Run Test for Unit 4	0 d	Sat 8/25/12	Sat 8/25/12
426	PG Test for Unit 4	0 d	Sun 11/25/12	Sun 11/25/12
427	**Power Cycle Piping (Unit 4)**	**337 d**	**Mon 3/28/11**	**Tue 2/28/12**
428	Receipt of Pipe, Pipe fittings & supports at site (lot 1) for Unit 4	0 d	Mon 3/28/11	Mon 3/28/11
429	Receipt of Pipe, Pipe fittings & supports at site (lot 2) for Unit 4	0 d	Tue 7/26/11	Tue 7/26/11
430	Erection of Piping including Hydro test for Unit 4	172 d	Mon 6/27/11	Thu 12/15/11
431	Insulation for Unit 4	155 d	Tue 9/27/11	Tue 2/28/12
432	Receipt of Other piping & pipe fittings at site for Unit 4	0 d	Mon 3/28/11	Mon 3/28/11
433	Erection of Other piping for Unit 4	315 d	Tue 3/29/11	Mon 2/6/12
434	**Power House building for Unit 4**	**448 d**	**Sat 5/1/10**	**Fri 7/22/11**
435	Construction of Power House building foundation incl excavation for Unit 4	120 d	Sat 5/1/10	Sat 8/28/10
436	Start & completion of Receipt of Turbine structure supplies at site for Unit 4	30 d	Thu 8/26/10	Fri 9/24/10
437	Turbine structural erection for Unit 4	120 d	Sat 10/9/10	Sat 2/5/11
438	Release of crane girders for EOT crane movement for STG - Unit 4	0 d	Thu 3/17/11	Thu 3/17/11
439	TG hall with roof ready for Unit 4	0 d	Wed 4/13/11	Wed 4/13/11
440	TG operating floor for unit 4	90 d	Sun 4/24/11	Fri 7/22/11
441	Receipt of bunker bay for Unit 4	0 d	Fri 9/24/10	Fri 9/24/10
442	Bunker bay for Unit 4	160 d	Sat 10/9/10	Thu 3/17/11
443	**Coal Handling for Phase 2**	**752 d**	**Fri 5/14/10**	**Sun 6/3/12**
444	Start & Completion of receipt of materials at site	150 d	Sun 2/27/11	Tue 7/26/11
445	Civil Works (track & reclaim hoppers, trf tower, conveyor & crusher house,coal yard) for Phase 2	470 d	Fri 5/14/10	Fri 8/26/11
446	Erection of Track Hopper for Phase 2	140 d	Mon 6/6/11	Sun 12/25/11
447	Coal crusher erection for Phase 2	180 d	Sat 9/17/11	Wed 3/14/12
448	Balance job of Conveyors erection for Phase 2	250 d	Sat 8/27/11	Wed 5/2/12
449	Paddle feeders erection for Phase 2	90 d	Mon 8/8/11	Sat 11/5/11
450	Stacker reclaimers assembly (1 no) for Phase 2	140 d	Thu 10/27/11	Wed 3/14/12
451	Transfer towers erection for Phase 2	250 d	Tue 5/10/11	Sat 1/14/12

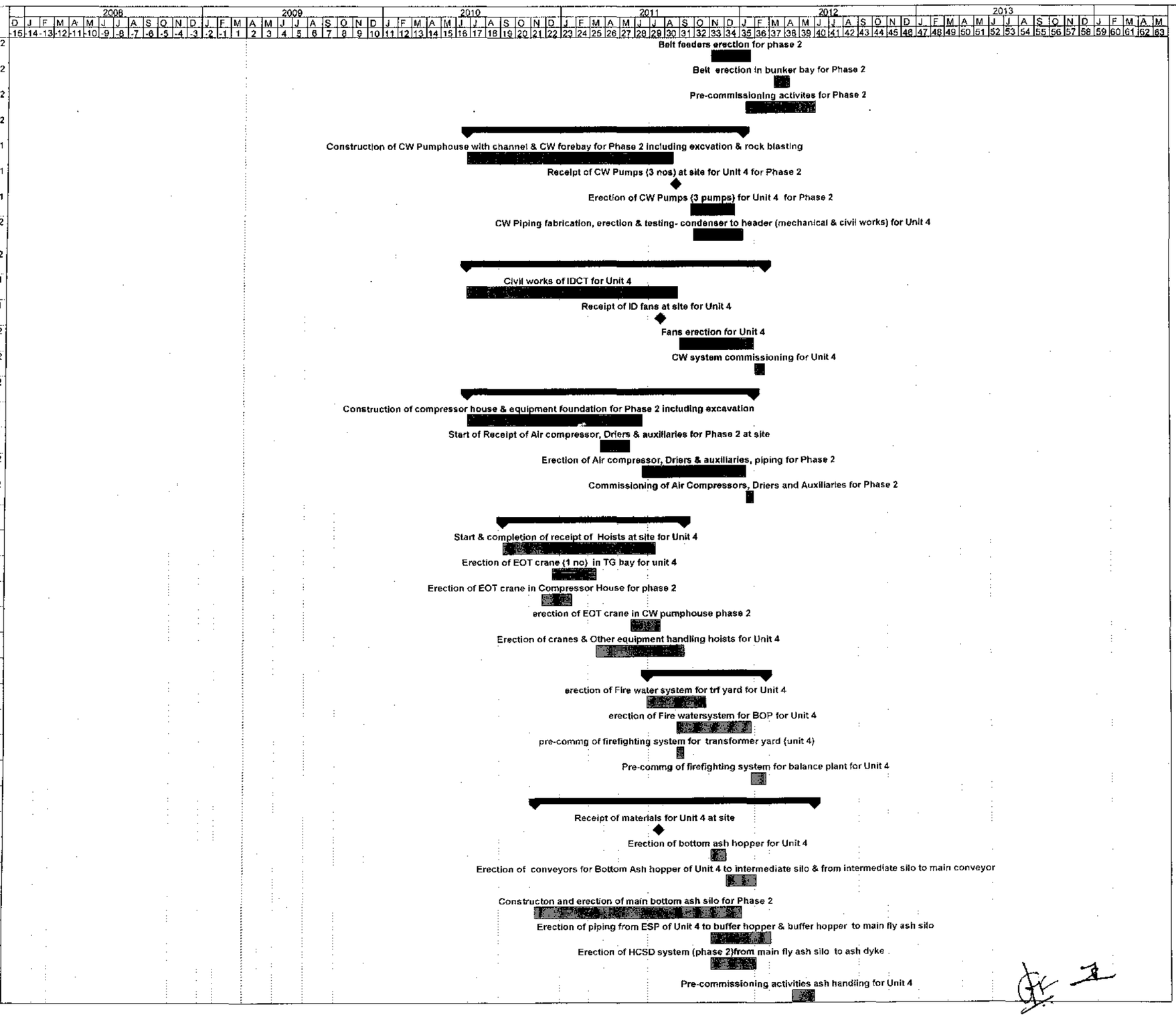


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
452	Belt feeders erection for phase 2	80 d	Sun 11/6/11	Tue 1/24/12
453	Belt erection in bunker bay for Phase 2	30 d	Mon 3/12/12	Tue 4/10/12
454	Pre-commissioning activites for Phase 2	141 d	Sun 1/15/12	Sun 6/3/12
455	**CW system for Unit 4**	**562 d**	**Sat 6/26/10**	**Sun 1/8/12**
456	Construction of CW Pumphouse with channel & CW forebay for Phase 2 including excvation & rock	420 d	Sat 6/26/10	Fri 8/19/11
457	Receipt of CW Pumps (3 nos) at site for Unit 4 for Phase 2	0 d	Thu 8/25/11	Thu 8/25/11
458	Erection of CW Pumps (3 pumps) for Unit 4 for Phase 2	90 d	Sun 9/25/11	Fri 12/23/11
459	CW Piping fabrication, erection & testing- condenser to header (mechanical & civil works) for Unit 4	100 d	Sat 10/1/11	Sun 1/8/12
460	**IDCT Construction for Unit 4**	**607 d**	**Sat 6/26/10**	**Wed 2/22/12**
461	Civil works of IDCT for Unit 4	430 d	Sat 6/26/10	Mon 8/29/11
462	Receipt of ID fans at site for Unit 4	0 d	Tue 7/26/11	Tue 7/26/11
463	Fans erection for Unit 4	150 d	Sun 9/4/11	Tue 1/31/12
464	CW system commissioning for Unit 4	20 d	Fri 2/3/12	Wed 2/22/12
465	**Air Compressors, Driers and Auxiliaries for Phase 2**	**582 d**	**Mon 6/28/10**	**Mon 1/30/12**
466	Construction of compressor house & equipment foundation for Phase 2 including excavation	355 d	Mon 6/28/10	Fri 6/17/11
467	Start of Receipt of Air compressor, Driers & auxiliaries for Phase 2 at site	60 d	Sat 3/26/11	Tue 5/24/11
468	Erection of Air compressor, Driers & auxiliaries, piping for Phase 2	210 d	Sun 6/19/11	Sat 1/14/12
469	Commissioning of Air Compressors, Driers and Auxiliaries for Phase 2	15 d	Mon 1/16/12	Mon 1/30/12
470	**Cranes & Hoists for Unit 4**	**370 d**	**Thu 9/9/10**	**Tue 9/13/11**
471	Start & completion of receipt of Hoists at site for Unit 4	310 d	Thu 9/9/10	Fri 7/15/11
472	Erection of EOT crane (1 no) in TG bay for unit 4	90 d	Sat 12/18/10	Thu 3/17/11
473	Erection of EOT crane in Compressor House for phase 2	60 d	Sun 11/28/10	Wed 1/26/11
474	erection of EOT crane in CW pumphouse phase 2	60 d	Sat 5/28/11	Tue 7/26/11
475	Erection of cranes & Other equipment handling hoists for Unit 4	180 d	Fri 3/18/11	Tue 9/13/11
476	**Fire Fighting System for Unit 4**	**240 d**	**Wed 6/29/11**	**Thu 2/23/12**
477	erection of Fire water system for trf yard for Unit 4	120 d	Wed 6/29/11	Wed 10/26/11
478	erection of Fire watersystem for BOP for Unit 4	150 d	Sun 8/28/11	Tue 1/24/12
479	pre-commg of firefighting system for transformer yard (unit 4)	15 d	Sun 8/28/11	Sun 9/11/11
480	Pre-commg of firefighting system for balance plant for Unit 4	30 d	Wed 1/25/12	Thu 2/23/12
481	**Ash Handling for Unit 4**	**566 d**	**Fri 11/12/10**	**Wed 5/30/12**
482	Receipt of materials for Unit 4 at site	0 d	Fri 7/22/11	Fri 7/22/11
483	Erection of bottom ash hopper for Unit 4	30 d	Sun 11/6/11	Mon 12/5/11
484	Erection of conveyors for Bottom Ash hopper of Unit 4 to intermediate silo & from intermediate silo to main conveyor	60 d	Tue 12/6/11	Fri 2/3/12
485	Constructon and erection of main bottom ash silo for Phase 2	420 d	Fri 11/12/10	Thu 1/5/12
486	Erection of piping from ESP of Unit 4 to buffer hopper & buffer hopper to main fly ash silo	120 d	Sun 11/6/11	Sun 3/4/12
487	Erection of HCSD system (phase 2)from main fly ash silo to ash dyke	90 d	Sun 11/6/11	Fri 2/3/12
488	Pre-commissioning activities ash handling for Unit 4	45 d	Mon 4/16/12	Wed 5/30/12

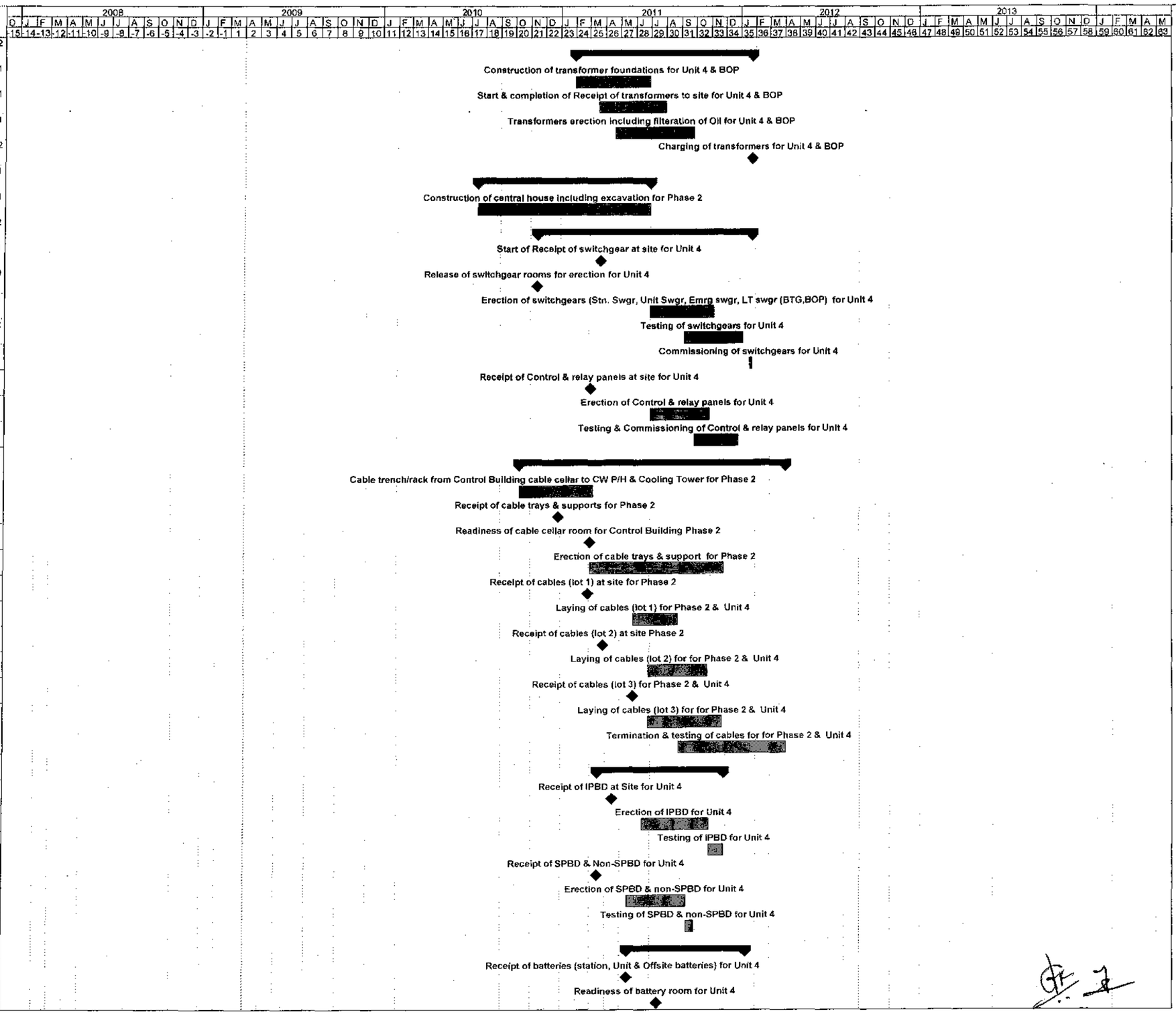


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
489	**Transformers (GT-1no ,UAT-2 no,Service transformers) for Unit 4 & BOP**	**359 d**	**Mon 1/31/11**	**Tue 1/24/12**
490	Construction of transformer foundations for Unit 4 & BOP	150 d	Mon 1/31/11	Wed 6/29/11
491	Start & completion of Receipt of transformers to site for Unit 4 & BOP	135 d	Sat 3/19/11	Sun 7/31/11
492	Transformers erection including filteration of Oil for Unit 4 & BOP	160 d	Wed 4/20/11	Mon 9/26/11
493	Charging of transformers for Unit 4 & BOP	0 d	Tue 1/24/12	Tue 1/24/12
494	**Control House for Phase -2**	**350 d**	**Fri 7/16/10**	**Thu 6/30/11**
495	Construction of central house including excavation for Phase 2	350 d	Fri 7/16/10	Thu 6/30/11
496	**Switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 4 & BOP**	**435 d**	**Mon 11/15/10**	**Tue 1/24/12**
497	Start of Receipt of switchgear at site for Unit 4	0 d	Wed 3/23/11	Wed 3/23/11
498	Release of switchgear rooms for erection for Unit 4	0 d	Mon 11/15/10	Mon 11/15/10
499	Erection of switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 4	130 d	Fri 7/1/11	Mon 11/7/11
500	Testing of switchgears for Unit 4	120 d	Fri 9/9/11	Fri 1/6/12
501	Commissioning of switchgears for Unit 4	5 d	Fri 1/20/12	Tue 1/24/12
502	Receipt of Control & relay panels at site for Unit 4	0 d	Thu 3/3/11	Thu 3/3/11
503	Erection of Control & relay panels for Unit 4	120 d	Fri 7/1/11	Fri 10/28/11
504	Testing & Commissioning of Control & relay panels for Unit 4	90 d	Thu 9/29/11	Tue 12/27/11
505	**Cable trays & Cable for Phase 2**	**541 d**	**Sun 10/10/10**	**Mon 4/2/12**
506	Cable trench/rack from Control Building cable cellar to CW P/H & Cooling Tower for Phase 2	150 d	Sun 10/10/10	Tue 3/8/11
507	Receipt of cable trays & supports for Phase 2	0 d	Tue 12/28/10	Tue 12/28/10
508	Readiness of cable cellar room for Control Building Phase 2	0 d	Thu 3/3/11	Thu 3/3/11
509	Erection of cable trays & support for Phase 2	270 d	Thu 3/3/11	Sun 11/27/11
510	Receipt of cables (lot 1) at site for Phase 2	0 d	Sat 2/26/11	Sat 2/26/11
511	Laying of cables (lot 1) for Phase 2 & Unit 4	90 d	Sun 5/29/11	Fri 8/26/11
512	Receipt of cables (lot 2) at site Phase 2	0 d	Mon 3/28/11	Mon 3/28/11
513	Laying of cables (lot 2) for for Phase 2 & Unit 4	120 d	Tue 6/28/11	Tue 10/25/11
514	Receipt of cables (lot 3) for Phase 2 & Unit 4	0 d	Fri 5/27/11	Fri 5/27/11
515	Laying of cables (lot 3) for for Phase 2 & Unit 4	150 d	Mon 6/27/11	Wed 11/23/11
516	Termination & testing of cables for for Phase 2 & Unit 4	220 d	Sat 8/27/11	Mon 4/2/12
517	**IPBD, SPBD & Non-SPBD for Unit 4**	**255 d**	**Wed 3/16/11**	**Sat 11/26/11**
518	Receipt of IPBD at Site for Unit 4	0 d	Fri 4/15/11	Fri 4/15/11
519	Erection of IPBD for Unit 4	135 d	Wed 6/15/11	Thu 10/27/11
520	Testing of IPBD for Unit 4	30 d	Fri 10/28/11	Sat 11/26/11
521	Receipt of SPBD & Non-SPBD for Unit 4	0 d	Wed 3/16/11	Wed 3/16/11
522	Erection of SPBD & non-SPBD for Unit 4	120 d	Mon 5/16/11	Mon 9/12/11
523	Testing of SPBD & non-SPBD for Unit 4	15 d	Tue 9/13/11	Tue 9/27/11
524	**Battery (station, Unit & Offsite batteries) for Unit 4**	**241 d**	**Sun 5/15/11**	**Wed 1/11/12**
525	Receipt of batteries (station, Unit & Offsite batteries) for Unit 4	0 d	Sun 5/15/11	Sun 5/15/11
526	Readiness of battery room for Unit 4	0 d	Fri 7/15/11	Fri 7/15/11



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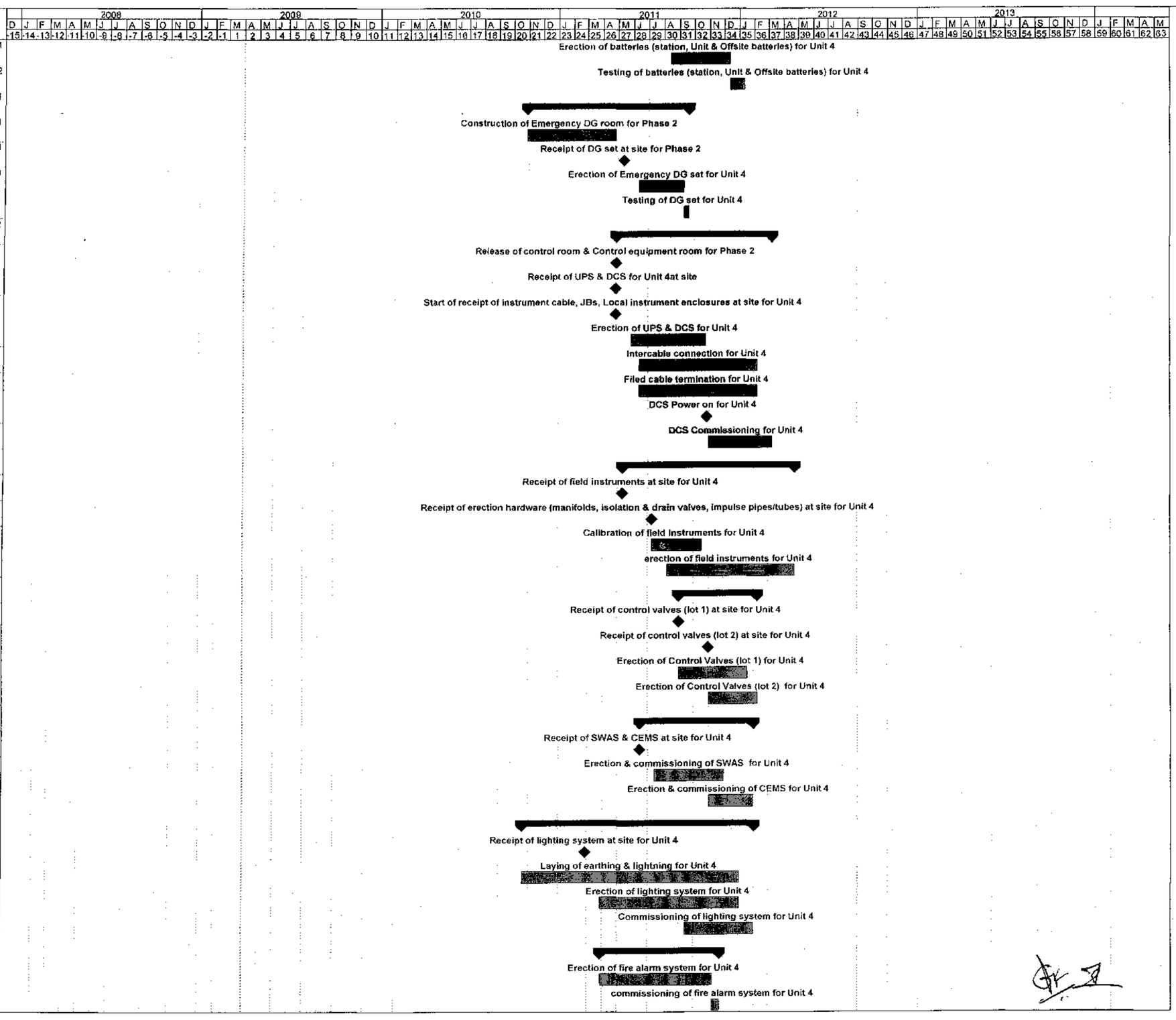
ID	Task description	Duration	Start	Finished
527	Erection of batteries (station, Unit & Offsite batteries) for Unit 4	120 d	Mon 8/15/11	Mon 12/12/11
528	Testing of batteries (station, Unit & Offsite batteries) for Unit 4	30 d	Tue 12/13/11	Wed 1/11/12
529	**Emergency Dgset for Unit 4**	**326 d**	**Fri 10/29/10**	**Mon 9/19/11**
530	Construction of Emergency DG room for Phase 2	180 d	Fri 10/29/10	Tue 4/26/11
531	Receipt of DG set at site for Phase 2	0 d	Thu 5/12/11	Thu 5/12/11
532	Erection of Emergency DG set for Unit 4	90 d	Sun 6/12/11	Fri 9/9/11
533	Testing of DG set for Unit 4	10 d	Sat 9/10/11	Mon 9/19/11
534	**DCS, UPS, cables for Unit 4**	**316 d**	**Wed 4/27/11**	**Thu 3/8/12**
535	Release of control room & Control equipment room for Phase 2	0 d	Thu 4/28/11	Thu 4/28/11
536	Receipt of UPS & DCS for Unit 4at site	0 d	Wed 4/27/11	Wed 4/27/11
537	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 4	0 d	Wed 4/27/11	Wed 4/27/11
538	Erection of UPS & DCS for Unit 4	150 d	Sun 5/29/11	Tue 10/25/11
539	intercable connection for Unit 4	240 d	Mon 6/13/11	Tue 2/7/12
540	Filed cable termination for Unit 4	240 d	Mon 6/13/11	Tue 2/7/12
541	DCS Power on for Unit 4	0 d	Thu 10/27/11	Thu 10/27/11
542	DCS Commissioning for Unit 4	130 d	Mon 10/31/11	Thu 3/8/12
543	**Field Instruments for Unit 4**	**350 d**	**Tue 5/10/11**	**Tue 4/24/12**
544	Receipt of field instruments at site for Unit 4	0 d	Tue 5/10/11	Tue 5/10/11
545	Receipt of erection hardware (manifolds, isolation & drain valves, impulse pipes/tubes) at site for Unit 4	0 d	Sat 7/9/11	Sat 7/9/11
546	Calibration of field instruments for Unit 4	100 d	Sun 7/10/11	Mon 10/17/11
547	erection of field instruments for Unit 4	260 d	Tue 8/9/11	Tue 4/24/12
548	**Control valves for Unit 4**	**160 d**	**Thu 9/1/11**	**Wed 2/8/12**
549	Receipt of control valves (lot 1) at site for Unit 4	0 d	Thu 9/1/11	Thu 9/1/11
550	Receipt of control valves (lot 2) at site for Unit 4	0 d	Mon 10/31/11	Mon 10/31/11
551	Erection of Control Valves (lot 1) for Unit 4	140 d	Fri 9/2/11	Thu 1/19/12
552	Erection of Control Valves (lot 2) for Unit 4	100 d	Tue 11/1/11	Wed 2/8/12
553	**CEMS & SWAS for Unit 4**	**230 d**	**Tue 5/14/11**	**Mon 1/30/12**
554	Receipt of SWAS & CEMS at site for Unit 4	0 d	Tue 5/14/11	Tue 5/14/11
555	Erection & commissioning of SWAS for Unit 4	140 d	Fri 7/15/11	Thu 12/1/11
556	Erection & commissioning of CEMS for Unit 4	90 d	Wed 11/2/11	Mon 1/30/12
557	**lighting system for Unit 4**	**470 d**	**Tue 10/19/10**	**Tue 1/31/12**
558	Receipt of lighting system at site for Unit 4	0 d	Fri 2/25/11	Fri 2/25/11
559	Laying of earthing & lightning for Unit 4	440 d	Tue 10/19/10	Sun 1/1/12
560	Erection of lighting system for Unit 4	280 d	Mon 3/28/11	Sun 1/1/12
561	Commissioning of lighting system for Unit 4	140 d	Wed 9/14/11	Tue 1/31/12
562	**fire alarm system for Unit 4**	**240 d**	**Mon 3/28/11**	**Tue 11/22/11**
563	Erection of fire alarm system for Unit 4	225 d	Mon 3/28/11	Mon 11/7/11
564	commissioning of fire alarm system for Unit 4	15 d	Tue 11/8/11	Tue 11/22/11



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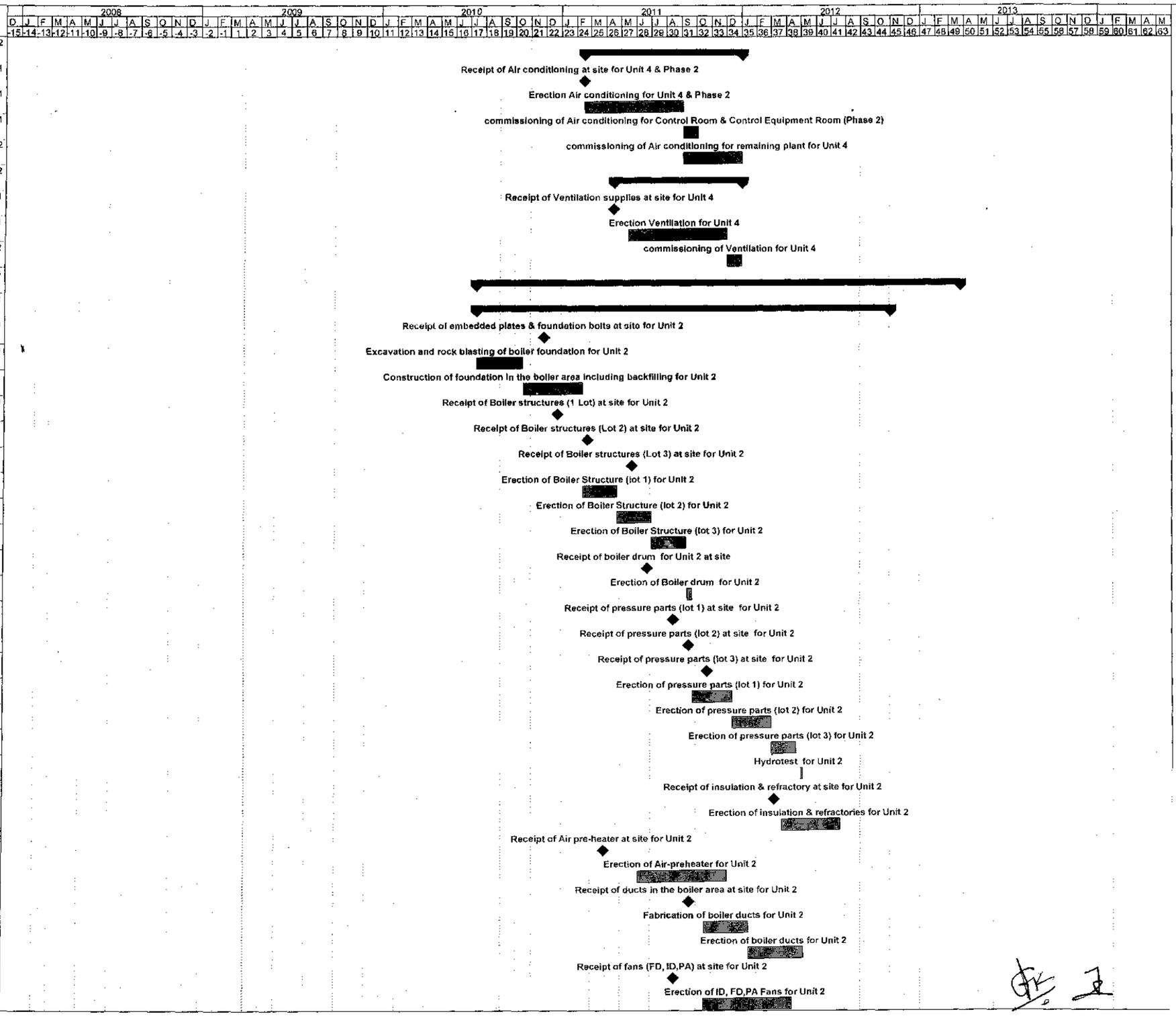
3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
565	**Air conditioning for Unit 4**	**320 d**	**Wed 2/16/11**	**Mon 1/2/12**
566	Receipt of Air conditioning at site for Unit 4 & Phase 2	0 d	Wed 2/16/11	Wed 2/16/11
567	Erection Air conditioning for Unit 4 & Phase 2	200 d	Thu 2/17/11	Sun 9/4/11
568	commissioning of Air conditioning for Control Room & Control Equipment Room (Phase 2)	30 d	Tue 9/6/11	Wed 10/5/11
569	commissioning of Air conditioning for remaining plant for Unit 4	120 d	Mon 9/5/11	Mon 1/2/12
570	**Ventilation unit for Unit 4**	**260 d**	**Sun 4/17/11**	**Mon 1/2/12**
571	Receipt of Ventilation supplies at site for Unit 4	0 d	Sun 4/17/11	Sun 4/17/11
572	Erection Ventilation for Unit 4	200 d	Wed 5/18/11	Sat 12/3/11
573	commissioning of Ventilation for Unit 4	30 d	Sun 12/4/11	Mon 1/2/12
574	**Schedule for Unit 2**	**985 d**	**Thu 7/15/10**	**Mon 3/25/13**
575	**Boiler & Boiler Auxiliaries (Unit 2)**	**842 d**	**Thu 7/15/10**	**Fri 11/2/12**
576	Receipt of embedded plates & foundation bolts at site for Unit 2	0 d	Sun 11/28/10	Sun 11/28/10
577	Excavation and rock blasting of boiler foundation for Unit 2	94 d	Thu 7/15/10	Sat 10/16/10
578	Construction of foundation in the boiler area including backfilling for Unit 2	120 d	Mon 10/18/10	Mon 2/14/11
579	Receipt of Boiler structures (1 Lot) at site for Unit 2	0 d	Sat 12/25/10	Sat 12/25/10
580	Receipt of Boiler structures (Lot 2) at site for Unit 2	0 d	Thu 2/24/11	Thu 2/24/11
581	Receipt of Boiler structures (Lot 3) at site for Unit 2	0 d	Wed 5/25/11	Wed 5/25/11
582	Erection of Boiler Structure (lot 1) for Unit 2	70 d	Tue 2/15/11	Mon 4/25/11
583	Erection of Boiler Structure (lot 2) for Unit 2	70 d	Tue 4/26/11	Mon 7/4/11
584	Erection of Boiler Structure (lot 3) for Unit 2	70 d	Tue 7/5/11	Mon 9/12/11
585	Receipt of boiler drum for Unit 2 at site	0 d	Sat 6/25/11	Sat 6/25/11
586	Erection of Boiler drum for Unit 2	10 d	Thu 9/15/11	Sat 9/24/11
587	Receipt of pressure parts (lot 1) at site for Unit 2	0 d	Wed 8/17/11	Wed 8/17/11
588	Receipt of pressure parts (lot 2) at site for Unit 2	0 d	Sat 9/17/11	Sat 9/17/11
589	Receipt of pressure parts (lot 3) at site for Unit 2	0 d	Mon 10/24/11	Mon 10/24/11
590	Erection of pressure parts (lot 1) for Unit 2	80 d	Sun 9/25/11	Tue 12/13/11
591	Erection of pressure parts (lot 2) for Unit 2	80 d	Wed 12/14/11	Fri 3/2/12
592	Erection of pressure parts (lot 3) for Unit 2	50 d	Sat 3/3/12	Sat 4/21/12
593	Hydrotest for Unit 2	4 d	Wed 5/2/12	Sat 5/5/12
594	Receipt of insulation & refractory at site for Unit 2	0 d	Thu 3/8/12	Thu 3/8/12
595	Erection of insulation & refractories for Unit 2	120 d	Sat 3/24/12	Sat 7/21/12
596	Receipt of Air pre-heater at site for Unit 2	0 d	Mon 3/28/11	Mon 3/28/11
597	Erection of Air-preheater for Unit 2	180 d	Mon 6/6/11	Fri 12/2/11
598	Receipt of ducts in the boiler area at site for Unit 2	0 d	Sat 9/17/11	Sat 9/17/11
599	Fabrication of boiler ducts for Unit 2	90 d	Tue 10/18/11	Sun 1/15/12
600	Erection of boiler ducts for Unit 2	112 d	Mon 1/16/12	Sun 5/6/12
601	Receipt of fans (FD, ID,PA) at site for Unit 2	0 d	Wed 8/17/11	Wed 8/17/11
602	Erection of ID, FD,PA Fans for Unit 2	180 d	Mon 10/17/11	Fri 4/13/12



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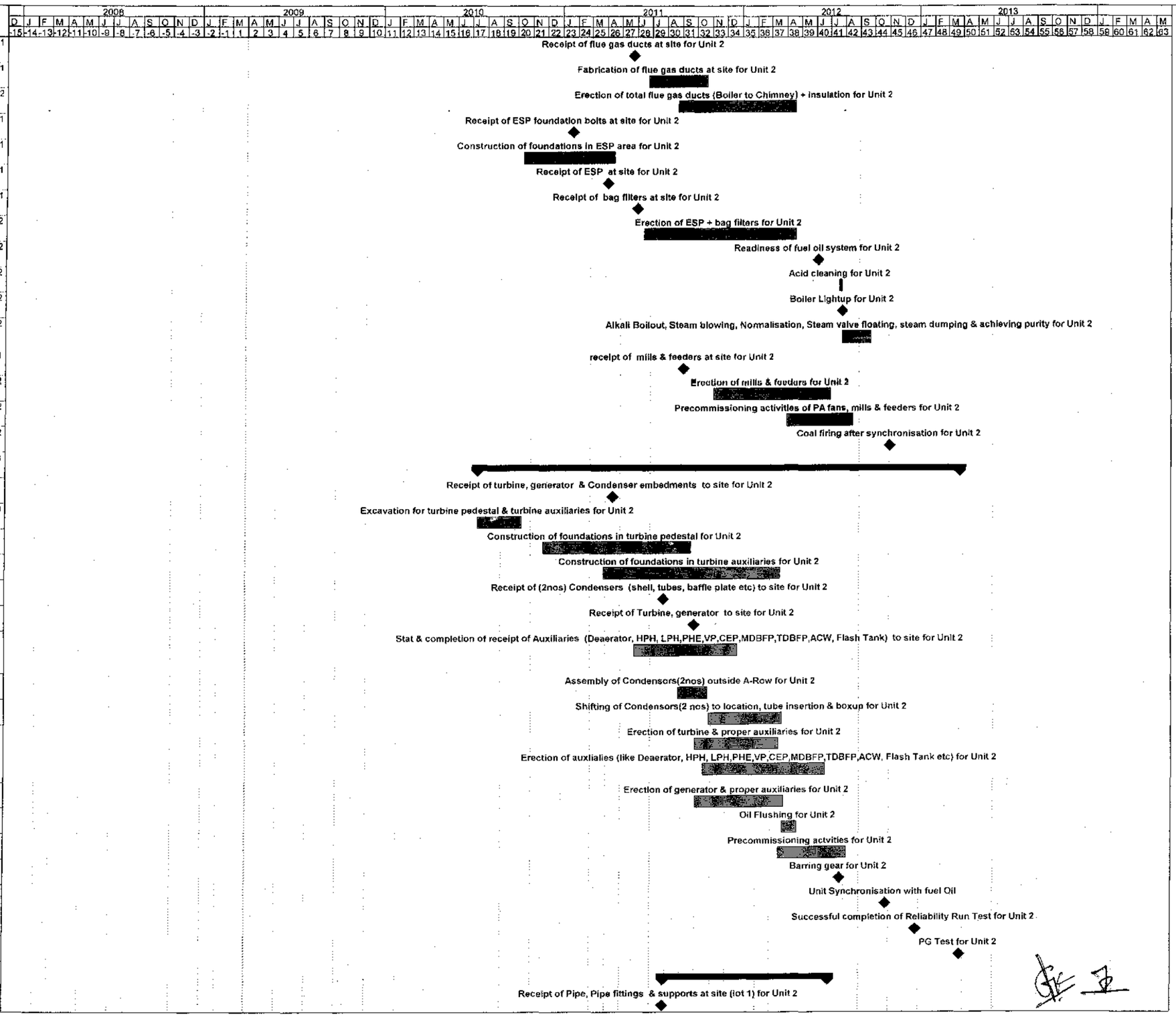
L1 SCHEDULE

ID	Task description	Duration	Start	Finished
603	Receipt of flue gas ducts at site for Unit 2	0 d	Wed 5/25/11	Wed 5/25/11
604	Fabrication of flue gas ducts at site for Unit 2	120 d	Sat 6/25/11	Sat 10/22/11
605	Erection of total flue gas ducts (Boiler to Chimney) + insulation for Unit 2	240 d	Wed 8/24/11	Thu 4/19/12
606	Receipt of ESP foundation bolts at site for Unit 2	0 d	Sat 1/22/11	Sat 1/22/11
607	Construction of foundations in ESP area for Unit 2	184 d	Fri 10/15/10	Sat 4/16/11
608	Receipt of ESP at site for Unit 2	0 d	Sun 4/3/11	Sun 4/3/11
609	Receipt of bag filters at site for Unit 2	0 d	Thu 6/2/11	Thu 6/2/11
610	Erection of ESP + bag filters for Unit 2	310 d	Thu 6/16/11	Fri 4/20/12
611	Readiness of fuel oil system for Unit 2	0 d	Wed 6/6/12	Wed 6/6/12
612	Acid cleaning for Unit 2	5 d	Sun 7/22/12	Thu 7/26/12
613	Boiler Lightup for Unit 2	0 d	Fri 7/27/12	Fri 7/27/12
614	Alkali Boilout, Steam blowing, Normalisation, Steam valve floating, steam dumping & achieving purity for Unit 2	60 d	Sat 7/28/12	Tue 9/25/12
615	receipt of mills & feeders at site for Unit 2	0 d	Tue 9/6/11	Tue 9/6/11
616	Erection of mills & feeders for Unit 2	240 d	Sun 11/6/11	Mon 7/2/12
617	Precommissioning activities of PA fans, mills & feeders for Unit 2	138 d	Wed 4/4/12	Sun 8/19/12
618	Coal firing after synchronisation for Unit 2	0 d	Fri 11/2/12	Fri 11/2/12
619	**Turbine (Unit 2)**	**984 d**	**Fri 7/16/10**	**Mon 3/25/13**
620	Receipt of turbine, generator & Condenser embedments to site for Unit 2	0 d	Fri 4/15/11	Fri 4/15/11
621	Excavation for turbine pedestal & turbine auxiliaries for Unit 2	90 d	Fri 7/16/10	Wed 10/13/10
622	Construction of foundations in turbine pedestal for Unit 2	300 d	Fri 11/26/10	Wed 9/21/11
623	Construction of foundations in turbine auxiliaries for Unit 2	360 d	Mon 3/28/11	Wed 3/21/12
624	Receipt of (2nos) Condensers (shell, tubes, baffle plate etc) to site for Unit 2	0 d	Thu 7/28/11	Thu 7/28/11
625	Receipt of Turbine, generator to site for Unit 2	0 d	Wed 9/28/11	Wed 9/28/11
626	Stat & completion of receipt of Auxiliaries (Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank) to site for Unit 2	210 d	Mon 5/30/11	Sun 12/25/11
627	Assembly of Condensors(2nos) outside A-Row for Unit 2	80 d	Sun 8/28/11	Wed 10/26/11
628	Shifting of Condensors(2 nos) to location, tube insertion & boxup for Unit 2	150 d	Fri 10/28/11	Sun 3/25/12
629	Erection of turbine & proper auxiliaries for Unit 2	170 d	Sat 10/1/11	Sun 3/18/12
630	Erection of auxiliaries (like Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank etc) for Unit 2	250 d	Sun 10/16/11	Thu 6/21/12
631	Erection of generator & proper auxiliaries for Unit 2	180 d	Sat 10/1/11	Wed 3/28/12
632	Oil Flushing for Unit 2	30 d	Mon 3/26/12	Tue 4/24/12
633	Precommissioning actvities for Unit 2	140 d	Mon 3/19/12	Sun 8/5/12
634	Barring gear for Unit 2	0 d	Sun 7/22/12	Sun 7/22/12
635	Unit Synchronisation with fuel Oil	0 d	Thu 10/25/12	Thu 10/25/12
636	Successful completion of Reliability Run Test for Unit 2	0 d	Tue 12/25/12	Tue 12/25/12
637	PG Test for Unit 2	0 d	Mon 3/25/13	Mon 3/25/13
638	**Power Cycle Piping (Unit 2)**	**337 d**	**Wed 7/27/11**	**Thu 6/28/12**
639	Receipt of Pipe, Pipe fittings & supports at site (lot 1) for Unit 2	0 d	Wed 7/27/11	Wed 7/27/11



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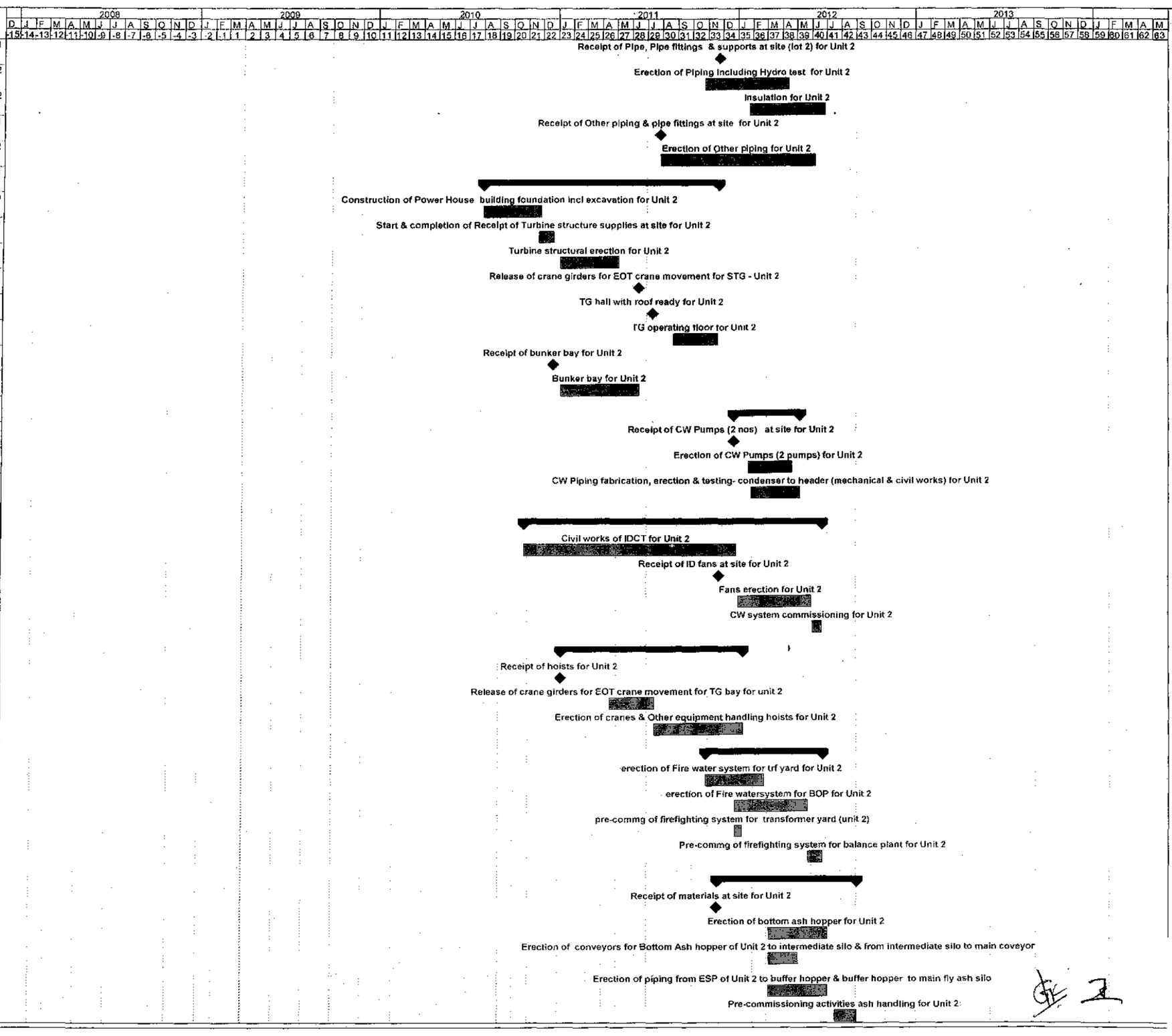
3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
640	Receipt of Pipe, Pipe fittings & supports at site (lot 2) for Unit 2	0 d	Thu 11/24/11	Thu 11/24/11
641	Erection of Piping including Hydro test for Unit 2	172 d	Wed 10/26/11	Sat 4/14/12
642	Insulation for Unit 2	155 d	Thu 1/26/12	Thu 6/28/12
643	Receipt of Other piping & pipe fittings at site for Unit 2	0 d	Wed 7/27/11	Wed 7/27/11
644	Erection of Other piping for Unit 2	315 d	Thu 7/28/11	Wed 6/6/12
645	**Power House building for Unit 2**	**479 d**	**Sun 8/1/10**	**Tue 11/22/11**
646	Construction of Power House building foundation incl excavation for Unit 2	120 d	Sun 8/1/10	Sun 11/28/10
647	Start & completion of Receipt of Turbine structure supplies at site for Unit 2	30 d	Wed 11/24/10	Thu 12/23/10
648	Turbine structural erection for Unit 2	120 d	Fri 1/7/11	Fri 5/6/11
649	Release of crane girders for EOT crane movement for STG - Unit 2	0 d	Wed 6/15/11	Wed 6/15/11
650	TG hall with roof ready for Unit 2	0 d	Wed 7/13/11	Wed 7/13/11
651	TG operating floor for Unit 2	90 d	Thu 8/25/11	Tue 11/22/11
652	Receipt of bunker bay for Unit 2	0 d	Thu 12/23/10	Thu 12/23/10
653	Bunker bay for Unit 2	160 d	Fri 1/7/11	Wed 6/15/11
654	**CW system for Unit 2**	**136 d**	**Sat 12/24/11**	**Tue 5/8/12**
655	Receipt of CW Pumps (2 nos) at site for Unit 2	0 d	Sat 12/24/11	Sat 12/24/11
656	Erection of CW Pumps (2 pumps) for Unit 2	90 d	Tue 1/24/12	Sun 4/22/12
657	CW Piping fabrication, erection & testing- condenser to header (mechanical & civil works) for Unit 2	100 d	Mon 1/30/12	Tue 5/8/12
658	**IDCT Construction for Unit 2**	**607 d**	**Mon 10/25/10**	**Fri 6/22/12**
659	Civil works of IDCT for Unit 2	430 d	Mon 10/25/10	Wed 12/28/11
660	Receipt of ID fans at site for Unit 2	0 d	Thu 11/24/11	Thu 11/24/11
661	Fans erection for Unit 2	150 d	Tue 1/3/12	Thu 5/31/12
662	CW system commissioning for Unit 2	20 d	Sun 6/3/12	Fri 6/22/12
663	**Cranes & Hoists for Unit 2**	**370 d**	**Fri 1/7/11**	**Thu 1/12/12**
664	Receipt of hoists for Unit 2	0 d	Fri 1/7/11	Fri 1/7/11
665	Release of crane girders for EOT crane movement for TG bay for unit 2	90 d	Mon 4/18/11	Sat 7/16/11
666	Erection of cranes & Other equipment handling hoists for Unit 2	180 d	Sun 7/17/11	Thu 1/12/12
667	**Fire Fighting System for Unit 2**	**240 d**	**Fri 10/28/11**	**Sat 6/23/12**
668	erection of Fire water system for trf yard for Unit 2	120 d	Fri 10/28/11	Fri 2/24/12
669	erection of Fire watersystem for BOP for Unit 2	150 d	Tue 12/27/11	Thu 5/24/12
670	pre-commg of firefighting system for transformer yard (unit 2)	15 d	Tue 12/27/11	Tue 1/10/12
671	Pre-commg of firefighting system for balance plant for Unit 2	30 d	Fri 5/25/12	Sat 6/23/12
672	**Ash Handling for Unit 2**	**287 d**	**Sat 11/19/11**	**Sat 9/1/12**
673	Receipt of materials at site for Unit 2	0 d	Sat 11/19/11	Sat 11/19/11
674	Erection of bottom ash hopper for Unit 2	120 d	Tue 3/6/12	Tue 7/3/12
675	Erection of conveyors for Bottom Ash hopper of Unit 2 to intermediate silo & from intermediate silo to main coveyor	60 d	Tue 3/6/12	Fri 5/4/12
676	Erection of piping from ESP of Unit 2 to buffer hopper & buffer hopper to main fly ash silo	120 d	Tue 3/6/12	Tue 7/3/12
677	Pre-commissioning activities ash handling for Unit 2	45 d	Thu 7/19/12	Sat 9/1/12

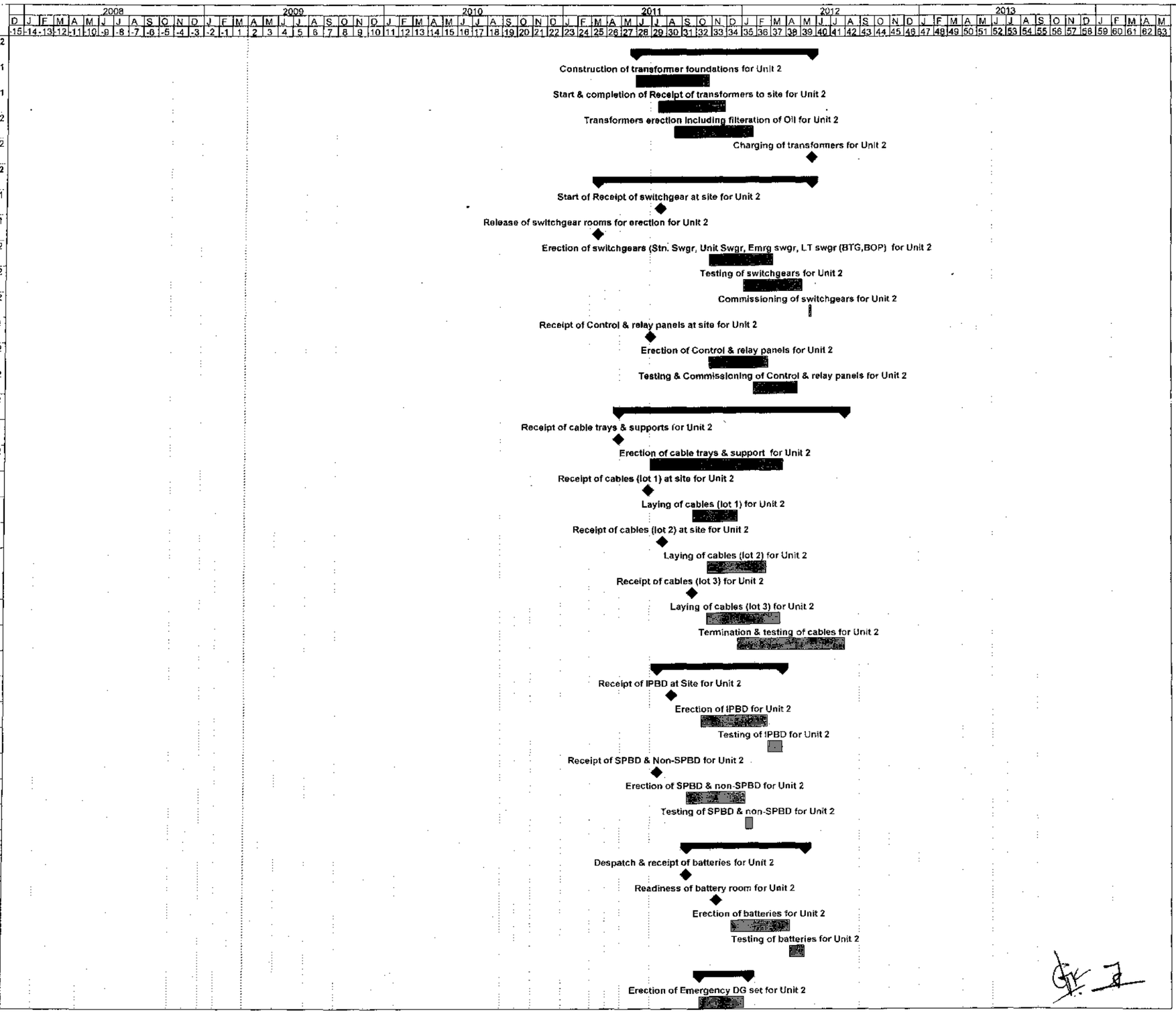


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
678	**Transformers (St-1,GT-1no,UAT-2 no,Service transformers) for Unit 2 & BOP**	**359 d**	**Wed 6/1/11**	**Thu 5/24/12**
679	Construction of transformer foundations for Unit 2	150 d	Wed 6/1/11	Fri 10/28/11
680	Start & completion of Receipt of transformers to site for Unit 2	135 d	Mon 7/18/11	Tue 11/29/11
681	Transformers erection including filteration of Oil for Unit 2	160 d	Fri 8/19/11	Wed 1/25/12
682	Charging of transformers for Unit 2	0 d	Thu 5/24/12	Thu 5/24/12
683	**Switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 2 & BOP**	**435 d**	**Wed 3/16/11**	**Thu 5/24/12**
684	Start of Receipt of switchgear at site for Unit 2	0 d	Fri 7/22/11	Fri 7/22/11
685	Release of switchgear rooms for erection for Unit 2	0 d	Wed 3/16/11	Wed 3/16/11
686	Erection of switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 2	130 d	Sun 10/30/11	Wed 3/7/12
687	Testing of switchgears for Unit 2	120 d	Sun 1/8/12	Sun 5/6/12
688	Commissioning of switchgears for Unit 2	5 d	Sun 5/20/12	Thu 5/24/12
689	Receipt of Control & relay panels at site for Unit 2	0 d	Sat 7/2/11	Sat 7/2/11
690	Erection of Control & relay panels for Unit 2	120 d	Sun 10/30/11	Sun 2/26/12
691	Testing & Commissioning of Control & relay panels for Unit 2	90 d	Sat 1/28/12	Thu 4/26/12
692	**Cable trays & Cable for Unit 2**	**461 d**	**Thu 4/28/11**	**Wed 8/1/12**
693	Receipt of cable trays & supports for Unit 2	0 d	Thu 4/28/11	Thu 4/28/11
694	Erection of cable trays & support for Unit 2	270 d	Sat 7/2/11	Tue 3/27/12
695	Receipt of cables (lot 1) at site for Unit 2	0 d	Mon 6/27/11	Mon 6/27/11
696	Laying of cables (lot 1) for Unit 2	90 d	Tue 9/27/11	Sun 12/25/11
697	Receipt of cables (lot 2) at site for Unit 2	0 d	Wed 7/27/11	Wed 7/27/11
698	Laying of cables (lot 2) for Unit 2	120 d	Thu 10/27/11	Thu 2/23/12
699	Receipt of cables (lot 3) for Unit 2	0 d	Sun 9/25/11	Sun 9/25/11
700	Laying of cables (lot 3) for Unit 2	150 d	Wed 10/26/11	Fri 3/23/12
701	Termination & testing of cables for Unit 2	220 d	Mon 12/26/11	Wed 8/1/12
702	**IPBD, SPBD & Non-SPBD for Unit 2**	**255 d**	**Fri 7/15/11**	**Mon 3/26/12**
703	Receipt of IPBD at Site for Unit 2	0 d	Sun 8/14/11	Sun 8/14/11
704	Erection of IPBD for Unit 2	135 d	Fri 10/14/11	Sat 2/25/12
705	Testing of IPBD for Unit 2	30 d	Sun 2/26/12	Mon 3/26/12
706	Receipt of SPBD & Non-SPBD for Unit 2	0 d	Fri 7/15/11	Fri 7/15/11
707	Erection of SPBD & non-SPBD for Unit 2	120 d	Wed 9/14/11	Wed 1/11/12
708	Testing of SPBD & non-SPBD for Unit 2	15 d	Thu 1/12/12	Thu 1/26/12
709	**Battery (station, Unit & Offsite batteries) for Unit 2**	**241 d**	**Tue 9/13/11**	**Fri 5/11/12**
710	Despatch & receipt of batteries for Unit 2	0 d	Tue 9/13/11	Tue 9/13/11
711	Readiness of battery room for Unit 2	0 d	Sun 11/13/11	Sun 11/13/11
712	Erection of batteries for Unit 2	120 d	Wed 12/14/11	Wed 4/11/12
713	Testing of batteries for Unit 2	30 d	Thu 4/12/12	Fri 5/11/12
714	**Emergency Dgset for Unit 2**	**100 d**	**Tue 10/11/11**	**Wed 1/18/12**
715	Erection of Emergency DG set for Unit 2	90 d	Tue 10/11/11	Sun 1/8/12



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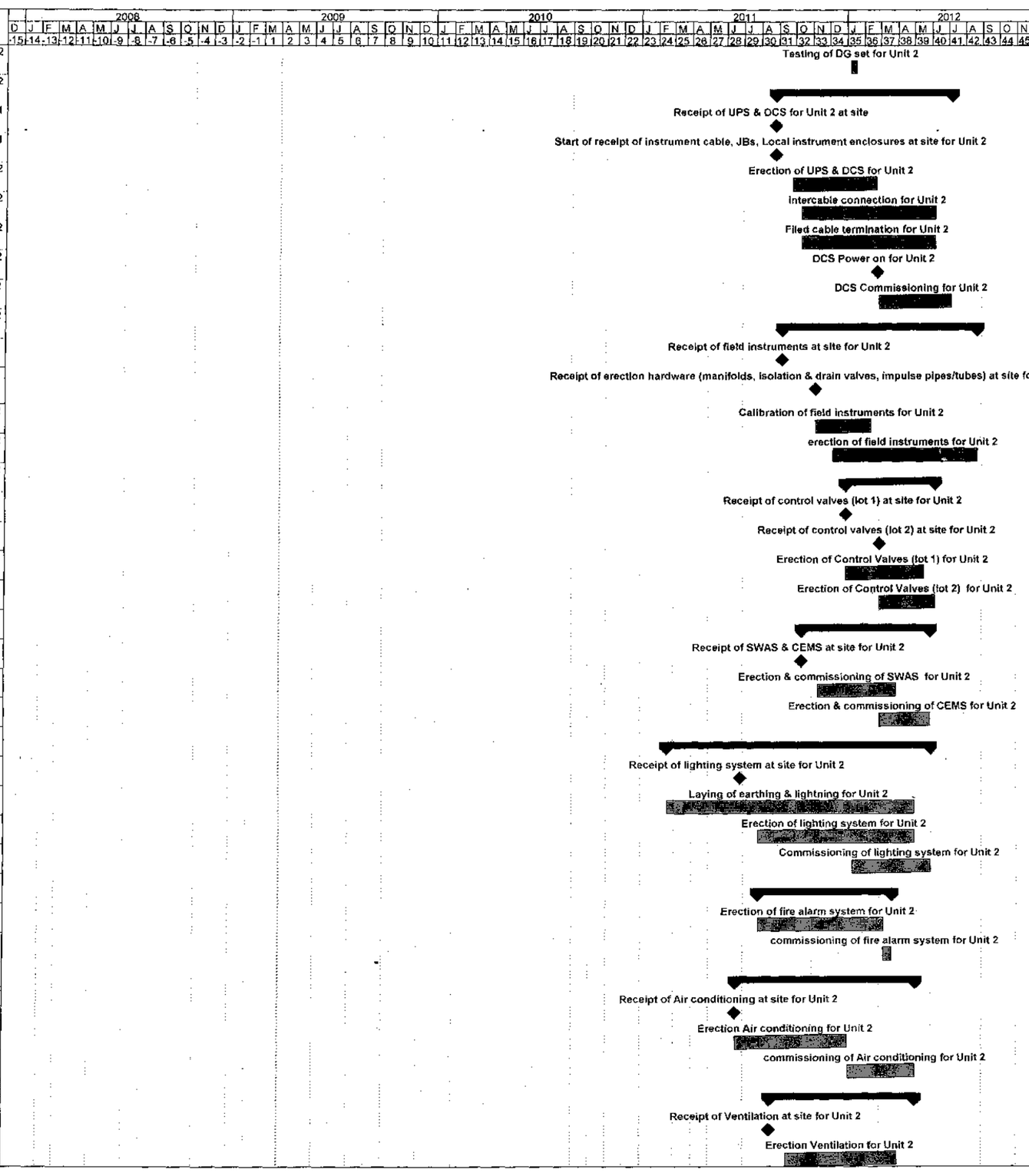
L1 SCHEDULE

ID	Task description	Duration	Start	Finished
716	Testing of DG set for Unit 2	10 d	Mon 1/9/12	Wed 1/18/12
717	**DCS, UPS, cables for Unit 2**	**316 d**	**Fri 8/26/11**	**Sat 7/7/12**
718	Receipt of UPS & DCS for Unit 2 at site	0 d	Fri 8/26/11	Fri 8/26/11
719	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 2	0 d	Fri 8/26/11	Fri 8/26/11
720	Erection of UPS & DCS for Unit 2	150 d	Tue 9/27/11	Thu 2/23/12
721	intercable connection for Unit 2	240 d	Wed 10/12/11	Thu 6/7/12
722	Filed cable termination for Unit 2	240 d	Wed 10/12/11	Thu 6/7/12
723	DCS Power on for Unit 2	0 d	Sat 2/25/12	Sat 2/25/12
724	DCS Commissioning for Unit 2	130 d	Wed 2/29/12	Sat 7/7/12
725	**Field Instruments for Unit 2**	**350 d**	**Thu 9/8/11**	**Thu 8/23/12**
726	Receipt of field instruments at site for Unit 2	0 d	Thu 9/8/11	Thu 9/8/11
727	Receipt of erection hardware (manifolds, isolation & drain valves, impulse pipes/tubes) at site for Unit 2	0 d	Mon 11/7/11	Mon 11/7/11
728	Calibration of field instruments for Unit 2	100 d	Tue 11/8/11	Wed 2/15/12
729	erection of field instruments for Unit 2	260 d	Thu 12/8/11	Thu 8/23/12
730	**Control valves for Unit 2**	**160 d**	**Sat 12/31/11**	**Fri 6/8/12**
731	Receipt of control valves (lot 1) at site for Unit 2	0 d	Sat 12/31/11	Sat 12/31/11
732	Receipt of control valves (lot 2) at site for Unit 2	0 d	Wed 2/29/12	Wed 2/29/12
733	Erection of Control Valves (lot 1) for Unit 2	140 d	Sun 1/1/12	Sat 5/19/12
734	Erection of Control Valves (lot 2) for Unit 2	100 d	Thu 3/1/12	Fri 6/8/12
735	**CEMS & SWAS for Unit 2**	**230 d**	**Thu 10/13/11**	**Wed 5/30/12**
736	Receipt of SWAS & CEMS at site for Unit 2	0 d	Thu 10/13/11	Thu 10/13/11
737	Erection & commissioning of SWAS for Unit 2	140 d	Sun 11/13/11	Sat 3/31/12
738	Erection & commissioning of CEMS for Unit 2	90 d	Fri 3/2/12	Wed 5/30/12
739	**lighting system for Unit 2**	**470 d**	**Thu 2/17/11**	**Thu 5/31/12**
740	Receipt of lighting system at site for Unit 2	0 d	Sun 6/26/11	Sun 6/26/11
741	Laying of earthing & lightning for Unit 2	440 d	Thu 2/17/11	Tue 5/1/12
742	Erection of lighting system for Unit 2	280 d	Wed 7/27/11	Tue 5/1/12
743	Commissioning of lighting system for Unit 2	140 d	Fri 1/13/12	Thu 5/31/12
744	**fire alarm system for Unit 2**	**240 d**	**Wed 7/27/11**	**Thu 3/22/12**
745	Erection of fire alarm system for Unit 2	225 d	Wed 7/27/11	Wed 3/7/12
746	commissioning of fire alarm system for Unit 2	15 d	Thu 3/8/12	Thu 3/22/12
747	**Air conditioning for Unit 2**	**321 d**	**Fri 6/17/11**	**Thu 5/3/12**
748	Receipt of Air conditioning at site for Unit 2	0 d	Fri 6/17/11	Fri 6/17/11
749	Erection Air conditioning for Unit 2	200 d	Sat 6/18/11	Tue 1/3/12
750	commissioning of Air conditioning for Unit 2	120 d	Thu 1/5/12	Thu 5/3/12
751	**Ventilation for Unit 2**	**260 d**	**Tue 8/16/11**	**Wed 5/2/12**
752	Receipt of Ventilation at site for Unit 2	0 d	Tue 8/16/11	Tue 8/16/11
753	Erection Ventilation for Unit 2	200 d	Fri 9/16/11	Mon 4/2/12

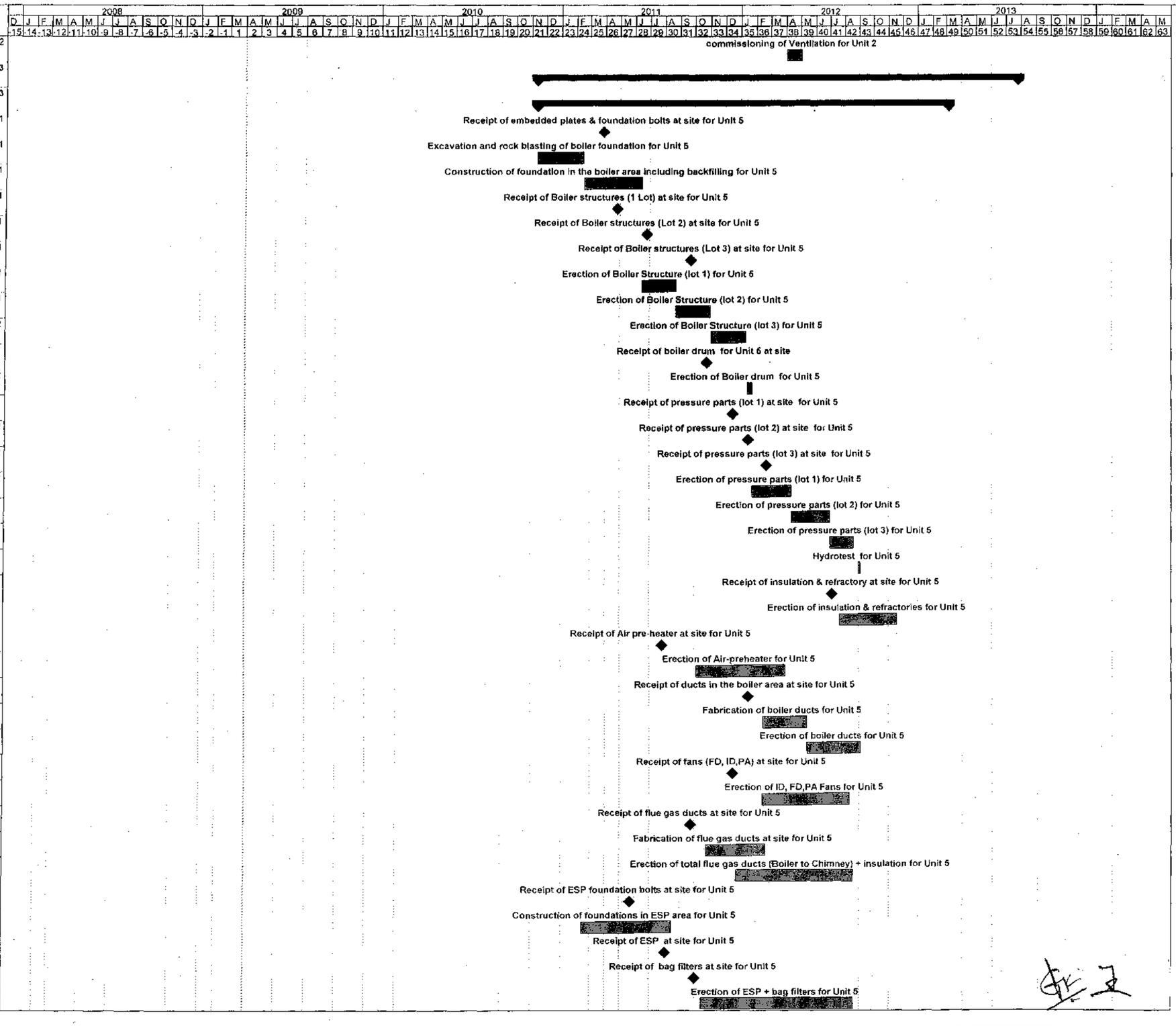


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
754	commissioning of Ventilation for Unit 2	30 d	Tue 4/3/12	Wed 5/2/12
755	**Schedule for Unit 5**	**986 d**	**Sat 11/13/10**	**Thu 7/25/13**
756	**Boiler & Boiler Auxiliaries (Unit 5)**	**844 d**	**Sat 11/13/10**	**Tue 3/5/13**
757	Receipt of embedded plates & foundation bolts at site for Unit 5	0 d	Mon 3/28/11	Mon 3/28/11
758	Excavation and rock blasting of boiler foundation for Unit 5	94 d	Sat 11/13/10	Mon 2/14/11
759	Construction of foundation in the boiler area including backfilling for Unit 5	120 d	Wed 2/16/11	Wed 6/15/11
760	Receipt of Boiler structures (1 Lot) at site for Unit 5	0 d	Mon 4/25/11	Mon 4/25/11
761	Receipt of Boiler structures (Lot 2) at site for Unit 5	0 d	Sat 6/25/11	Sat 6/25/11
762	Receipt of Boiler structures (Lot 3) at site for Unit 5	0 d	Fri 9/23/11	Fri 9/23/11
763	Erection of Boiler Structure (lot 1) for Unit 5	70 d	Thu 6/16/11	Wed 8/24/11
764	Erection of Boiler Structure (lot 2) for Unit 5	70 d	Thu 8/25/11	Wed 11/2/11
765	Erection of Boiler Structure (lot 3) for Unit 5	70 d	Thu 11/3/11	Wed 1/11/12
766	Receipt of boiler drum for Unit 5 at site	0 d	Tue 10/25/11	Tue 10/25/11
767	Erection of Boiler drum for Unit 5	10 d	Sun 1/15/12	Tue 1/24/12
768	Receipt of pressure parts (lot 1) at site for Unit 5	0 d	Fri 12/16/11	Fri 12/16/11
769	Receipt of pressure parts (lot 2) at site for Unit 5	0 d	Mon 1/16/12	Mon 1/16/12
770	Receipt of pressure parts (lot 3) at site for Unit 5	0 d	Wed 2/22/12	Wed 2/22/12
771	Erection of pressure parts (lot 1) for Unit 5	80 d	Wed 1/25/12	Fri 4/13/12
772	Erection of pressure parts (lot 2) for Unit 5	80 d	Sat 4/14/12	Mon 7/2/12
773	Erection of pressure parts (lot 3) for Unit 5	50 d	Tue 7/3/12	Tue 8/21/12
774	Hydrotest for Unit 5	4 d	Sat 9/1/12	Tue 9/4/12
775	Receipt of insulation & refractory at site for Unit 5	0 d	Sat 7/7/12	Sat 7/7/12
776	Erection of insulation & refractories for Unit 5	120 d	Mon 7/23/12	Mon 11/19/12
777	Receipt of Air pre-heater at site for Unit 5	0 d	Wed 7/27/11	Wed 7/27/11
778	Erection of Air-preheater for Unit 5	180 d	Wed 10/5/11	Sun 4/1/12
779	Receipt of ducts in the boiler area at site for Unit 5	0 d	Mon 1/16/12	Mon 1/16/12
780	Fabrication of boiler ducts for Unit 5	90 d	Thu 2/16/12	Tue 5/15/12
781	Erection of boiler ducts for Unit 5	112 d	Wed 5/16/12	Tue 9/4/12
782	Receipt of fans (FD, ID,PA) at site for Unit 5	0 d	Fri 12/16/11	Fri 12/16/11
783	Erection of ID, FD,PA Fans for Unit 5	180 d	Wed 2/15/12	Sun 8/12/12
784	Receipt of flue gas ducts at site for Unit 5	0 d	Fri 9/23/11	Fri 9/23/11
785	Fabrication of flue gas ducts at site for Unit 5	120 d	Mon 10/24/11	Mon 2/20/12
786	Erection of total flue gas ducts (Boiler to Chimney) + insulation for Unit 5	240 d	Fri 12/23/11	Sat 8/18/12
787	Receipt of ESP foundation bolts at site for Unit 5	0 d	Sun 5/22/11	Sun 5/22/11
788	Construction of foundations in ESP area for Unit 5	184 d	Sun 2/13/11	Mon 8/15/11
789	Receipt of ESP at site for Unit 5	0 d	Tue 8/2/11	Tue 8/2/11
790	Receipt of bag filters at site for Unit 5	0 d	Sat 10/1/11	Sat 10/1/11
791	Erection of ESP + bag filters for Unit 5	310 d	Sat 10/15/11	Sun 8/19/12



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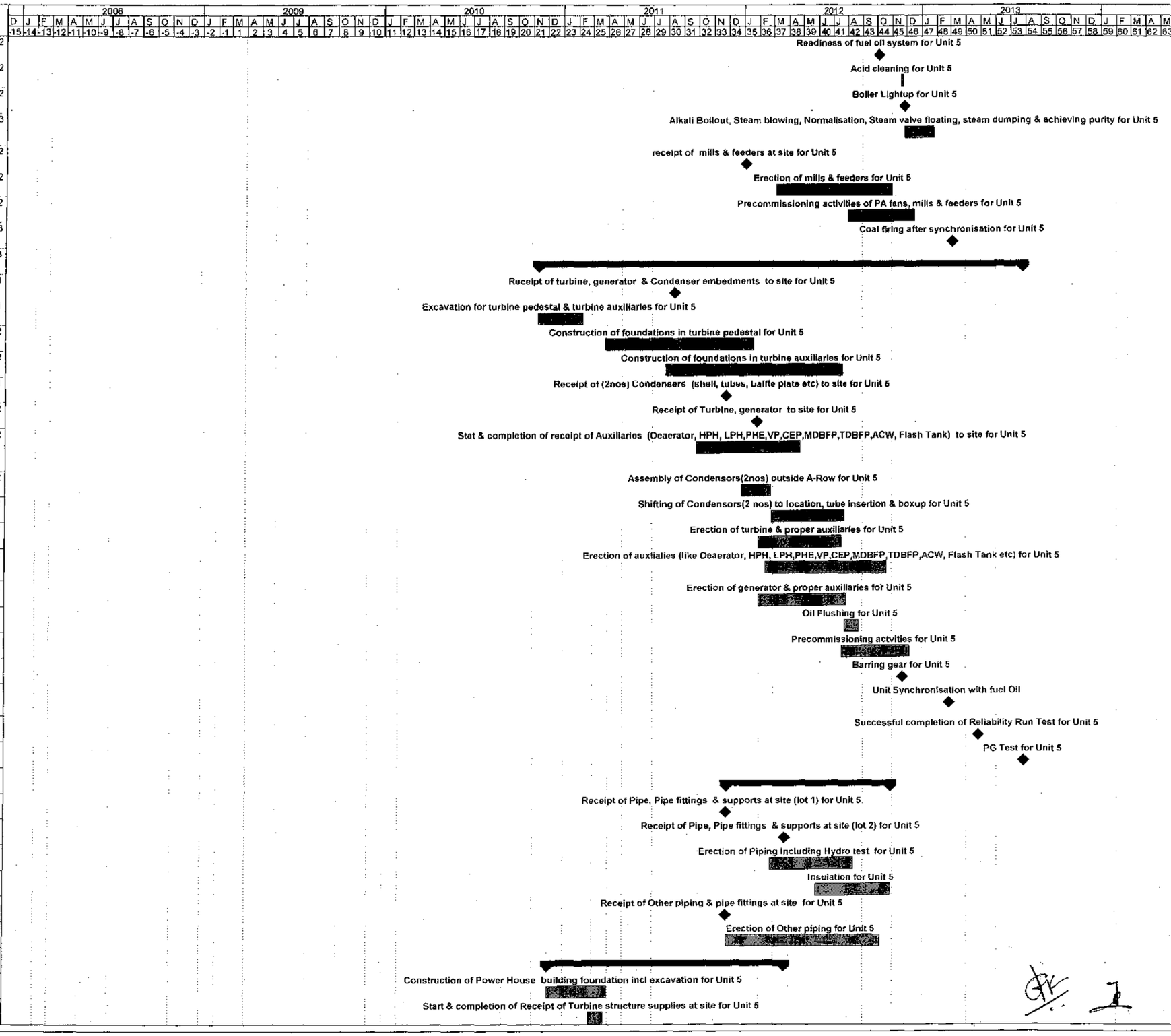
3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
792	Readiness of fuel oil system for Unit 5	0 d	Fri 10/5/12	Fri 10/5/12
793	Acid cleaning for Unit 5	5 d	Tue 11/20/12	Sat 11/24/12
794	Boiler Lightup for Unit 5	0 d	Tue 11/27/12	Tue 11/27/12
795	Alkali Boilout, Steam blowing, Normalisation, Steam valve floating, steam dumping & achieving purity for Unit 5	60 d	Wed 11/28/12	Sat 1/26/13
796	receipt of mills & feeders at site for Unit 5	0 d	Thu 1/5/12	Thu 1/5/12
797	Erection of mills & feeders for Unit 5	240 d	Tue 3/6/12	Wed 10/31/12
798	Precommissioning activities of PA fans, mills & feeders for Unit 5	138 d	Fri 8/3/12	Tue 12/18/12
799	Coal firing after synchronisation for Unit 5	0 d	Tue 3/5/13	Tue 3/5/13
800	**Turbine (Unit 5)**	**985 d**	**Sun 11/14/10**	**Thu 7/25/13**
801	Receipt of turbine, generator & Condenser embedments to site for Unit 5	0 d	Mon 8/15/11	Mon 8/15/11
802	Excavation for turbine pedestal & turbine auxiliaries for Unit 5	90 d	Sun 11/14/10	Fri 2/11/11
803	Construction of foundations in turbine pedestal for Unit 5	300 d	Mon 3/28/11	Sat 1/21/12
804	Construction of foundations in turbine auxiliaries for Unit 5	360 d	Thu 7/28/11	Sat 7/21/12
805	Receipt of (2nos) Condensers (shell, tubes, baffle plate etc) to site for Unit 5	0 d	Sun 11/27/11	Sun 11/27/11
806	Receipt of Turbine, generator to site for Unit 5	0 d	Sat 1/28/12	Sat 1/28/12
807	Stat & completion of receipt of Auxiliaries (Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank) to site for Unit 5	210 d	Thu 9/29/11	Wed 4/25/12
808	Assembly of Condensors(2nos) outside A-Row for Unit 5	60 d	Wed 12/28/11	Sat 2/25/12
809	Shifting of Condensors(2 nos) to location, tube insertion & boxup for Unit 5	150 d	Mon 2/27/12	Wed 7/25/12
810	Erection of turbine & proper auxiliaries for Unit 5	170 d	Wed 2/1/12	Thu 7/19/12
811	Erection of auxliaries (like Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank etc) for Unit 5	250 d	Tue 2/14/12	Sat 10/20/12
812	Erection of generator & proper auxiliaries for Unit 5	180 d	Wed 2/1/12	Sun 7/29/12
813	Oil Flushing for Unit 5	30 d	Thu 7/26/12	Fri 8/24/12
814	Precommissioning actvities for Unit 5	140 d	Fri 7/20/12	Thu 12/6/12
815	Barring gear for Unit 5	0 d	Thu 11/22/12	Thu 11/22/12
816	Unit Synchronisation with fuel Oil	0 d	Mon 2/25/13	Mon 2/25/13
817	Successful completion of Reliability Run Test for Unit 5	0 d	Thu 4/25/13	Thu 4/25/13
818	PG Test for Unit 5	0 d	Thu 7/25/13	Thu 7/25/13
819	**Power Cycle Piping (Unit 5)**	**337 d**	**Fri 11/25/11**	**Sat 10/27/12**
820	Receipt of Pipe, Pipe fittings & supports at site (lot 1) for Unit 5	0 d	Fri 11/25/11	Fri 11/25/11
821	Receipt of Pipe, Pipe fittings & supports at site (lot 2) for Unit 5	0 d	Sat 3/24/12	Sat 3/24/12
822	Erection of Piping including Hydro test for Unit 5	172 d	Fri 2/24/12	Mon 8/13/12
823	Insulation for Unit 5	155 d	Sat 5/26/12	Sat 10/27/12
824	Receipt of Other piping & pipe fittings at site for Unit 5	0 d	Fri 11/25/11	Fri 11/25/11
825	Erection of Other piping for Unit 5	315 d	Sat 11/26/11	Fri 10/5/12
826	**Power House building for Unit 5**	**478 d**	**Wed 12/1/10**	**Thu 3/22/12**
827	Construction of Power House building foundation incl excavation for Unit 5	120 d	Wed 12/1/10	Wed 3/30/11
828	Start & completion of Receipt of Turbine structure supplies at site for Unit 5	30 d	Tue 2/22/11	Wed 3/23/11



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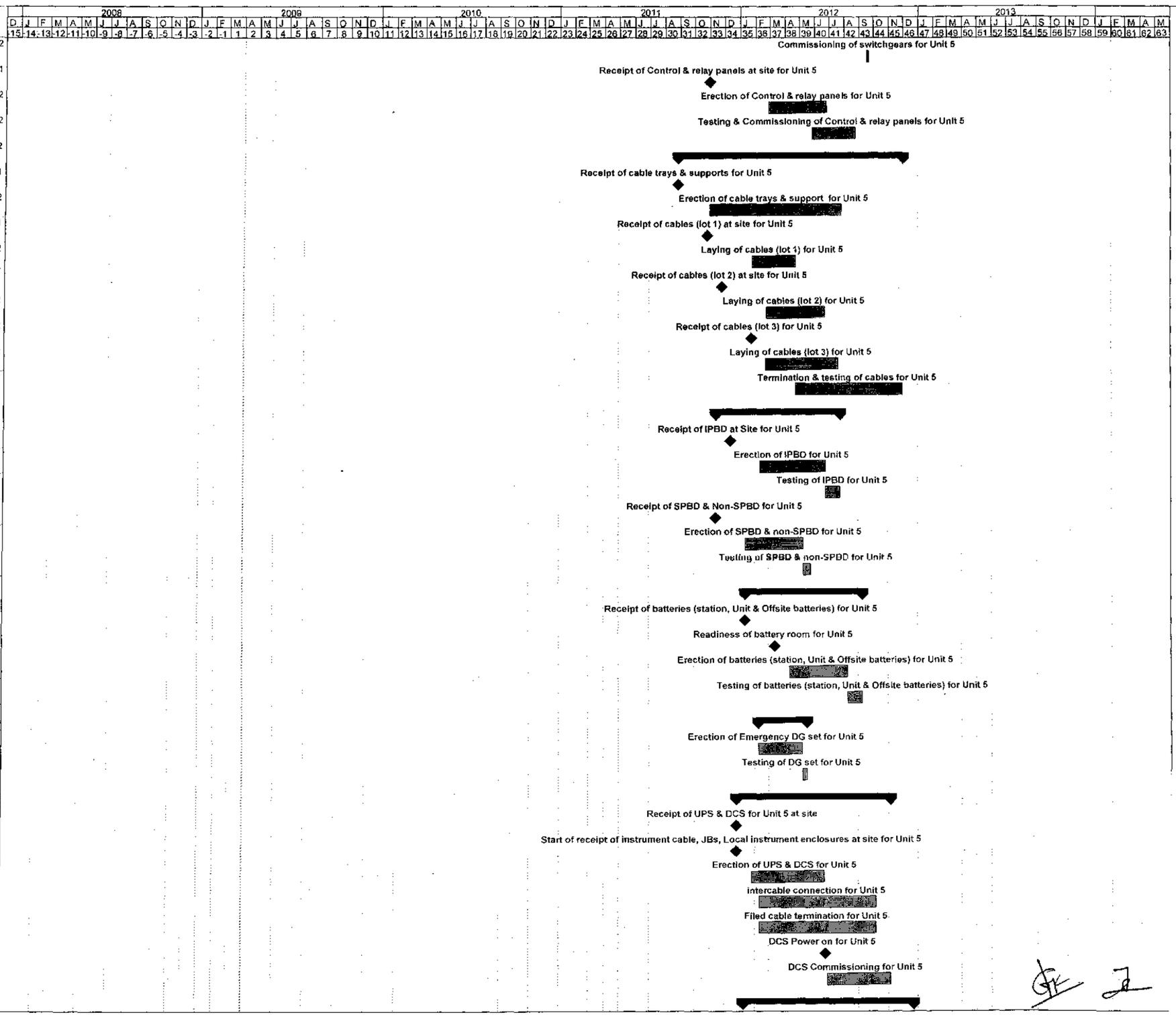
3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
867	Commissioning of switchgears for Unit 5	5 d	Tue 9/18/12	Sat 9/22/12
868	Receipt of Control & relay panels at site for Unit 5	0 d	Mon 10/31/11	Mon 10/31/11
869	Erection of Control & relay panels for Unit 5	120 d	Tue 2/28/12	Tue 6/26/12
870	Testing & Commissioning of Control & relay panels for Unit 5	90 d	Mon 5/28/12	Sat 8/25/12
871	**Cable trays & Cable for Unit 5**	**461 d**	**Sat 8/27/11**	**Fri 11/30/12**
872	Receipt of cable trays & supports for Unit 5	0 d	Sat 8/27/11	Sat 8/27/11
873	Erection of cable trays & support for Unit 5	270 d	Mon 10/31/11	Thu 7/26/12
874	Receipt of cables (lot 1) at site for Unit 5	0 d	Wed 10/26/11	Wed 10/26/11
875	Laying of cables (lot 1) for Unit 5	90 d	Thu 1/26/12	Tue 4/24/12
876	Receipt of cables (lot 2) at site for Unit 5	0 d	Fri 11/25/11	Fri 11/25/11
877	Laying of cables (lot 2) for Unit 5	120 d	Sat 2/25/12	Sat 6/23/12
878	Receipt of cables (lot 3) for Unit 5	0 d	Tue 1/24/12	Tue 1/24/12
879	Laying of cables (lot 3) for Unit 5	150 d	Fri 2/24/12	Sun 7/22/12
880	Termination & testing of cables for Unit 5	220 d	Wed 4/25/12	Fri 11/30/12
881	**IPBD, SPBD & Non-SPBD for Unit 5**	**255 d**	**Sun 11/13/11**	**Wed 7/25/12**
882	Receipt of IPBD at Site for Unit 5	0 d	Tue 12/13/11	Tue 12/13/11
883	Erection of IPBD for Unit 5	135 d	Sun 2/12/12	Mon 6/25/12
884	Testing of IPBD for Unit 5	30 d	Tue 6/26/12	Wed 7/25/12
885	Receipt of SPBD & Non-SPBD for Unit 5	0 d	Sun 11/13/11	Sun 11/13/11
886	Erection of SPBD & non-SPBD for Unit 5	120 d	Fri 1/13/12	Fri 5/11/12
887	Testing of SPBD & non-SPBD for Unit 5	15 d	Sat 5/12/12	Sat 5/26/12
888	**Battery (station, Unit & Offsite batteries) for Un it 5**	**241 d**	**Thu 1/12/12**	**Sun 9/9/12**
889	Receipt of batteries (station, Unit & Offsite batteries) for Unit 5	0 d	Thu 1/12/12	Thu 1/12/12
890	Readiness of battery room for Unit 5	0 d	Tue 3/13/12	Tue 3/13/12
891	Erection of batteries (station, Unit & Offsite batteries) for Unit 5	120 d	Fri 4/13/12	Fri 8/10/12
892	Testing of batteries (station, Unit & Offsite batteries) for Unit 5	30 d	Sat 8/11/12	Sun 9/9/12
893	**Emergency Dgset for Unit 5**	**100 d**	**Thu 2/9/12**	**Fri 5/18/12**
894	Erection of Emergency DG set for Unit 5	90 d	Thu 2/9/12	Tue 5/8/12
895	Testing of DG set for Unit 5	10 d	Wed 5/9/12	Fri 5/18/12
896	**DCS, UPS, cables for Unit 5**	**316 d**	**Sun 12/25/11**	**Mon 11/5/12**
897	Receipt of UPS & DCS for Unit 5 at site	0 d	Sun 12/25/11	Sun 12/25/11
898	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 5	0 d	Sun 12/25/11	Sun 12/25/11
899	Erection of UPS & DCS for Unit 5	150 d	Thu 1/26/12	Sat 6/23/12
900	intercable connection for Unit 5	240 d	Fri 2/10/12	Sat 10/6/12
901	Filed cable termination for Unit 5	240 d	Fri 2/10/12	Sat 10/6/12
902	DCS Power on for Unit 5	0 d	Mon 6/25/12	Mon 6/25/12
903	DCS Commissioning for Unit 5	130 d	Fri 6/29/12	Mon 11/5/12
904	**Field Instruments for Unit 5**	**350 d**	**Sat 1/7/12**	**Sat 12/22/12**

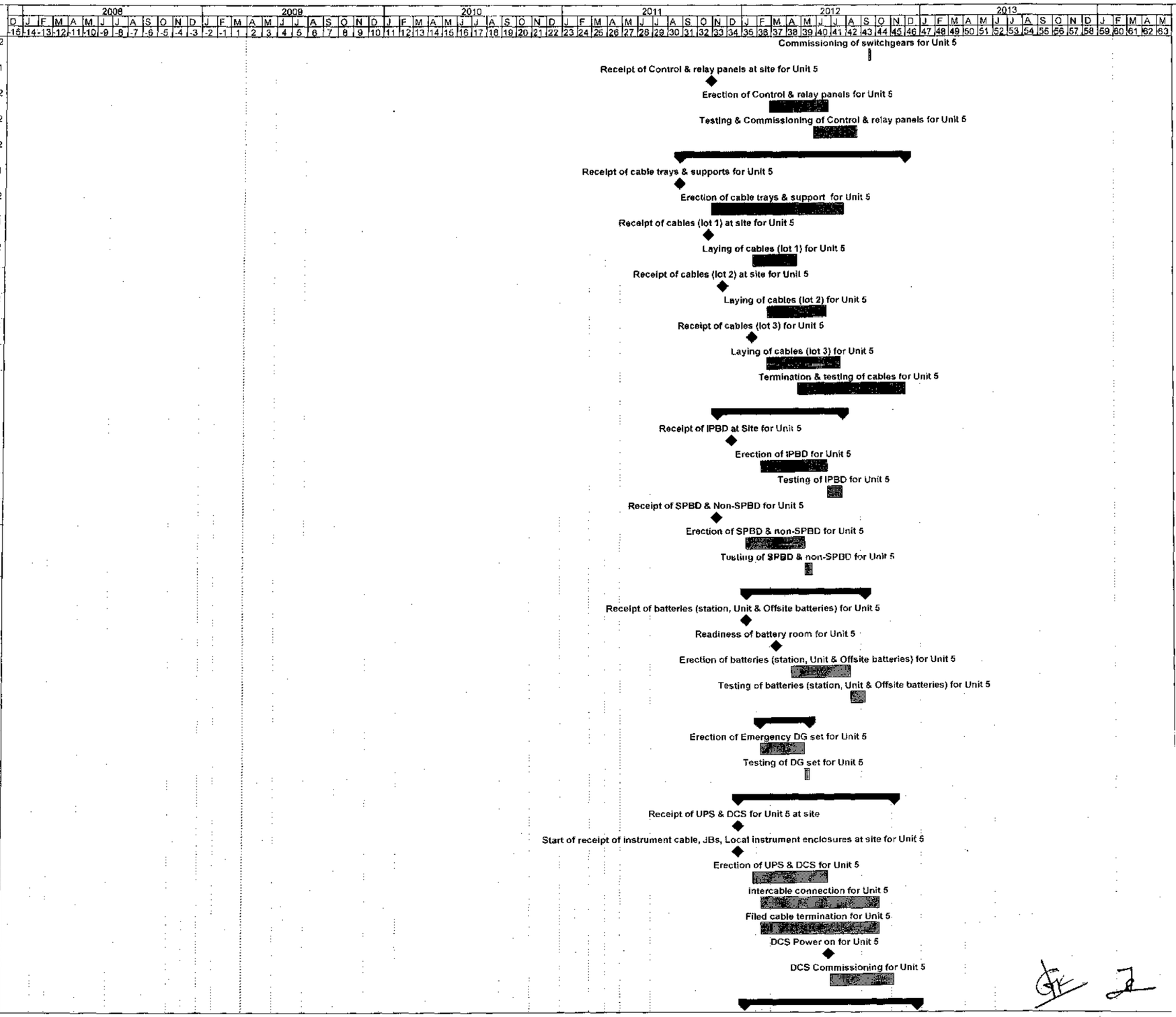


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
867	Commissioning of switchgears for Unit 5	5 d	Tue 9/18/12	Sat 9/22/12
868	Receipt of Control & relay panels at site for Unit 5	0 d	Mon 10/31/11	Mon 10/31/11
869	Erection of Control & relay panels for Unit 5	120 d	Tue 2/28/12	Tue 6/26/12
870	Testing & Commissioning of Control & relay panels for Unit 5	90 d	Mon 5/28/12	Sat 8/25/12
871	**Cable trays & Cable for Unit 5**	**461 d**	**Sat 8/27/11**	**Fri 11/30/12**
872	Receipt of cable trays & supports for Unit 5	0 d	Sat 8/27/11	Sat 8/27/11
873	Erection of cable trays & support for Unit 5	270 d	Mon 10/31/11	Thu 7/26/12
874	Receipt of cables (lot 1) at site for Unit 5	0 d	Wed 10/26/11	Wed 10/26/11
875	Laying of cables (lot 1) for Unit 5	90 d	Thu 1/26/12	Tue 4/24/12
876	Receipt of cables (lot 2) at site for Unit 5	0 d	Fri 11/25/11	Fri 11/25/11
877	Laying of cables (lot 2) for Unit 5	120 d	Sat 2/25/12	Sat 6/23/12
878	Receipt of cables (lot 3) for Unit 5	0 d	Tue 1/24/12	Tue 1/24/12
879	Laying of cables (lot 3) for Unit 5	150 d	Fri 2/24/12	Sun 7/22/12
880	Termination & testing of cables for Unit 5	220 d	Wed 4/25/12	Fri 11/30/12
881	**IPBD, SPBD & Non-SPBD for Unit 5**	**255 d**	**Sun 11/13/11**	**Wed 7/25/12**
882	Receipt of IPBD at Site for Unit 5	0 d	Tue 12/13/11	Tue 12/13/11
883	Erection of IPBD for Unit 5	135 d	Sun 2/12/12	Mon 8/25/12
884	Testing of IPBD for Unit 5	30 d	Tue 6/26/12	Wed 7/25/12
885	Receipt of SPBD & Non-SPBD for Unit 5	0 d	Sun 11/13/11	Sun 11/13/11
886	Erection of SPBD & non-SPBD for Unit 5	120 d	Fri 1/13/12	Fri 5/11/12
887	Testing of SPBD & non-SPBD for Unit 5	15 d	Sat 5/12/12	Sat 5/26/12
888	**Battery (station, Unit & Offsite batteries) for Un it 5**	**241 d**	**Thu 1/12/12**	**Sun 9/9/12**
889	Receipt of batteries (station, Unit & Offsite batteries) for Unit 5	0 d	Thu 1/12/12	Thu 1/12/12
890	Readiness of battery room for Unit 5	0 d	Tue 3/13/12	Tue 3/13/12
891	Erection of batteries (station, Unit & Offsite batteries) for Unit 5	120 d	Fri 4/13/12	Fri 8/10/12
892	Testing of batteries (station, Unit & Offsite batteries) for Unit 5	30 d	Sat 8/11/12	Sun 9/9/12
893	**Emergency Dgset for Unit 5**	**100 d**	**Thu 2/9/12**	**Fri 5/18/12**
894	Erection of Emergency DG set for Unit 5	90 d	Thu 2/9/12	Tue 5/8/12
895	Testing of DG set for Unit 5	10 d	Wed 5/9/12	Fri 5/18/12
896	**DCS, UPS, cables for Unit 5**	**316 d**	**Sun 12/25/11**	**Mon 11/5/12**
897	Receipt of UPS & DCS for Unit 5 at site	0 d	Sun 12/25/11	Sun 12/25/11
898	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 5	0 d	Sun 12/25/11	Sun 12/25/11
899	Erection of UPS & DCS for Unit 5	150 d	Thu 1/26/12	Sat 6/23/12
900	intercable connection for Unit 5	240 d	Fri 2/10/12	Sat 10/6/12
901	Filed cable termination for Unit 5	240 d	Fri 2/10/12	Sat 10/6/12
902	DCS Power on for Unit 5	0 d	Mon 6/25/12	Mon 6/25/12
903	DCS Commissioning for Unit 5	130 d	Fri 6/29/12	Mon 11/5/12
904	**Field Instruments for Unit 5**	**350 d**	**Sat 1/7/12**	**Sat 12/22/12**

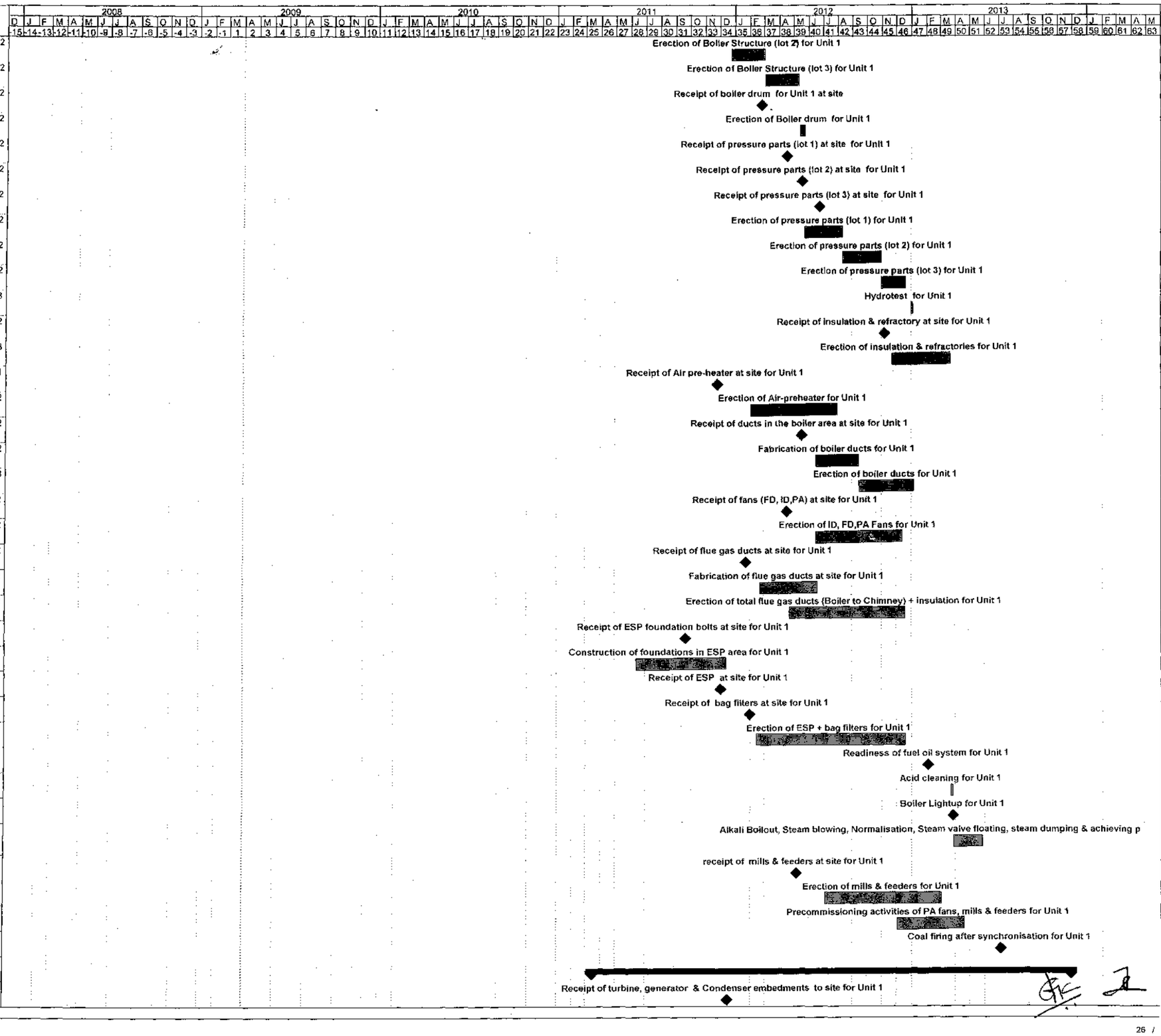


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
943	Erection of Boiler Structure (lot 2) for Unit 1	70 d	Sun 12/25/11	Sat 3/3/12
944	Erection of Boiler Structure (lot 3) for Unit 1	70 d	Sun 3/4/12	Sat 5/12/12
945	Receipt of boiler drum for Unit 1 at site	0 d	Sat 2/25/12	Sat 2/25/12
946	Erection of Boiler drum for Unit 1	10 d	Tue 5/15/12	Thu 5/24/12
947	Receipt of pressure parts (lot 1) at site for Unit 1	0 d	Tue 4/17/12	Tue 4/17/12
948	Receipt of pressure parts (lot 2) at site for Unit 1	0 d	Fri 5/18/12	Fri 5/18/12
949	Receipt of pressure parts (lot 3) at site for Unit 1	0 d	Sun 6/24/12	Sun 6/24/12
950	Erection of pressure parts (lot 1) for Unit 1	80 d	Fri 5/25/12	Sun 8/12/12
951	Erection of pressure parts (lot 2) for Unit 1	80 d	Mon 8/13/12	Wed 10/31/12
952	Erection of pressure parts (lot 3) for Unit 1	50 d	Thu 11/1/12	Thu 12/20/12
953	Hydrotest for Unit 1	4 d	Tue 1/1/13	Fri 1/4/13
954	Receipt of insulation & refractory at site for Unit 1	0 d	Wed 11/7/12	Wed 11/7/12
955	Erection of insulation & refractories for Unit 1	120 d	Fri 11/23/12	Fri 3/22/13
966	Receipt of Air pre-heater at site for Unit 1	0 d	Sat 11/26/11	Sat 11/26/11
957	Erection of Air-preheater for Unit 1	180 d	Sat 2/4/12	Wed 8/1/12
958	Receipt of ducts in the boiler area at site for Unit 1	0 d	Fri 5/18/12	Fri 5/18/12
959	Fabrication of boiler ducts for Unit 1	90 d	Mon 6/18/12	Sat 9/15/12
960	Erection of boiler ducts for Unit 1	112 d	Sun 9/16/12	Sat 1/5/13
961	Receipt of fans (FD, ID,PA) at site for Unit 1	0 d	Tue 4/17/12	Tue 4/17/12
962	Erection of ID, FD,PA Fans for Unit 1	180 d	Sun 6/17/12	Thu 12/13/12
963	Receipt of flue gas ducts at site for Unit 1	0 d	Mon 1/23/12	Mon 1/23/12
964	Fabrication of flue gas ducts at site for Unit 1	120 d	Thu 2/23/12	Thu 6/21/12
965	Erection of total flue gas ducts (Boiler to Chimney) + insulation for Unit 1	240 d	Mon 4/23/12	Tue 12/18/12
966	Receipt of ESP foundation bolts at site for Unit 1	0 d	Thu 9/22/11	Thu 9/22/11
967	Construction of foundations in ESP area for Unit 1	184 d	Tue 6/14/11	Wed 12/14/11
968	Receipt of ESP at site for Unit 1	0 d	Fri 12/2/11	Fri 12/2/11
969	Receipt of bag filters at site for Unit 1	0 d	Tue 1/31/12	Tue 1/31/12
970	Erection of ESP + bag filters for Unit 1	310 d	Mon 2/13/12	Tue 12/18/12
971	Readiness of fuel oil system for Unit 1	0 d	Sun 2/3/13	Sun 2/3/13
972	Acid cleaning for Unit 1	5 d	Sat 3/23/13	Wed 3/27/13
973	Boiler Lightup for Unit 1	0 d	Wed 3/27/13	Wed 3/27/13
974	Alkali Boilout, Steam blowing, Normalisation, Steam valve floating, steam dumping & achieving purity for Unit 1	60 d	Fri 3/29/13	Mon 5/27/13
975	receipt of mills & feeders at site for Unit 1	0 d	Sun 5/6/12	Sun 5/6/12
976	Erection of mills & feeders for Unit 1	240 d	Fri 7/6/12	Sat 3/2/13
977	Precommissioning activities of PA fans, mills & feeders for Unit 1	138 d	Mon 12/3/12	Fri 4/19/13
978	Coal firing after synchronisation for Unit 1	0 d	Thu 7/4/13	Thu 7/4/13
979	**Turbine (Unit 1)**	**987 d**	**Tue 3/15/11**	**Mon 11/25/13**
980	Receipt of turbine, generator & Condenser embedments to site for Unit 1	0 d	Thu 12/15/11	Thu 12/15/11

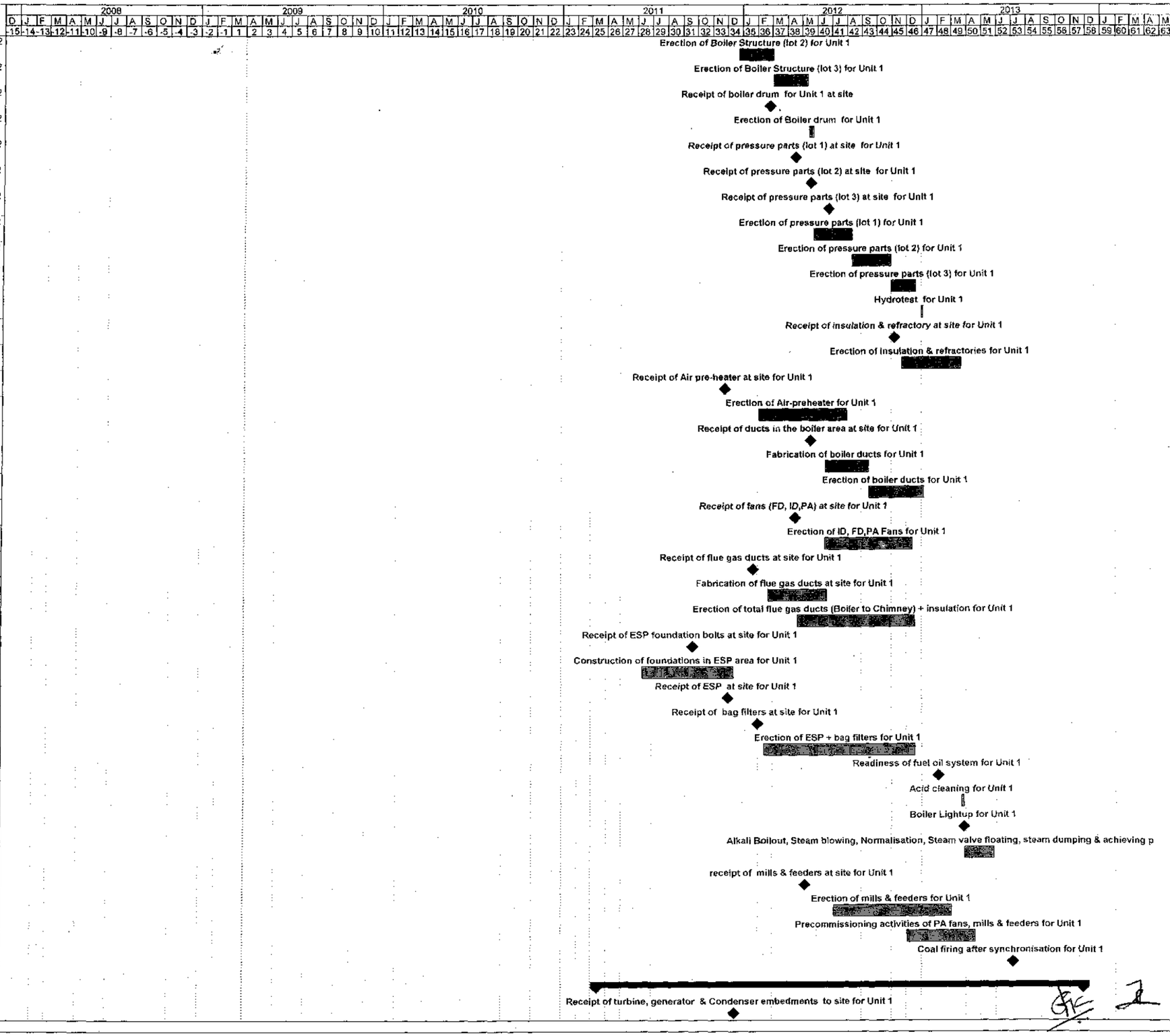


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
943	Erection of Boiler Structure (lot 2) for Unit 1	70 d	Sun 12/25/11	Sat 3/3/12
944	Erection of Boiler Structure (lot 3) for Unit 1	70 d	Sun 3/4/12	Sat 5/12/12
945	Receipt of boiler drum for Unit 1 at site	0 d	Sat 2/25/12	Sat 2/25/12
946	Erection of Boiler drum for Unit 1	10 d	Tue 5/15/12	Thu 5/24/12
947	Receipt of pressure parts (lot 1) at site for Unit 1	0 d	Tue 4/17/12	Tue 4/17/12
948	Receipt of pressure parts (lot 2) at site for Unit 1	0 d	Fri 5/18/12	Fri 5/18/12
949	Receipt of pressure parts (lot 3) at site for Unit 1	0 d	Sun 6/24/12	Sun 6/24/12
950	Erection of pressure parts (lot 1) for Unit 1	80 d	Fri 5/25/12	Sun 8/12/12
951	Erection of pressure parts (lot 2) for Unit 1	80 d	Mon 8/13/12	Wed 10/31/12
952	Erection of pressure parts (lot 3) for Unit 1	50 d	Thu 11/1/12	Thu 12/20/12
953	Hydrotest for Unit 1	4 d	Tue 1/1/13	Fri 1/4/13
954	Receipt of insulation & refractory at site for Unit 1	0 d	Wed 11/7/12	Wed 11/7/12
955	Erection of insulation & refractories for Unit 1	120 d	Fri 11/23/12	Fri 3/22/13
956	Receipt of Air pre heater at site for Unit 1	0 d	Sat 11/26/11	Sat 11/26/11
957	Erection of Air-preheater for Unit 1	180 d	Sat 2/4/12	Wed 8/1/12
958	Receipt of ducts in the boiler area at site for Unit 1	0 d	Fri 5/18/12	Fri 5/18/12
959	Fabrication of boiler ducts for Unit 1	90 d	Mon 6/18/12	Sat 9/15/12
960	Erection of boiler ducts for Unit 1	112 d	Sun 9/16/12	Sat 1/5/13
961	Receipt of fans (FD, ID,PA) at site for Unit 1	0 d	Tue 4/17/12	Tue 4/17/12
962	Erection of ID, FD,PA Fans for Unit 1	180 d	Sun 6/17/12	Thu 12/13/12
963	Receipt of flue gas ducts at site for Unit 1	0 d	Mon 1/23/12	Mon 1/23/12
964	Fabrication of flue gas ducts at site for Unit 1	120 d	Thu 2/23/12	Thu 6/21/12
965	Erection of total flue gas ducts (Boiler to Chimney) + insulation for Unit 1	240 d	Mon 4/23/12	Tue 12/18/12
966	Receipt of ESP foundation bolts at site for Unit 1	0 d	Thu 9/22/11	Thu 9/22/11
967	Construction of foundations in ESP area for Unit 1	184 d	Tue 6/14/11	Wed 12/14/11
968	Receipt of ESP at site for Unit 1	0 d	Fri 12/2/11	Fri 12/2/11
969	Receipt of bag filters at site for Unit 1	0 d	Tue 1/31/12	Tue 1/31/12
970	Erection of ESP + bag filters for Unit 1	310 d	Mon 2/13/12	Tue 12/18/12
971	Readiness of fuel oil system for Unit 1	0 d	Sun 2/3/13	Sun 2/3/13
972	Acid cleaning for Unit 1	5 d	Sat 3/23/13	Wed 3/27/13
973	Boiler Lightup for Unit 1	0 d	Wed 3/27/13	Wed 3/27/13
974	Alkali Boilout, Steam blowing, Normalisation, Steam valve floating, steam dumping & achieving purity for Unit 1	60 d	Fri 3/29/13	Mon 5/27/13
975	receipt of mills & feeders at site for Unit 1	0 d	Sun 5/6/12	Sun 5/6/12
976	Erection of mills & feeders for Unit 1	240 d	Fri 7/6/12	Sat 3/2/13
977	Precommissioning activities of PA fans, mills & feeders for Unit 1	138 d	Mon 12/3/12	Fri 4/19/13
978	Coal firing after synchronisation for Unit 1	0 d	Thu 7/4/13	Thu 7/4/13
979	**Turbine (Unit 1)**	**987 d**	**Tue 3/15/11**	**Mon 11/25/13**
980	Receipt of turbine, generator & Condenser embedments to site for Unit 1	0 d	Thu 12/15/11	Thu 12/15/11

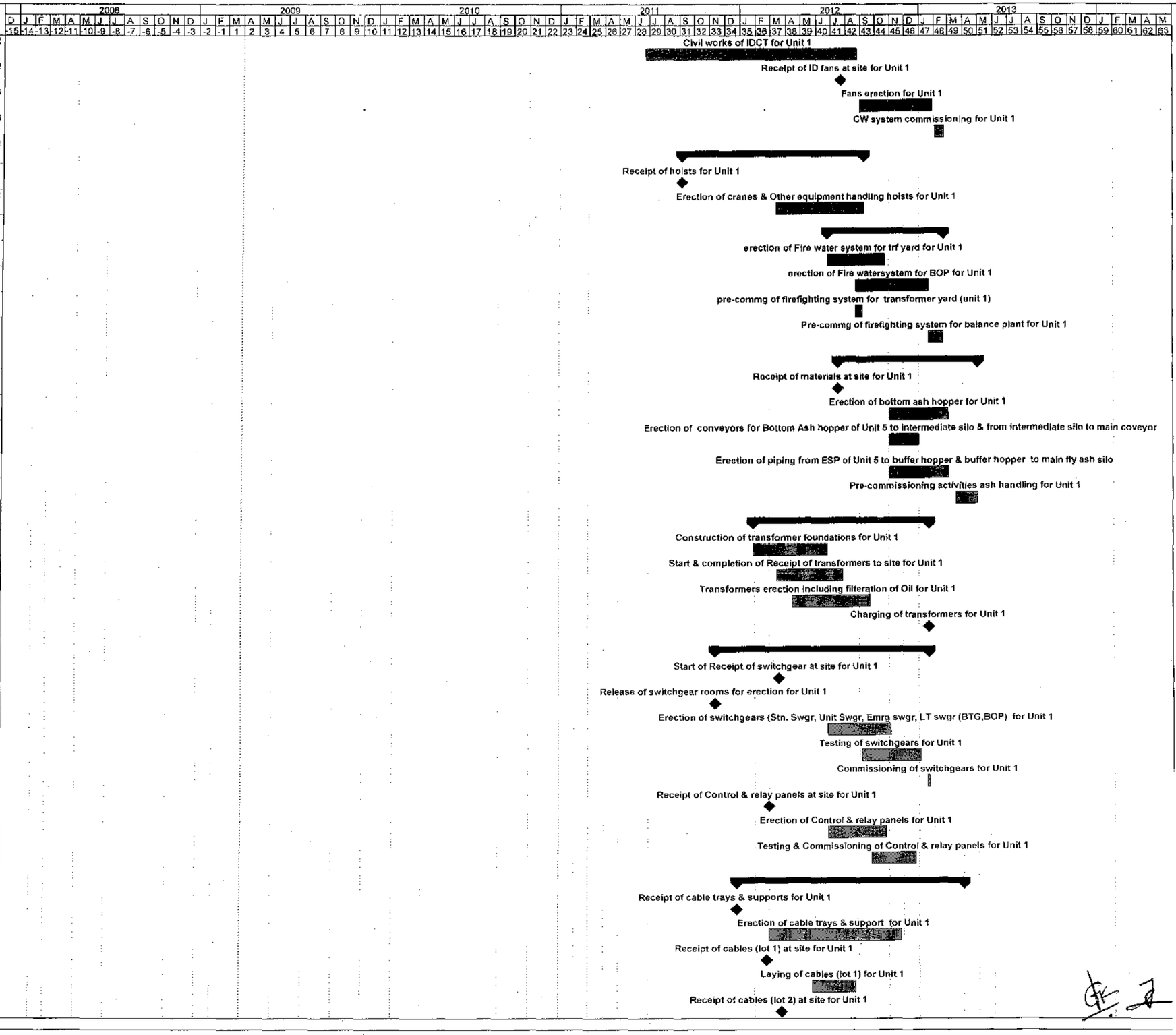


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1018	Civil works of IDCT for Unit 1	430 d	Fri 6/24/11	Sun 8/26/12
1019	Receipt of ID fans at site for Unit 1	0 d	Mon 7/23/12	Mon 7/23/12
1020	Fans erection for Unit 1	150 d	Sat 9/1/12	Mon 1/28/13
1021	CW system commissioning for Unit 1	20 d	Sun 2/3/13	Fri 2/22/13
1022	**Cranes & Hoists for Unit 1**	**369 d**	**Tue 9/6/11**	**Sun 9/9/12**
1023	Receipt of hoists for Unit 1	0 d	Tue 9/6/11	Tue 9/6/11
1024	Erection of cranes & Other equipment handling hoists for Unit 1	180 d	Wed 3/14/12	Sun 9/9/12
1025	**Fire Fighting System for Unit 1**	**240 d**	**Tue 5/26/12**	**Wed 2/20/13**
1026	erection of Fire water system for trf yard for Unit 1	120 d	Tue 5/26/12	Tue 10/23/12
1027	erection of Fire watersystem for BOP for Unit 1	150 d	Sat 8/25/12	Mon 1/21/13
1028	pre-commg of firefighting system for transformer yard (unit 1)	15 d	Sat 8/25/12	Sat 9/8/12
1029	Pre-commg of firefighting system for balance plant for Unit 1	30 d	Tue 1/22/13	Wed 2/20/13
1030	**Ash Handling for Unit 1**	**287 d**	**Wed 7/18/12**	**Wed 5/1/13**
1031	Receipt of materials at site for Unit 1	0 d	Wed 7/18/12	Wed 7/18/12
1032	Erection of bottom ash hopper for Unit 1	120 d	Sat 11/3/12	Sat 3/2/13
1033	Erection of conveyors for Bottom Ash hopper of Unit 5 to intermediate silo & from intermediate silo to main coveyor	60 d	Sat 11/3/12	Tue 1/1/13
1034	Erection of piping from ESP of Unit 5 to buffer hopper & buffer hopper to main fly ash silo	120 d	Sat 11/3/12	Sat 3/2/13
1035	Pre-commissioning activities ash handling for Unit 1	45 d	Mon 3/18/13	Wed 5/1/13
1036	**Transformers (GT-1,UAT-2,Service transformers) for Unit 1 & BOP**	**359 d**	**Sun 1/29/12**	**Mon 1/21/13**
1037	Construction of transformer foundations for Unit 1	150 d	Sun 1/29/12	Tue 6/26/12
1038	Start & completion of Receipt of transformers to site for Unit 1	135 d	Fri 3/16/12	Sat 7/28/12
1039	Transformers erection including filteration of Oil for Unit 1	160 d	Tue 4/17/12	Sun 9/23/12
1040	Charging of transformers for Unit 1	0 d	Mon 1/21/13	Mon 1/21/13
1041	**Switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP)**	**435 d**	**Sun 11/13/11**	**Mon 1/21/13**
1042	Start of Receipt of switchgear at site for Unit 1	0 d	Tue 3/20/12	Tue 3/20/12
1043	Release of switchgear rooms for erection for Unit 1	0 d	Sun 11/13/11	Sun 11/13/11
1044	Erection of switchgears (Stn. Swgr, Unit Swgr, Emrg swgr, LT swgr (BTG,BOP) for Unit 1	130 d	Thu 6/28/12	Sun 11/4/12
1045	Testing of switchgears for Unit 1	120 d	Thu 9/6/12	Thu 1/3/13
1046	Commissioning of switchgears for Unit 1	5 d	Thu 1/17/13	Mon 1/21/13
1047	Receipt of Control & relay panels at site for Unit 1	0 d	Wed 2/29/12	Wed 2/29/12
1048	Erection of Control & relay panels for Unit 1	120 d	Thu 6/28/12	Thu 10/25/12
1049	Testing & Commissioning of Control & relay panels for Unit 1	90 d	Wed 9/26/12	Mon 12/24/12
1050	**Cable trays & Cable for Unit 1**	**461 d**	**Mon 12/26/11**	**Sun 3/31/13**
1051	Receipt of cable trays & supports for Unit 1	0 d	Mon 12/26/11	Mon 12/26/11
1052	Erection of cable trays & support for Unit 1	270 d	Wed 2/29/12	Sat 11/24/12
1053	Receipt of cables (lot 1) at site for Unit 1	0 d	Fri 2/24/12	Fri 2/24/12
1054	Laying of cables (lot 1) for Unit 1	90 d	Sat 5/26/12	Thu 8/23/12
1055	Receipt of cables (lot 2) at site for Unit 1	0 d	Sun 3/25/12	Sun 3/25/12

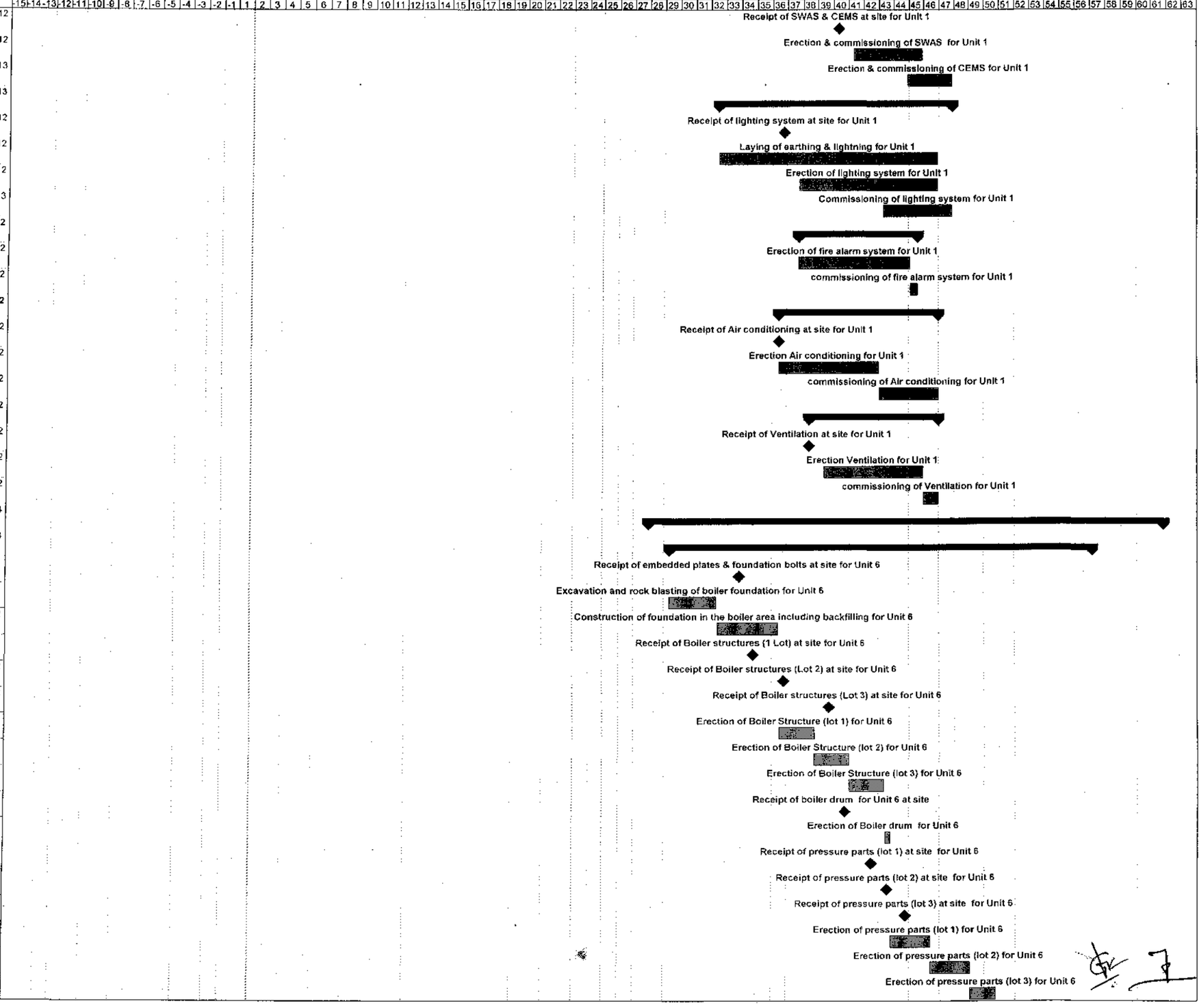


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1094	Receipt of SWAS & CEMS at site for Unit 1	0 d	Mon 8/11/12	Mon 8/11/12
1095	Erection & commissioning of SWAS for Unit 1	140 d	Thu 7/12/12	Wed 11/28/12
1096	Erection & commissioning of CEMS for Unit 1	90 d	Tue 10/30/12	Sun 1/27/13
1097	**lighting system for Unit 1**	**470 d**	**Mon 10/17/11**	**Mon 1/28/13**
1098	Receipt of lighting system at site for Unit 1	0 d	Thu 2/23/12	Thu 2/23/12
1099	Laying of earthing & lightning for Unit 1	440 d	Mon 10/17/11	Sat 12/29/12
1100	Erection of lighting system for Unit 1	280 d	Sun 3/25/12	Sat 12/29/12
1101	Commissioning of lighting system for Unit 1	140 d	Tue 9/11/12	Mon 1/28/13
1102	**fire alarm system for Unit 1**	**240 d**	**Sun 3/25/12**	**Mon 11/19/12**
1103	Erection of fire alarm system for Unit 1	225 d	Sun 3/25/12	Sun 11/4/12
1104	commissioning of fire alarm system for Unit 1	15 d	Mon 11/5/12	Mon 11/19/12
1105	**Air conditioning for Unit 1**	**321 d**	**Tue 2/14/12**	**Mon 12/31/12**
1106	Receipt of Air conditioning at site for Unit 1	0 d	Tue 2/14/12	Tue 2/14/12
1107	Erection Air conditioning for Unit 1	200 d	Wed 2/15/12	Sat 9/1/12
1108	commissioning of Air conditioning for Unit 1	120 d	Mon 9/3/12	Mon 12/31/12
1109	**Ventilation for Unit 1**	**260 d**	**Sat 4/14/12**	**Sun 12/30/12**
1110	Receipt of Ventilation at site for Unit 1	0 d	Sat 4/14/12	Sat 4/14/12
1111	Erection Ventilation for Unit 1	200 d	Tue 5/15/12	Fri 11/30/12
1112	commissioning of Ventilation for Unit 1	30 d	Sat 12/1/12	Sun 12/30/12
1113	**Schedule for Unit 6**	**1029 d**	**Wed 6/1/11**	**Tue 3/25/14**
1114	**Boiler & Boiler Auxiliaries (Unit 6)**	**845 d**	**Wed 7/13/11**	**Sun 11/3/13**
1115	Receipt of embedded plates & foundation bolts at site for Unit 6	0 d	Mon 11/28/11	Mon 11/28/11
1116	Excavation and rock blasting of boiler foundation for Unit 6	94 d	Wed 7/13/11	Fri 10/14/11
1117	Construction of foundation in the boiler area including backfilling for Unit 6	120 d	Mon 10/17/11	Mon 2/13/12
1118	Receipt of Boiler structures (1 Lot) at site for Unit 6	0 d	Sun 12/25/11	Sun 12/25/11
1119	Receipt of Boiler structures (Lot 2) at site for Unit 6	0 d	Fri 2/24/12	Fri 2/24/12
1120	Receipt of Boiler structures (Lot 3) at site for Unit 6	0 d	Thu 5/24/12	Thu 5/24/12
1121	Erection of Boiler Structure (lot 1) for Unit 6	70 d	Thu 2/16/12	Wed 4/25/12
1122	Erection of Boiler Structure (lot 2) for Unit 6	70 d	Thu 4/26/12	Wed 7/4/12
1123	Erection of Boiler Structure (lot 3) for Unit 6	70 d	Thu 7/5/12	Wed 9/12/12
1124	Receipt of boiler drum for Unit 6 at site	0 d	Mon 6/25/12	Mon 6/25/12
1125	Erection of Boiler drum for Unit 6	10 d	Sat 9/15/12	Mon 9/24/12
1126	Receipt of pressure parts (lot 1) at site for Unit 6	0 d	Fri 8/17/12	Fri 8/17/12
1127	Receipt of pressure parts (lot 2) at site for Unit 6	0 d	Mon 9/17/12	Mon 9/17/12
1128	Receipt of pressure parts (lot 3) at site for Unit 6	0 d	Wed 10/24/12	Wed 10/24/12
1129	Erection of pressure parts (lot 1) for Unit 6	80 d	Tue 9/25/12	Thu 12/13/12
1130	Erection of pressure parts (lot 2) for Unit 6	80 d	Fri 12/14/12	Sun 3/3/13
1131	Erection of pressure parts (lot 3) for Unit 6	50 d	Mon 3/4/13	Mon 4/22/13

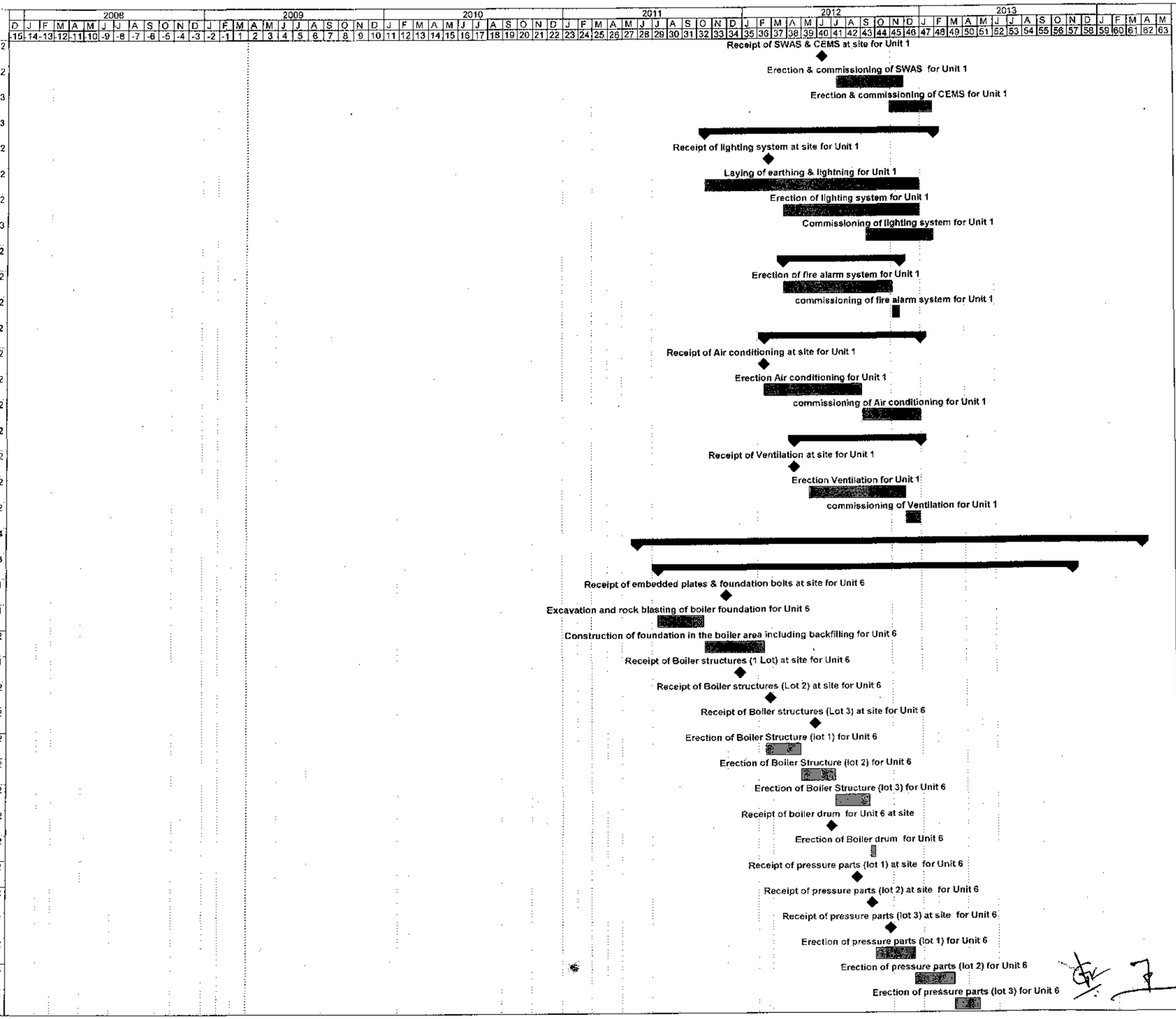


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1094	Receipt of SWAS & CEMS at site for Unit 1	0 d	Mon 6/11/12	Mon 6/11/12
1095	Erection & commissioning of SWAS for Unit 1	140 d	Thu 7/12/12	Wed 11/28/12
1096	Erection & commissioning of CEMS for Unit 1	90 d	Tue 10/30/12	Sun 1/27/13
1097	**lighting system for Unit 1**	**470 d**	**Mon 10/17/11**	**Mon 1/28/13**
1098	Receipt of lighting system at site for Unit 1	0 d	Thu 2/23/12	Thu 2/23/12
1099	Laying of earthing & lightning for Unit 1	440 d	Mon 10/17/11	Sat 12/29/12
1100	Erection of lighting system for Unit 1	280 d	Sun 3/25/12	Sat 12/29/12
1101	Commissioning of lighting system for Unit 1	140 d	Tue 9/11/12	Mon 1/28/13
1102	**fire alarm system for Unit 1**	**240 d**	**Sun 3/25/12**	**Mon 11/19/12**
1103	Erection of fire alarm system for Unit 1	225 d	Sun 3/25/12	Sun 11/4/12
1104	commissioning of fire alarm system for Unit 1	15 d	Mon 11/5/12	Mon 11/19/12
1105	**Air conditioning for Unit 1**	**321 d**	**Tue 2/14/12**	**Mon 12/31/12**
1106	Receipt of Air conditioning at site for Unit 1	0 d	Tue 2/14/12	Tue 2/14/12
1107	Erection Air conditioning for Unit 1	200 d	Wed 2/15/12	Sat 9/1/12
1108	commissioning of Air conditioning for Unit 1	120 d	Mon 9/3/12	Mon 12/31/12
1109	**Ventilation for Unit 1**	**260 d**	**Sat 4/14/12**	**Sun 12/30/12**
1110	Receipt of Ventilation at site for Unit 1	0 d	Sat 4/14/12	Sat 4/14/12
1111	Erection Ventilation for Unit 1	200 d	Tue 5/15/12	Fri 11/30/12
1112	commissioning of Ventilation for Unit 1	30 d	Sat 12/1/12	Sun 12/30/12
1113	**Schedule for Unit 6**	**1029 d**	**Wed 6/1/11**	**Tue 3/25/14**
1114	**Boiler & Boiler Auxiliaries (Unit 6)**	**845 d**	**Wed 7/13/11**	**Sun 11/3/13**
1115	Receipt of embedded plates & foundation bolts at site for Unit 6	0 d	Mon 11/28/11	Mon 11/28/11
1116	Excavation and rock blasting of boiler foundation for Unit 6	94 d	Wed 7/13/11	Fri 10/14/11
1117	Construction of foundation in the boiler area including backfilling for Unit 6	120 d	Mon 10/17/11	Mon 2/13/12
1118	Receipt of Boiler structures (1 Lot) at site for Unit 6	0 d	Sun 12/25/11	Sun 12/25/11
1119	Receipt of Boiler structures (Lot 2) at site for Unit 6	0 d	Fri 2/24/12	Fri 2/24/12
1120	Receipt of Boiler structures (Lot 3) at site for Unit 6	0 d	Thu 5/24/12	Thu 5/24/12
1121	Erection of Boiler Structure (lot 1) for Unit 6	70 d	Thu 2/16/12	Wed 4/25/12
1122	Erection of Boiler Structure (lot 2) for Unit 6	70 d	Thu 4/26/12	Wed 7/4/12
1123	Erection of Boiler Structure (lot 3) for Unit 6	70 d	Thu 7/5/12	Wed 9/12/12
1124	Receipt of boiler drum for Unit 6 at site	0 d	Mon 6/25/12	Mon 6/25/12
1125	Erection of Boiler drum for Unit 6	10 d	Sat 9/15/12	Mon 9/24/12
1126	Receipt of pressure parts (lot 1) at site for Unit 6	0 d	Fri 8/17/12	Fri 8/17/12
1127	Receipt of pressure parts (lot 2) at site for Unit 6	0 d	Mon 9/17/12	Mon 9/17/12
1128	Receipt of pressure parts (lot 3) at site for Unit 6	0 d	Wed 10/24/12	Wed 10/24/12
1129	Erection of pressure parts (lot 1) for Unit 6	80 d	Tue 9/25/12	Thu 12/13/12
1130	Erection of pressure parts (lot 2) for Unit 6	80 d	Fri 12/14/12	Sun 3/3/13
1131	Erection of pressure parts (lot 3) for Unit 6	50 d	Mon 3/4/13	Mon 4/22/13

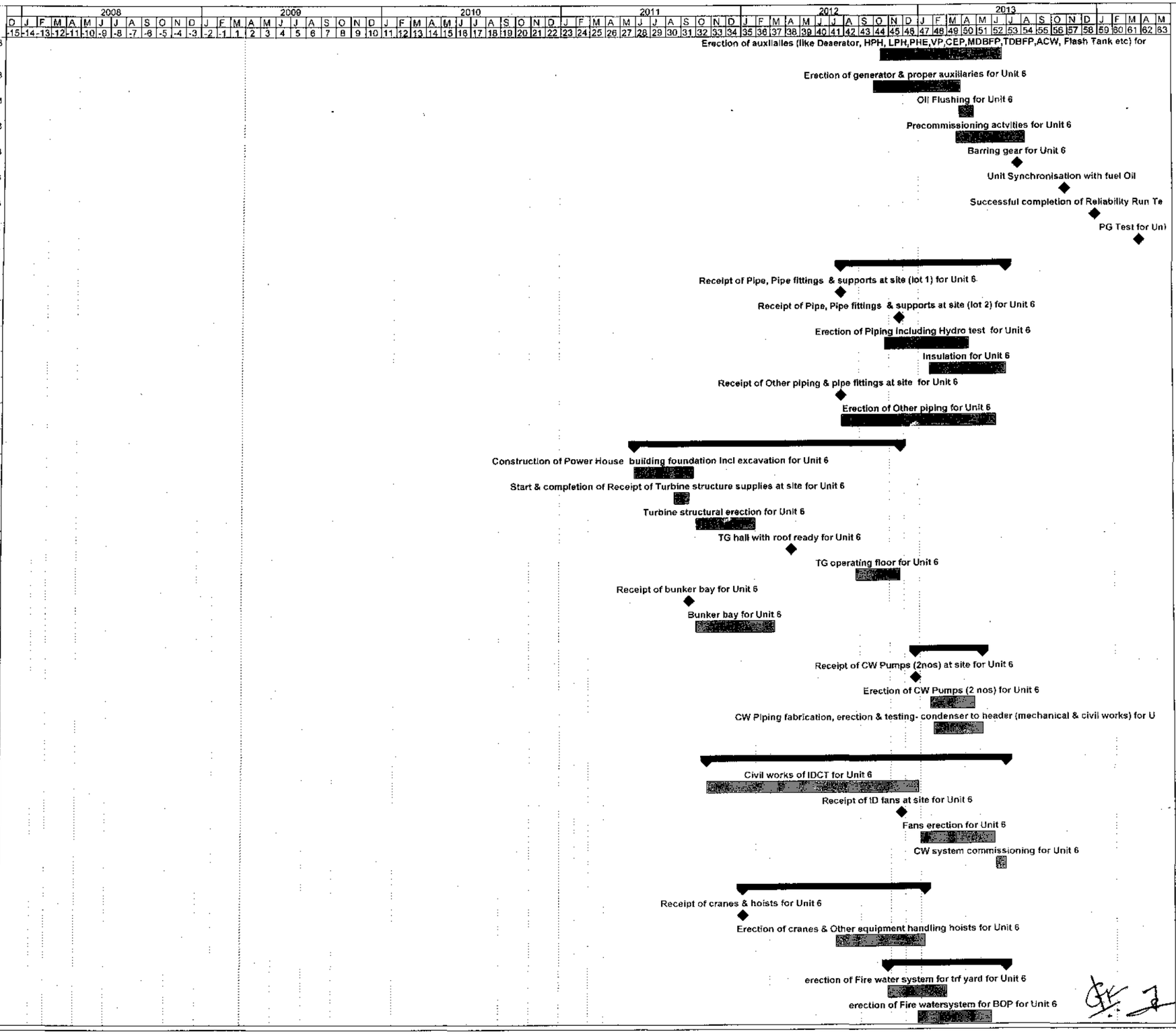


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1169	Erection of auxliaries (like Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank etc) for Unit 6	250 d	Mon 10/15/12	Fri 9/21/13
1170	Erection of generator & proper auxiliaries for Unit 6	180 d	Mon 10/1/12	Fri 3/29/13
1171	Oil Flushing for Unit 6	30 d	Tue 3/26/13	Wed 4/24/13
1172	Precommissioning actvities for Unit 6	140 d	Wed 3/20/13	Tue 8/6/13
1173	Barring gear for Unit 6	0 d	Mon 7/22/13	Mon 7/22/13
1174	Unit Synchronisation with fuel Oil	0 d	Fri 10/25/13	Fri 10/25/13
1175	Successful completion of Reliability Run Test for Unit 6	0 d	Wed 12/25/13	Wed 12/25/13
1176	PG Test for Unit 6	0 d	Tue 3/25/14	Tue 3/25/14
1177	**Power Cycle Piping (Unit 6)**	**337 d**	**Wed 7/25/12**	**Thu 6/27/13**
1178	Receipt of Pipe, Pipe fittings & supports at site (lot 1) for Unit 6	0 d	Wed 7/25/12	Wed 7/25/12
1179	Receipt of Pipe, Pipe fittings & supports at site (lot 2) for Unit 6	0 d	Thu 11/22/12	Thu 11/22/12
1180	Erection of Piping including Hydro test for Unit 6	172 d	Wed 10/24/12	Sat 4/13/13
1181	Insulation for Unit 6	155 d	Thu 1/24/13	Thu 6/27/13
1182	Receipt of Other piping & pipe fittings at site for Unit 6	0 d	Wed 7/25/12	Wed 7/25/12
1183	Erection of Other piping for Unit 6	315 d	Thu 7/26/12	Wed 6/5/13
1184	**Power House building for Unit 6**	**541 d**	**Wed 6/1/11**	**Thu 11/22/12**
1185	Construction of Power House building foundation incl excavation for Unit 6	120 d	Wed 6/1/11	Wed 9/28/11
1186	Start & completion of Receipt of Turbine structure supplies at site for Unit 6	30 d	Sun 8/21/11	Mon 9/19/11
1187	Turbine structural erection for Unit 6	120 d	Tue 10/4/11	Tue 1/31/12
1188	TG hall with roof ready for Unit 6	0 d	Fri 4/13/12	Fri 4/13/12
1189	TG operating floor for Unit 6	90 d	Sat 8/25/12	Thu 11/22/12
1190	Receipt of bunker bay for Unit 6	0 d	Mon 9/19/11	Mon 9/19/11
1191	Bunker bay for Unit 6	160 d	Tue 10/4/11	Sun 3/11/12
1192	**CW system for Unit 6**	**136 d**	**Sat 12/22/12**	**Tue 5/7/13**
1193	Receipt of CW Pumps (2nos) at site for Unit 6	0 d	Sat 12/22/12	Sat 12/22/12
1194	Erection of CW Pumps (2 nos) for Unit 6	90 d	Tue 1/22/13	Sun 4/21/13
1195	CW Piping fabrication, erection & testing- condenser to header (mechanical & civil works) for Unit 6	100 d	Mon 1/28/13	Tue 5/7/13
1196	**IDCT Construction for Unit 6**	**608 d**	**Mon 10/24/11**	**Sat 6/22/13**
1197	Civil works of IDCT for Unit 6	430 d	Mon 10/24/11	Wed 12/26/12
1198	Receipt of ID fans at site for Unit 6	0 d	Thu 11/22/12	Thu 11/22/12
1199	Fans erection for Unit 6	150 d	Tue 1/1/13	Thu 5/30/13
1200	CW system commissioning for Unit 6	20 d	Mon 6/3/13	Sat 6/22/13
1201	**Cranes & Hoists for Unit 6**	**369 d**	**Thu 1/5/12**	**Tue 1/8/13**
1202	Receipt of cranes & hoists for Unit 6	0 d	Thu 1/5/12	Thu 1/5/12
1203	Erection of cranes & Other equipment handling hoists for Unit 6	180 d	Fri 7/13/12	Tue 1/8/13
1204	**Fire Fighting System for Unit 6**	**240 d**	**Thu 10/25/12**	**Fri 6/21/13**
1205	erection of Fire water system for trf yard for Unit 6	120 d	Thu 10/25/12	Thu 2/21/13
1206	erection of Fire watersystem for BOP for Unit 6	150 d	Mon 12/24/12	Wed 5/22/13

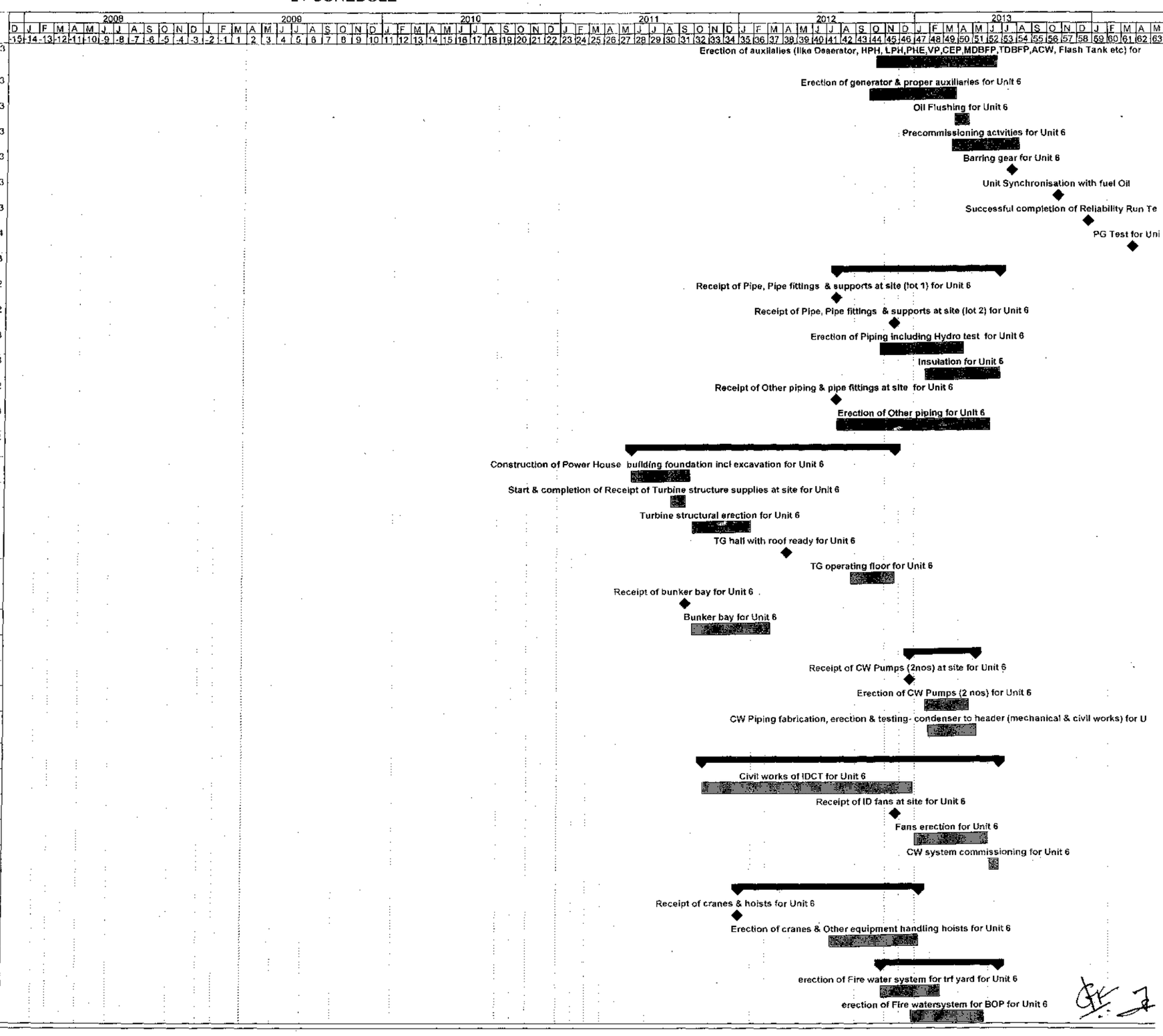


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1169	Erection of auxiliaries (like Deaerator, HPH, LPH,PHE,VP,CEP,MDBFP,TDBFP,ACW, Flash Tank etc) for Unit 6	250 d	Mon 10/15/12	Fri 6/21/13
1170	Erection of generator & proper auxiliaries for Unit 6	180 d	Mon 10/1/12	Fri 3/29/13
1171	Oil Flushing for Unit 6	30 d	Tue 3/26/13	Wed 4/24/13
1172	Precommissioning actvities for Unit 6	140 d	Wed 3/20/13	Tue 8/6/13
1173	Barring gear for Unit 6	0 d	Mon 7/22/13	Mon 7/22/13
1174	Unit Synchronisation with fuel Oil	0 d	Fri 10/25/13	Fri 10/25/13
1175	Successful completion of Reliability Run Test for Unit 6	0 d	Wed 12/25/13	Wed 12/25/13
1176	PG Test for Unit 6	0 d	Tue 3/25/14	Tue 3/25/14
1177	**Power Cycle Piping (Unit 6)**	**337 d**	**Wed 7/25/12**	**Thu 6/27/13**
1178	Receipt of Pipe, Pipe fittings & supports at site (lot 1) for Unit 6	0 d	Wed 7/25/12	Wed 7/25/12
1179	Receipt of Pipe, Pipe fittings & supports at site (lot 2) for Unit 6	0 d	Thu 11/22/12	Thu 11/22/12
1180	Erection of Piping including Hydro test for Unit 6	172 d	Wed 10/24/12	Sat 4/13/13
1181	Insulation for Unit 6	155 d	Thu 1/24/13	Thu 6/27/13
1182	Receipt of Other piping & pipe fittings at site for Unit 6	0 d	Wed 7/25/12	Wed 7/25/12
1183	Erection of Other piping for Unit 6	315 d	Thu 7/26/12	Wed 6/5/13
1184	**Power House building for Unit 6**	**541 d**	**Wed 6/1/11**	**Thu 11/22/12**
1185	Construction of Power House building foundation incl excavation for Unit 6	120 d	Wed 6/1/11	Wed 9/28/11
1186	Start & completion of Receipt of Turbine structure supplies at site for Unit 6	30 d	Sun 8/21/11	Mon 9/19/11
1187	Turbine structural erection for Unit 6	120 d	Tue 10/4/11	Tue 1/31/12
1188	TG hall with roof ready for Unit 6	0 d	Fri 4/13/12	Fri 4/13/12
1189	TG operating floor for Unit 6	90 d	Sat 8/25/12	Thu 11/22/12
1190	Receipt of bunker bay for Unit 6	0 d	Mon 9/19/11	Mon 9/19/11
1191	Bunker bay for Unit 6	160 d	Tue 10/4/11	Sun 3/11/12
1192	**CW system for Unit 6**	**136 d**	**Sat 12/22/12**	**Tue 5/7/13**
1193	Receipt of CW Pumps (2nos) at site for Unit 6	0 d	Sat 12/22/12	Sat 12/22/12
1194	Erection of CW Pumps (2 nos) for Unit 6	90 d	Tue 1/22/13	Sun 4/21/13
1195	CW Piping fabrication, erection & testing- condenser to header (mechanical & civil works) for Unit 6	100 d	Mon 1/28/13	Tue 5/7/13
1196	**IDCT Construction for Unit 6**	**508 d**	**Mon 10/24/11**	**Sat 6/22/13**
1197	Civil works of IDCT for Unit 6	430 d	Mon 10/24/11	Wed 12/26/12
1198	Receipt of ID fans at site for Unit 6	0 d	Thu 11/22/12	Thu 11/22/12
1199	Fans erection for Unit 6	150 d	Tue 1/1/13	Thu 5/30/13
1200	CW system commissioning for Unit 6	20 d	Mon 6/3/13	Sat 6/22/13
1201	**Cranes & Hoists for Unit 6**	**369 d**	**Thu 1/5/12**	**Tue 1/8/13**
1202	Receipt of cranes & hoists for Unit 6	0 d	Thu 1/5/12	Thu 1/5/12
1203	Erection of cranes & Other equipment handling hoists for Unit 6	180 d	Fri 7/13/12	Tue 1/8/13
1204	**Fire Fighting System for Unit 6**	**240 d**	**Thu 10/25/12**	**Fri 6/21/13**
1205	erection of Fire water system for trf yard for Unit 6	120 d	Thu 10/25/12	Thu 2/21/13
1206	erection of Fire watersystem for BOP for Unit 6	150 d	Mon 12/24/12	Wed 5/22/13

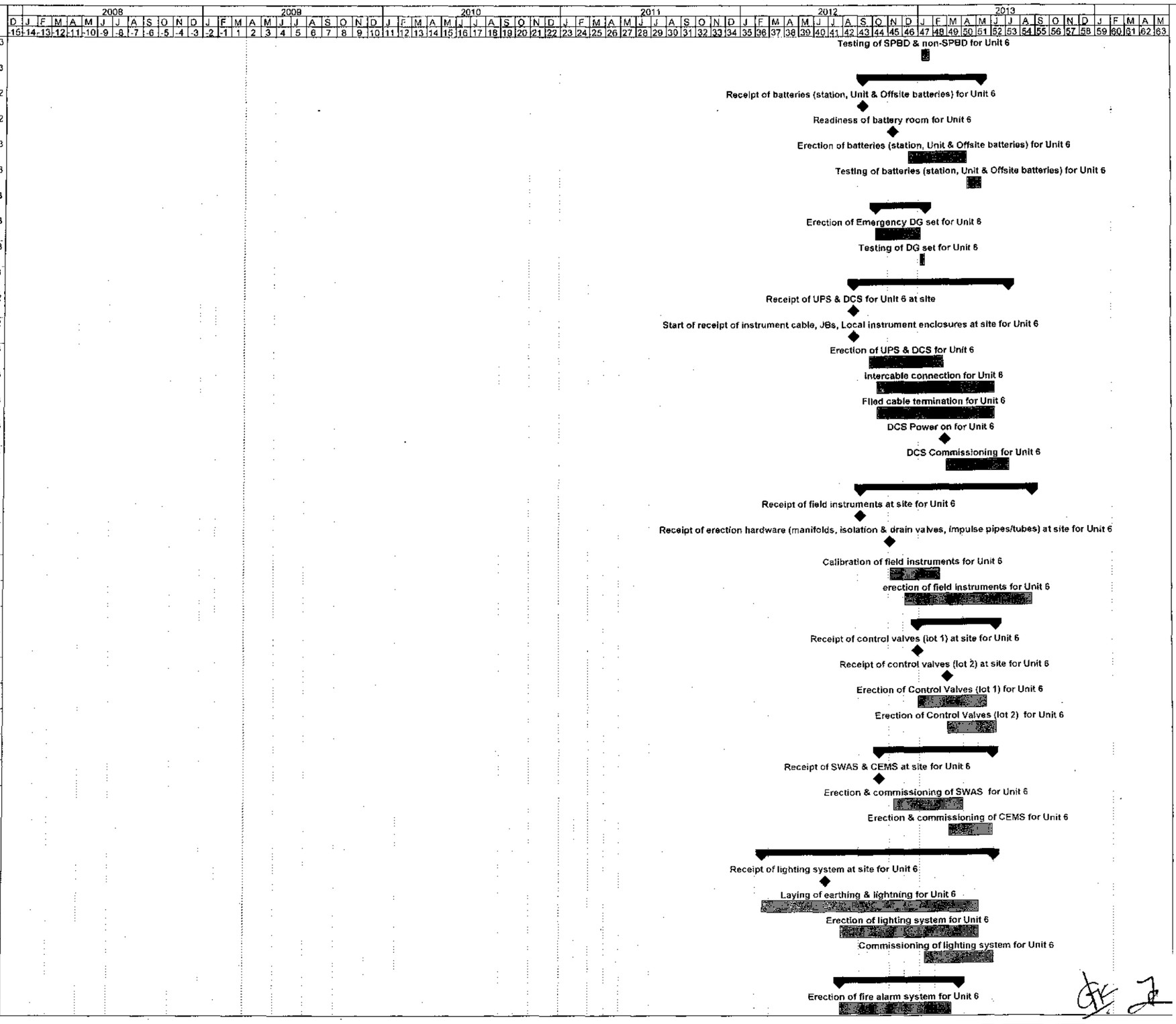


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1245	Testing of SPBD & non-SPBD for Unit 6	15 d	Thu 1/10/13	Thu 1/24/13
1246	**Battery (station, Unit & Offsite batteries) for Unit 6**	**241 d**	**Tue 9/11/12**	**Fri 5/10/13**
1247	Receipt of batteries (station, Unit & Offsite batteries) for Unit 6	0 d	Tue 9/11/12	Tue 9/11/12
1248	Readiness of battery room for Unit 6	0 d	Sun 11/11/12	Sun 11/11/12
1249	Erection of batteries (station, Unit & Offsite batteries) for Unit 6	120 d	Wed 12/12/12	Wed 4/10/13
1250	Testing of batteries (station, Unit & Offsite batteries) for Unit 6	30 d	Thu 4/11/13	Fri 5/10/13
1251	**Emergency Dgset for Unit 6**	**100 d**	**Mon 10/8/12**	**Tue 1/15/13**
1252	Erection of Emergency DG set for Unit 6	90 d	Mon 10/8/12	Sat 1/5/13
1253	Testing of DG set for Unit 6	10 d	Sun 1/6/13	Tue 1/15/13
1254	**DCS, UPS, cables for unit 6**	**316 d**	**Fri 8/24/12**	**Sat 7/6/13**
1255	Receipt of UPS & DCS for Unit 6 at site	0 d	Fri 8/24/12	Fri 8/24/12
1256	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 6	0 d	Fri 8/24/12	Fri 8/24/12
1257	Erection of UPS & DCS for Unit 6	150 d	Tue 9/25/12	Thu 2/21/13
1258	intercable connection for Unit 6	240 d	Wed 10/10/12	Thu 6/6/13
1259	Filed cable termination for Unit 6	240 d	Wed 10/10/12	Thu 6/6/13
1260	DCS Power on for Unit 6	0 d	Sat 2/23/13	Sat 2/23/13
1261	DCS Commissioning for Unit 6	130 d	Wed 2/27/13	Sat 7/6/13
1262	**Field Instruments for Unit 6**	**350 d**	**Wed 9/5/12**	**Wed 8/21/13**
1263	Receipt of field instruments at site for Unit 6	0 d	Wed 9/5/12	Wed 9/5/12
1264	Receipt of erection hardware (manifolds, isolation & drain valves, impulse pipes/tubes) at site for Unit 6	0 d	Sun 11/4/12	Sun 11/4/12
1265	Calibration of field instruments for Unit 6	100 d	Mon 11/5/12	Tue 2/12/13
1266	erection of field instruments for Unit 6	260 d	Wed 12/5/12	Wed 8/21/13
1267	**Control valves for Unit 6**	**160 d**	**Sat 12/29/12**	**Fri 6/7/13**
1268	Receipt of control valves (lot 1) at site for Unit 6	0 d	Sat 12/29/12	Sat 12/29/12
1269	Receipt of control valves (lot 2) at site for Unit 6	0 d	Wed 2/27/13	Wed 2/27/13
1270	Erection of Control Valves (lot 1) for Unit 6	140 d	Sun 12/30/12	Sat 5/18/13
1271	Erection of Control Valves (lot 2) for Unit 6	100 d	Thu 2/28/13	Fri 6/7/13
1272	**CEMS & SWAS for Unit 6**	**230 d**	**Thu 10/11/12**	**Wed 5/29/13**
1273	Receipt of SWAS & CEMS at site for Unit 6	0 d	Thu 10/11/12	Thu 10/11/12
1274	Erection & commissioning of SWAS for Unit 6	140 d	Sun 11/11/12	Sat 3/30/13
1275	Erection & commissioning of CEMS for Unit 6	90 d	Fri 3/1/13	Wed 5/29/13
1276	**lighting system for Unit 6**	**470 d**	**Thu 2/16/12**	**Thu 5/30/13**
1277	Receipt of lighting system at site for Unit 6	0 d	Sun 6/24/12	Sun 6/24/12
1278	Laying of earthing & lightning for Unit 6	440 d	Thu 2/16/12	Tue 4/30/13
1279	Erection of lighting system for Unit 6	280 d	Wed 7/25/12	Tue 4/30/13
1280	Commissioning of lighting system for Unit 6	140 d	Fri 1/11/13	Thu 5/30/13
1281	**fire alarm system for Unit 6**	**240 d**	**Tue 7/24/12**	**Wed 3/20/13**
1282	Erection of fire alarm system for Unit 6	225 d	Tue 7/24/12	Tue 3/5/13



WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

L1 SCHEDULE

ID	Task description	Duration	Start	Finished
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1246	**Battery (station, Unit & Offsite batteries) for Unit 6**	**241 d**	**Tue 9/11/12**	**Fri 5/10/13**
1247	Receipt of batteries (station, Unit & Offsite batteries) for Unit 6	0 d	Tue 9/11/12	Tue 9/11/12
1248	Readiness of battery room for Unit 6	0 d	Sun 11/11/12	Sun 11/11/12
1249	Erection of batteries (station, Unit & Offsite batteries) for Unit 6	120 d	Wed 12/12/12	Wed 4/10/13
1250	Testing of batteries (station, Unit & Offsite batteries) for Unit 6	30 d	Thu 4/11/13	Fri 5/10/13
1251	**Emergency Dgset for Unit 6**	**100 d**	**Mon 10/8/12**	**Tue 1/15/13**
1252	Erection of Emergency DG set for Unit 6	90 d	Mon 10/8/12	Sat 1/5/13
1253	Testing of DG set for Unit 6	10 d	Sun 1/6/13	Tue 1/15/13
1254	**DCS, UPS, cables for unit 6**	**316 d**	**Fri 8/24/12**	**Sat 7/6/13**
1255	Receipt of UPS & DCS for Unit 6 at site	0 d	Fri 8/24/12	Fri 8/24/12
1256	Start of receipt of instrument cable, JBs, Local instrument enclosures at site for Unit 6	0 d	Fri 8/24/12	Fri 8/24/12
1257	Erection of UPS & DCS for Unit 6	150 d	Tue 9/25/12	Thu 2/21/13
1258	intercable connection for Unit 6	240 d	Wed 10/10/12	Thu 6/6/13
1259	Filed cable termination for Unit 6	240 d	Wed 10/10/12	Thu 6/6/13
1260	DCS Power on for Unit 6	0 d	Sat 2/23/13	Sat 2/23/13
1261	DCS Commissioning for Unit 6	130 d	Wed 2/27/13	Sat 7/6/13
1262	**Field Instruments for Unit 6**	**350 d**	**Wed 9/5/12**	**Wed 8/21/13**
1263	Receipt of field instruments at site for Unit 6	0 d	Wed 9/5/12	Wed 9/5/12
1264	Receipt of erection hardware (manifolds, isolation & drain valves, impulse pipes/tubes) at site for Unit 6	0 d	Sun 11/4/12	Sun 11/4/12
1265	Calibration of field instruments for Unit 6	100 d	Mon 11/5/12	Tue 2/12/13
1266	erection of field instruments for Unit 6	260 d	Wed 12/5/12	Wed 8/21/13
1267	**Control valves for Unit 6**	**160 d**	**Sat 12/29/12**	**Fri 6/7/13**
1268	Receipt of control valves (lot 1) at site for Unit 6	0 d	Sat 12/29/12	Sat 12/29/12
1269	Receipt of control valves (lot 2) at site for Unit 6	0 d	Wed 2/27/13	Wed 2/27/13
1270	Erection of Control Valves (lot 1) for Unit 6	140 d	Sun 12/30/12	Sat 5/18/13
1271	Erection of Control Valves (lot 2) for Unit 6	100 d	Thu 2/28/13	Fri 6/7/13
1272	**CEMS & SWAS for Unit 6**	**230 d**	**Thu 10/11/12**	**Wed 5/29/13**
1273	Receipt of SWAS & CEMS at site for Unit 6	0 d	Thu 10/11/12	Thu 10/11/12
1274	Erection & commissioning of SWAS for Unit 6	140 d	Sun 11/11/12	Sat 3/30/13
1275	Erection & commissioning of CEMS for Unit 6	90 d	Fri 3/1/13	Wed 5/29/13
1276	**lighting system for Unit 6**	**470 d**	**Thu 2/16/12**	**Thu 5/30/13**
1277	Receipt of lighting system at site for Unit 6	0 d	Sun 6/24/12	Sun 6/24/12
1278	Laying of earthing & lightning for Unit 6	440 d	Thu 2/16/12	Tue 4/30/13
1279	Erection of lighting system for Unit 6	280 d	Wed 7/25/12	Tue 4/30/13
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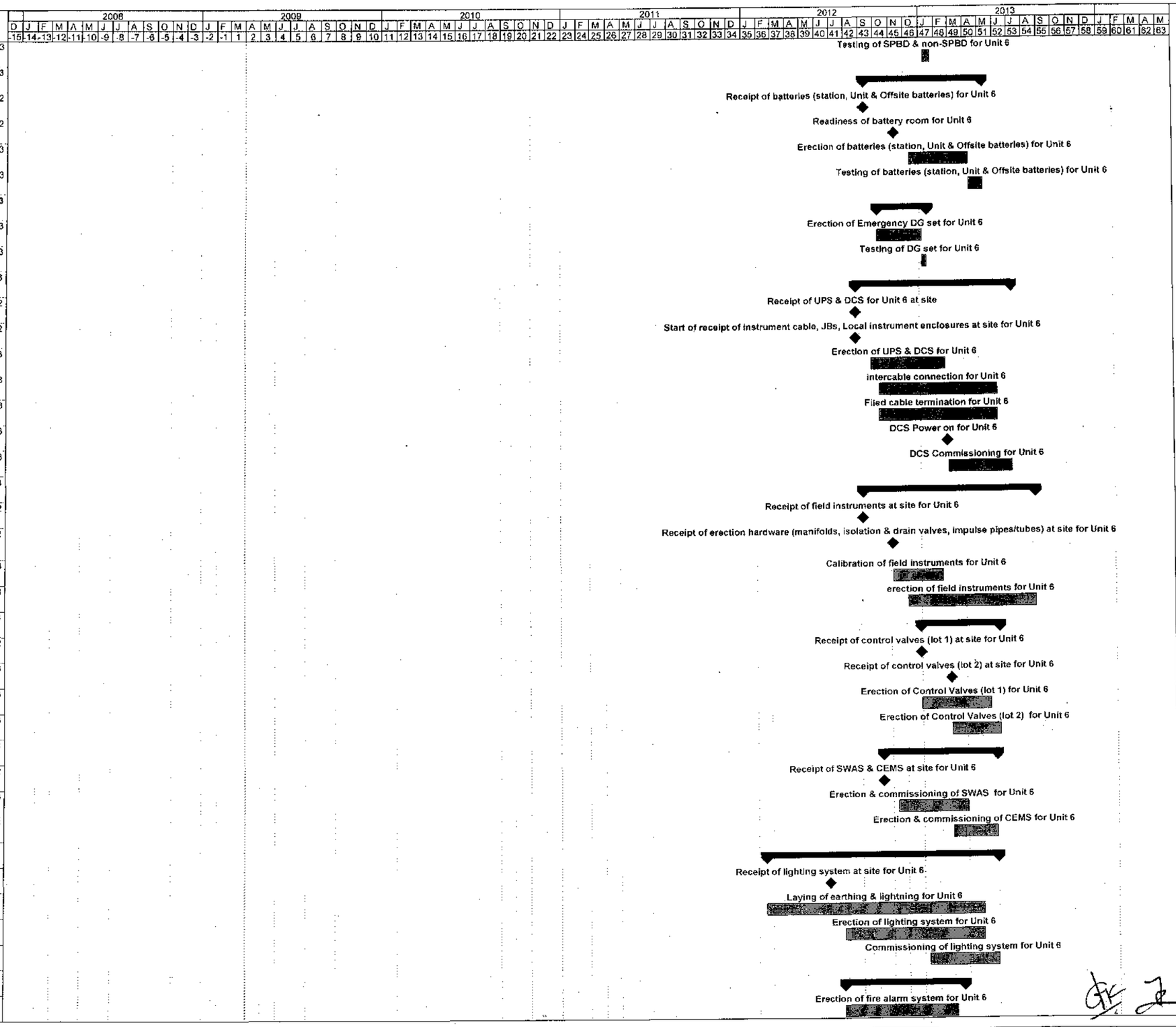
1281	**fire alarm system for Unit 6**	**240 d**	**Tue 7/24/12**	**Wed 3/20/13**
1282	Erection of fire alarm system for Unit 6	225 d	Tue 7/24/12	Tue 3/5/13

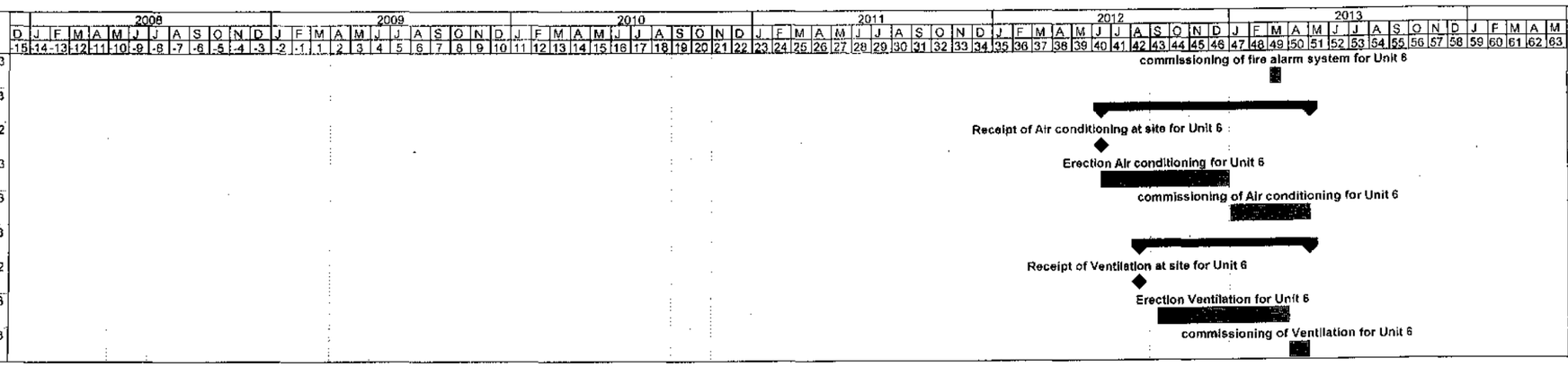


WARDHA POWER COMPANY PRIVATE LIMITED

3600 MW COAL BASED POWER PROJECT AT NARIYARA VILLAGE, AKALTARA TEHSIL, JANJGIR-CHAMPA DISTRICT, CHATTISGARH

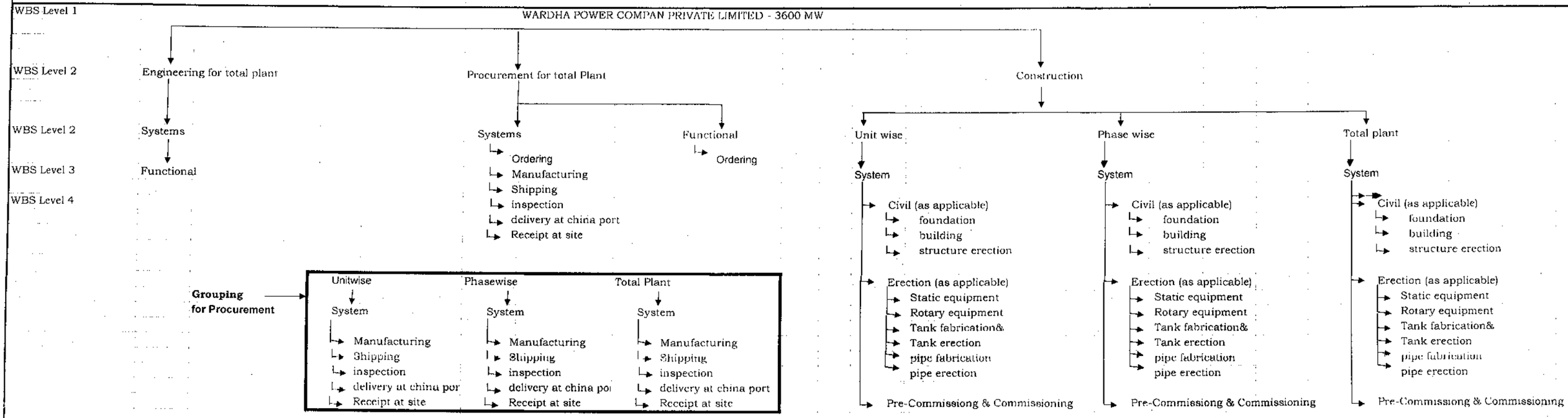
L1 SCHEDULE

ID	Task description	Duration	Start	Finished
1283	commissioning of fire alarm system for Unit 6	15 d	Wed 3/6/13	Wed 3/20/13
1284	**Air conditioning for Unit 6**	**321 d**	**Fri 6/15/12**	**Thu 5/2/13**
1285	Receipt of Air conditioning at site for Unit 6	0 d	Fri 6/15/12	Fri 6/15/12
1286	Erection Air conditioning for Unit 6	200 d	Sat 6/16/12	Tue 1/1/13
1287	commissioning of Air conditioning for Unit 6	120 d	Thu 1/3/13	Thu 5/2/13
1288	**Ventilation for Unit 6**	**260 d**	**Tue 8/14/12**	**Wed 5/1/13**
1289	Receipt of Ventilation at site for Unit 6	0 d	Tue 8/14/12	Tue 8/14/12
1290	Erection Ventilation for Unit 6	200 d	Fri 9/14/12	Mon 4/1/13
1291	commissioning of Ventilation for Unit 6	30 d	Tue 4/2/13	Wed 5/1/13



ANNEXURE-3

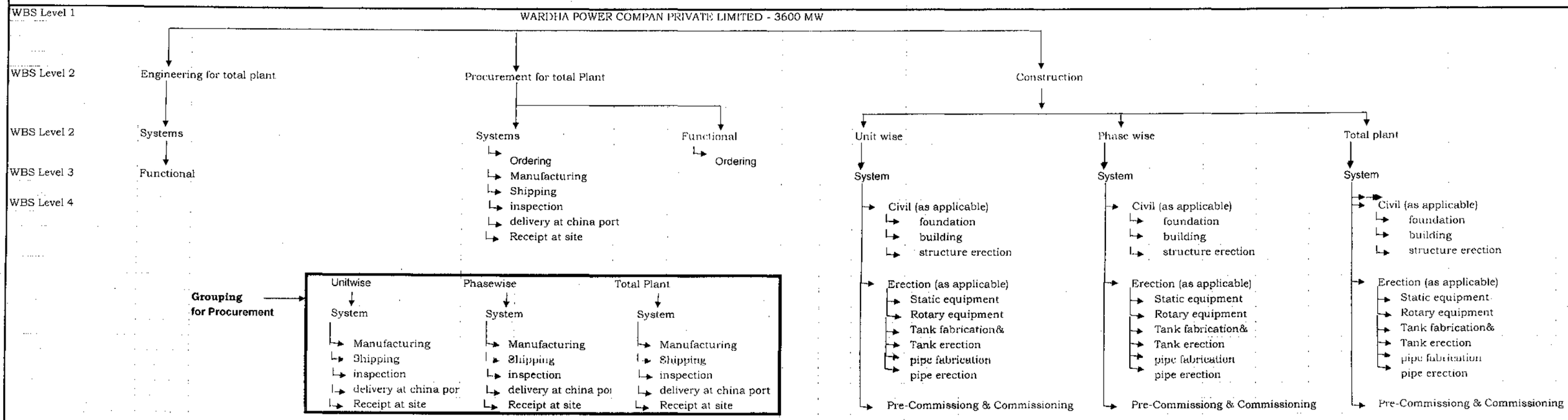
WBS STRUCTURE FOR WARDHA POWER COMPANY PRIVATE LIMITED - 3600 MW



Unit	Unit 3// Unit 4// Unit 2// Unit 5 // Unit 1 // Unit 6 ⟶ As per construction methodology
Phase	Unit 1, 2 , 3 // Unit 4,5,6
Total	Unit 1,2,3,4,5,6
Project Stage	Engineering // Procurement// Construction
Systems	Electrical System / C&I system / CHP / AHP/ CW system / Raw water system / Water Treatment Plant etc
Functional	Civil, Erection, commissioning
Activity ID :	Plant ID - Project Stage-Unit//Phase//Total-System-Functional-000000 ; (WPCPL requested SEPCO to follow KKS numbering system)
Shipping means	peparation of report to customs, loading on ship, transporation within india
Manufacturing means	Engineering of eqpuipment, material purchase by manufacturer, material cutting & bending, assembly, testing, package

ANNEXURE-3

WBS STRUCTURE FOR WARDHA POWER COMPANY PRIVATE LIMITED - 3600 MW



Unit	Unit 3// Unit 4// Unit 2// Unit 5 // Unit 1 // Unit 6 ⟶ As per construction methodology
Phase	Unit 1, 2 , 3 // Unit 4,5,6
Total	Unit 1,2,3,4,5,6
Project Stage	Engineering // Procurement// Construction
Systems	Electrical System / C&I cystem / CHP / AHP/ CW system / Raw water system / Water Treatment Plant etc
Functional	Civil, Erection, commissioning
Activity ID :	Plant ID - Project Stage-Unit//Phase//Total-System-Functional-000000 ; (WPCPL requested SEPCO to follow KKS numbering system)
Shipping means	peparation of report to customs, loading on ship, transporation within india
Manufacturing means	Engineering of eqpuipment, material purchase by manufacturer, material cutting & bending, assembly, testing, package

A LIST OF BUILDINGS & STRUCTURES

1	MAIN GATE
2	FUEL/MATERIAL GATE
3	SECURITY POST AND TIME OFFICE
4	SECURITY POST
5	ADMINISTRATION BUILDING
6	TURBINE BUILDING
7	DEAERATOR BAY
8	BUNKER BAY
9	MAIN AND AUXILIARY TRANSFORMERS
10	STATION TRANSFORMER
11	BOILERS & AUXILIARIES
12	E.S.P.
13	I.D. FANS
14	CHIMNEY
15	FLY ASH SILOS
16	ESP-MP CONTROL HOUSE
17	OIL PUMP HOUSE AND FUEL OIL TANK YARD
18	400 KV SWITCHYARD
19	RAW WATER RESERVOIR
20	RAW WATER PRE-TREATMENT PLANT
21	D.M. TREATMENT PLANT
22	COOLING WATER TOWERS
23	C.W. PUMP HOUSE & ELECTRICAL ROOM.
24	DIESEL GENERATOR SET
25	TRANSFER TOWER
26	COAL CRUSHER HOUSE.
27	FIRE STATION
28	COAL HANDLING CONVEYER
29	COAL STOCK PILE
30	COOLING WATER TREATMENT PLANT
31	ROAD WEIGHT BRIDGE & CONTROL ROOM
32	AUTO GARAGE
33	WORK SHOP
34	STORES
35	COAL HANDLING COMPLEX BUILDING
36	CYCLE & SCOOTER STAND.
37	PLANT SERVICE BUILDING
38	CAR PARKING
39	PLANT AMENITIES & CANTEEN
40	CENTRAL CONTROL BUILDING
41	BASIC WATER TREATMENT SKID FOR BOILER ACID WASHING
42	RAW WATER PUMP HOUSE
43	BUILDOZER STORE HOUSE
44	WASTE WATER TREATMENT STATION
45	SERVICE/INSTRUMENT AIR COMPRESSOR HOUSE
46	TRUCK HOPPER
47	RAILWAY SIDING
48	LOCO SHED
49	OFFICE HOUSE
50	SWITCHYARD RELAY BUILDING
51	START-UP BOILER HOUSE
52	TRUCK PARKING
53	ASH SLURRY PUMP HOUSE
54	COAL WASTE WATER TREATMENT BUILDING
55	COAL WASHING WATER POND AND PUMP HOUSE
56	COAL SETTLING POND
57	GENERAL PUMP HOUSE & PONDS(INCLUDING FIRE FIGHTING PUMPS)
58	TRUCK HOPPER CONTROL BUILDING
59	RAILWAY WORK BRIDGE
60	HYDROGEN GENERATION PLANT
61	SPACE FOR FLUE GAS DESULPHURISATION PLANT
62	ABSORBER BLOCKS
63	ENVIRONMENTAL MONITORING ROOM
64	ELECTRICAL TOWER BAY
65	BOTTOM ASH SILO & MILL REJECTS SILO
66	ASH HANDLING AIR COMPRESSOR HOUSE
67	FLY ASH INTERMEDIATE SILOS
68	SUMP POND
69	BOTTOM ASH SILO
70	RAIN WATER HARVEST POND
71	CW WASTE WATER TREATMENT PLANT
72	DE PUMP HOUSE

LEGEND

NO.	DESCRIPTION	LEGEND
1	NEW BUILDING	PLAIN
2	UNDERGROUND WATER POOL	
3	FENCE	
4	PLANT BOUNDARY WALL	
5	ROAD	
6	COMPREHENSIVE PIPE RACK	

0 40 80 120 160 200M

SCALE-1:2000

NOTE

1. THIS DRAWING IS ACCORDING TO THE EMPLOYER'S ATTACHMENT THE PLOT PLAN OF POWER PLANT AREA (1:2500).
2. THE COORDINATES ELEVATIONS AND DIMENSIONS IN THIS DRAWING ARE IN METER.

KEY MAP

BOTTOM ASH YARD

FLY ASH YARD

OUT LINE

OUT LINE

WARDHA POWER COMPANY PVT. LIMITED
NEAR AKALTARA IN CHHATISGARH

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

CONTRACTOR: SEPCO ELECTRIC POWER CONSTRUCTION CORP.,PRC

NORTHEAST ELECTRIC POWER DESIGN INSTITUTE OF CHINA POWER ENGINEERING CONSULTING GROUP

3X600 MW COAL BASED POWER PROJECT AT KANTEKA, AMLORI-CHANDA CHHATISGARH

DESIGN STAGE: PROPOSAL DESIGN

APPROVED BY | CHECKED BY | REVIEWED BY | DESIGNED BY | DATE 2.10.2009 | SCALE 1:2500 | DRG NO FB2X63-Z01

GENERAL LAYOUT

25/3/09

2009.3.25
(ZHENG ZHEN LEI)

MINUTES OF MEETING BETWEEN 14th March'09 TO 31st March'09 SCHEDULE FOR 3600 MW POWER PLANT AT VILLAGE NARIYARA, AKALTARA TALUK, JANJGIR-CHAMPA DISTRICT

Team Members

WPCPL	SEPCO
1. G.P.Rao(part)	
2. G Shankar	1. Wang Lei
3. B Ganesh Kumar	2. LIU Hong Yuan (part)
4. C.V.K Prasad	3. Xue Li (part)
5. G.V.Subba Rao	4. Wang Heng (part)
6. SBR Prasad	
7. Shartchandran (part)	

1. SEPCO had submitted L2 schedule for discussion in the meeting. However, since L1 schedule has to be finalized as part of contract, SEPCO were requested to prepare and provide L1 Schedule. Accordingly SEPCO has furnished the L1 schedule for discussion.

2. During discussion on the subject schedule, SEPCO agreed for commissioning the units in the following order: Unit 3, Unit 4, Unit 2, Unit 5, unit 1 and Unit 6 (considering the Units - 1 to 6 arranged from South to North). The Level-1 Construction methodology is attached as **Annexure-2** to this MOM.
   SEPCO will submit detailed construction methodology latest by 31st May 2009.

3. SEPCO submitted the L1 Schedule for first unit and informed that this schedule is applicable for any unit out of the 6 units to start with. Further, SEPCO developed and submitted this schedule for the balance units in line with their above preferred construction methodology. The L1 Schedule is attached as **Annexure-1** to this MOM. Major milestones as in the L1 schedule are placed at **Annexure-1 A**. The zero date will be as defined in the Contract. The Zero Date reckoned is 26-Feb-09.

4. Both the parties acknowledge that any activities not covered in L1 Schedule shall be covered in the revised L2 Schedule. The L2 Schedule shall cover all work packages included in the EPC scope of work.

(Ganesh Kumar) 31/3/09

WANG LEI 31.3.09

5. L2 schedule submitted by SEPCO to be revised in line with the finalized L1 schedule latest by 31st May 2009. This schedule shall be discussed and approved after the approval of detailed Construction Methodology (Refer Sr. No. 2)

6. The agreed Work Break-down Structure (WBS) and Activity codes (AC) is enclosed as per **Annexure-3**.

7. SEPCO agreed that further detailing of L1 schedule to L2, L3 & L4 schedules, as required by WPCPL site & Head Office will be developed. These Schedules shall incorporate the agreed WBS & AC.

8. However, while submitting the L1, L2, L3 schedules in Primavera to WPCPL, SEPCO shall follow the Grouping format for procurement as indicated in the Annexure-3.

9. SEPCO shall submit by 5th of every month, the Monthly Progress report for the previous month. Typical index of the Monthly progress report is enclosed as **Annexure – 4.** SEPCO shall develop Monthly Progress report format based on the above index and submit before the Kick-Off meeting. The report format & the index shall be discussed and finalized during the Kick-off meeting.

10. The first detailed progress report in the proforma agreed to be submitted by SEPCO for the month of April'2009. However, a brief progress report for the Month of March'09 may be submitted by first week of April'2009.

11. WPCPL informed SEPCO to provide project measurement methodology by 15st April 2009, which will be used to develop the S-curve and also to report project progress. This methodology shall be discussed and finalized during Kick-Off meeting.

12. SEPCO agreed that they will develop and update all project schedules in Primavera with the version compatible to the latest version (available in the market). The agreed L1 schedule shall be submitted by SEPCO in Primavera Format by 25th April '09. WPCPL requested SEPCO to arrange schedules in Primavera from their sub-contractors / vendors.

13. SEPCO to develop Occupational Health and Safety manual and submit by 15th of April 2009. It will be discussed and finalized during the Kick-Off meeting.

14. In line with construction methodology (Annexure-2), SEPCO to provide the T&P to be mobilized by them latest by 31st May'2009. In addition SEPCO will update the T&P list as and when their sub-contracts for site works are awarded. Also, in line with Construction Methodology, SEPCO to provide by 31st May 2009 the manpower mobilization in the similar format as provided earlier.

15. The construction facilities indicated in the Plot Plan (DRG no. F625KB-Z01) by SEPCO shall be discussed and finalized during kick- off meeting.

16. SEPCO has informed that the Engineering document submission schedule will be as follows,
    a. Plot plan during Kick-Off meeting
    b. DBR drawing schedule for total power plant by 15th May '09
    c. Engineering Schedule for Power block area + drawing list in the Balance of Plant by 31st July '09
    d. Engineering Schedule for balance of plant except Coal Handling Plant area & Ash Handling Plant Area by 25th Aug '09
    e. Engineering Schedule for CHP & AHP by 10th October 2009

The Engineering Schedule format shall be discussed and finalized during Kick-Off meeting.

17. Shipping Schedule shall be submitted by SEPCO by 31st May 2009. A typical Shipping Schedule format is attached as **Annexure-5.** This will be discussed and finalized.

Encl: Annexure -1& 1A
Annexure – 2
Annexure – 3
Annexure – 4
Annexure – 5

ANNEXURE-1

1/2

WPCPL 3600 MW PROJECT - MILESTONE CHART BASED ON L1 SCHEDULE

Sr. No.	Milestones	Unit-3	Unit-4	Unit-2	Unit-5	Unit-1	Unit-6
		Target	Target	Target	Target	Target	Target
A.	**Commencement of Civil Works**						
1	Commencement Boiler foundation Excavation	8.5	12.5	16.5	20.5	24.5	28.5
2	Commencement of Power House excavation	10	14	17	21	24	27
3	TG Deck completion	23	27	31	35	39	43
4	TG Operating Floor completion	25	29	33	37	41	45
5	Control room completion	22	26	22	26	22	26
B.	**Boiler**						
1	Commencement of receipt of Boiler Supplies at site	13	17	21	25	29	33
2	Commencement of Boiler erection	15.5	19.5	23.5	27.5	31.5	35.5
3	Boiler Drum lifting	23	27	31	35	39	43
4	Hydro Test (total pressure parts)	30	34	38	42	46	50
5	Completion of Boiler Supplies	27	31	35	39	43	47
C	**Turbine & Generator**						
1	Commencement of TG Supplies	17.5	21.5	25.5	29.5	33.5	37.5
2	Commencement of Condenser Erection	22	26	30	34	38	42
3	Commencement of Main Turbine Erection	23	27	31	35	39	43
4	Generator Stator Lifting	24	28	32	36	40	44
5	Completion of leveling & alignement of turbine cylinders	28	32	36	40	44	48
6	Boxing up of Turbine & Generator	29	33	37	41	45	49
7	Oil flushing complete	30	34	38	42	46	50
8	Completion of Governing system & Barring Gear	33	37	41	45	49	53
9	Completion of TG Supplies	29	33	37	41	45	49
D.	**Balance of Plant systems**						
1	Commencement of Erection of Coal Handling Plant	22	26	22	26	22	26
2	Commencement of Erection of Ash Handling Plant	24	24	24	24	24	24
3	Commencement of Erection of Water Supply and Treatment Plant	21	21	21	21	21	21
4	Commencement of Erection of CW (including CW pipe erection)	15	15	15	15	15	15
5	Commencement of Erection of Fuel Oil Handling Plant	23.5	23.5	23.5	23.5	23.5	23.5
6	Commencement of Erection of Compressed Air Plant	23.5	27.5	23.5	27.5	23.5	27.5
E.	**Commissioning Activities**						
1	Commissioning of Water Supply and Water Treatment Systems*	28	28	28	28	28	28
2	Commissioning of CW system	32	36	40	44	48	52
3	Commissioning of Fuel Oil System	31	31	31	31	31	31
4	Commissioning of Compressed Air Plant for instrument & service air	31	35	31	35	31	35

WPCPL 3600 MW PROJECT - MILESTONE CHART BASED ON L1 SCHEDULE

Sr. No.	Milestones	Unit-3	Unit-4	Unit-2	Unit-5	Unit-1	Unit-6
		Target	Target	Target	Target	Target	Target
5	Commissioning of Coal Handling System	35	39	35	39	35	39
6	Switchyard Back Charging	30	30	30	30	30	30
7	Boiler Light up	33	37	41	45	49	53
8	Steam Blowing including Normalisation	34	38	42	46	50	54
9	Safety Valve Floating	35	39	43	47	51	55
9	Unit Synchronisation	36	40	44	48	52	56
10	Coal Firing	36.25	40.25	44.25	48.25	52.25	56.25
11	Commissioning of Ash Handling System	35.0	39.0	43.0	47.0	51.0	55.0
12	Commissioning of Effluent Treatment Plant	32	32	32	32	32	32
13	Reliability Run Test completion	38	42	46	50	54	58
14	Performance Guarantee test	41	45	49	53	57	61

* Temporary Instrument air & power for commissioning of Water system shall be arranged by SEPCO

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7. DETAILED ORDERING STATUS
   a. CUMULATIVE ORDERING STATISTICS
   b. ORDERING DURING THE MONTH
8. DETAILED MANUFACTURING STATUS
   a. CUMULATIVE MANUFACTURING STATISTICS
   b. MANUFACTURING DURING THE MONTH
   c. MANUFACTURING PHOTOS
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15. PAYMENT STATUS & CASH Flow S-CURVES
16. PROGRESS UPDATED L2 SCHEDULE

ANNEXURE -4

MONTHLY PROGRESS REPORT 1/2

APRIL'09

OF

3600 MW COAL BASED POWER PLANT

AT

VILLAGE NARIYARA, AKALTARA TEHSIL, JANJGIR CHAMPA DISTRICT

Typical Shipping Sch.

ANNEXURE-5

[redacted]

SHIPPING SCHEDULE FOR [redacted]

Sl No	Description of item to be imported	Unit (Kg/tons /Nos/LOT)	Quantity	Total Price (CFR) in USD	Country of Origin/ Delivery from (Name of the Country)	Shipping Schedule (FOB)	Receipt at Plant site Schedule (Estimated)
	No.1 shipment			[redacted]	CHINA	2007.09.15	2007.12.15
1 (i)	Holding down bolt of steel frame for four sets of boiler (1st batch)	Sets	4	[redacted]	CHINA		2007.12.15
1 (ii)	Holding down bolt of steel frame for main house steel structure and its mounting yoke(1st batch)	LOT	1	[redacted]	CHINA		2007.12.15
	No.2 shipment			[redacted]	CHINA		2008.1.30
2 (i)	Steel structure for main power house(2nd batch)	LOT	1	[redacted]	CHINA		2008.1.30
2 (ii)	Generator bedded parts,\pedestal,\ holding down bolts etc.	LOT	4	[redacted]	CHINA		2008.1.30
2 (iii)	Holding down bolt of steel frame for main house steel structure and its mounting yoke(3rd batch)	LOT	1	[redacted]	CHINA		2008.1.30
2 (iv)	Metarials for installation(1st batch)	LOT	1	[redacted]	CHINA		2008.1.30
	No.3shipment			[redacted]	CHINA		2008.2.28
3 (i)	Steel structure for main power house(4th batch)	LOT	1	[redacted]	CHINA		2008.2.28
3 (ii)	Steel structure for main power house(5th batch)	LOT	1	[redacted]	CHINA		2008.2.28

[redacted]

ANNEXURE-2

1/1

Wardha 6x 600 MW -SEPCO - Construction Methodology – Level 1

1. As discussed project schedule given for First unit is applicable for any unit out of the 6 units to start with .
2. Construction Methodology Level -1
   The plan is to follow this sequence of erection and commissioning
   Unit 3,4,2,5,1,6
   This will facilitate material feeding for erection , movements of cranes and enable commissioning 6 units in 4 months intervals between each unit utilizing 8 months time gap between adjacent units in this sequence of commissioning.
   Requirements of first unit commissioning (Third Unit).
   - Total boiler completion
   - Total ESP and its bag filters completion
   - Main power house building for unit 3,2,1
   - Coal bunker bay for unit 3,2,1
   - Cooling tower for first unit (unit 3)
   - Channel and fore bay for phase-1
   - CW pumps erection in phase-1
   - Ash handling system (bottom ash) from Intermediate Silo to Ash dyke (silo) for entire plant to be completed for evacuation by truck to the ash dyke (bottom ash)
   - Ash handling system (bottom ash) from individual unit to intermediate silo to be completed
   - Ash handling system (fly ash) from silos to ash dyke to be completed for the entire plant.
   - Ash handling system (fly ash) - from ESP (of individual units) to phase-1 silo to be completed
   - From phase-1 silo the HCSD system to be made ready for disposal at ash dyke (fly ash)
   - Coal handling system for unit 1,2,3 to be completed
   - Coal handling plant conveyor (for unit 4,5,6) above phase I ID fan should also be completed
   - Coal handling plant (conveyor crossings) at all railway crossing to be completed
   - Coal yard for phase-1 to be completed
   - Two stacker reclaimer to be completed
   - Tracker hopper-1 to be completed, 2nd track hopper wherever affected to be completed
   - Central control room for unit 1,2,3 to be completed
   - Fuel Oil pump house for the entire plant to be completed
   - Raw water system, pre-treatment system, DM plant system for the entire plant to be completed
   - Switchyard for the entire plant to be completed
   - Fire fighting system for the entire switchyard and coal handling plant, Ash handling plant, Unit-3 and other areas as required to be completed
   - Air compressor (instrument air and service air) for the plant to be completed
   - Ash system compressor for the plant to be completed
   - 2 EOT cranes in the TG hall to be completed

Mar 21, 2009

- Chimney along with unit 3 steel flue to be completed.

Requirement for Second Unit commissioning (Fourth Unit)

- Unit-2 chimney to be completed
- Coal handling plant entire plant to be completed
- Coal handling plant balance works for unit 4,5,6 to be completed
- Coal yard for phase-2 to be completed
- 2nd track hopper to be fully completed
- 3rd stacker reclaimer to be completed
- 2nd Central control room to be made ready
- Unit related cooling tower to be ready
- Channel and fore bay for phase-2
- CW pumps erection in phase-2
- Firefighting balance to be completed
- Any unit related system to be completed
- 3rd EOT crane in the TG hall to be completed

Positioning of the cranes

- For Boiler erection
  - 4 nos. tower cranes of capacity around 80 tones and two 250 tones crawler cranes will be deputed
  - In the ESP area two nos. 8 tone tower cranes and one nos. 75 tone tower crane will be provided
- Turbine hall structure
  - Two nos. 75 tone cranes per phase will be available for erecting the structures
- Central Control Room
  - Two nos. 75 tone crane will be made available
- Bunker Bay
  - Two nos. 250 tone cranes per phase will be available for erecting the structures
- CHP
  - Cranes as required will be made available at various points
- Other balance of Plant
  - Cranes as required will be made available at various points
- Fabrication of Bunker, structures etc.
  - Four 40 tone gantry cranes (50 Mts) will be made available for fabrication of bunker hopper, steel structures fabrication in the yard adjacent to power house

3. In addition to above the list of T&P to be mobilized by SEPCO and its sub-contractors will be provided separately.

4. Detailed construction methodology will be submitted in 2 months time

Mar 21, 2009

IDCT
WTP
SWYD
N
U1
U2
U3
U4
U5
U6
C#5
C#3
C#1
C#2
C#4
C#6
CH-1
CH-2

Schedule of Special Tools And Tackles

Sl No.	System/sub-system	Description	Spec	Unit	Qty.
1	Boiler	Spanner for large bolt on suspension		Nos	1
2		Specific spanner for bolt on manhole		Nos	1
3		Motorized spanner for high tension bolt		Nos	1
4		Manual spanner for high tension bolt		Nos	1
5		Dismantle tools for air preheater		Set	1
6		Compaction device for safety valve adjustment, calibration and hydraulic test		Set	1
7		Tools for safety valve grinding and repair		Set	1
8	Blind valve for main steam and reheat steam hydraulic test	Dismantle tools		One for each valve	1
9	Soot blower	Specific tools for soot blower		Set	1
10	Coal feeder	Horizontal calibration pole		Nos	1
11		Position detector		Nos	1
12		Detector cable		Nos	1
13		Glistening paper		Nos	1
14		Calibration weight		Nos	1
15		Roller dismantle seat		Nos	1
16		Roller hoist pole		Nos	1
17		Roller extension pole		Nos	1
18	Pulverizer	Roller turning device		Nos	1
19		Roller hoist device		Nos	1
20		Roller bushing dismantle device		Nos	1
21		Reducer moving device		Nos	1
22		Alignment device for reducer and side machinery		Nos	1
23		Spring pre-tension device		Nos	1
24		Coupling bolt pre-tension device between reducer and pulverizer tray		Nos	1
25		Oil level pole		Nos	1
26		PC sample device		Nos	1
27		Embedded bolt pre-tension device		Nos	1
28	ID fan	Adjustable torque wrench		Set	1
29		Dismantle device		Set	1

Sl No.	System/sub-system	Description	Spec	Unit	Qty.
30		Screw dismantle and hoist device		Set	1
31	FD fan	Wheel hub lug ring		Set	1
32		Blade fasten bolt		Nos	1
33	FD fan	Blade angle adjustment tray		Set	1
34		Wheel hub and main bearing dismantle tools		Set	1
35		Torque wrench		Set	1
36		Grease gun		Nos	1
37	Fan hoisting equipment	Torque wrench		Set	1
38		Grease gun		Set	1
39		Inner hexagon spanner		Set	1
40	Pulverizer hoisting equipment	Torque wrench		Set	1
41		Grease gun		Set	1
42	Elevator	Multi-purpose meter		Nos	1
43		Spanner		Set	1
44		Screw driver		Set	1
45	Steam turbine	Rotor hoisting tool		Set	1
46		Cylinder hoisting tool		Set	1
47		Shaft carrying tool for bushing turn		Set	1
48		Temporary blinder for main stop valve and combined reheat valve on steam blowing		Set	1
49		Specific spanner for steam governor parts		Set	1
50		Specific spanner for hot tension bolt on steam cylinder		Set	1
51		High temperature grease fill-in device		Set	1
52		DEH specific tool		Set	1
53		Bridge gage for measure bushing abrasion		Set	1
54		Heater for hot tension bolt on steam cylinder		Set	1
55		Specific screw tap for screw hole on steam cylinder		Set	1
56		Specific tool for coupler alignment		Set	1
57		TSI specific test and maintenance tool		Set	1
58	Generator	Generator rotor extraction tool		Set	1
59		Guiding blade seat dismantle and		Set	1

Sl No.	System/sub-system	Description	Spec	Unit	Qty.
		installation tool			
60		Bearing dismantle and installation tool		Set	1
61		Seating bushing dismantle and installation tool		Set	1
62		Cooler dismantle and installation tool		Set	1
63		Porcelain bushing terminal dismantle and installation tool		Set	1
64		Retaining ring dismantle and installation tool		Set	1
65		Glue injection gun		Set	1
66		Side cover bolt heater		Set	1
67		Tilted instrument for gas sealing test		Set	1
68		Rotor vent hole detection device		Set	1
69		Insulation detector for water inner cooled stator		Set	1
70		Corrugated sheet measuring tool		Set	1
71	Condenser	Completed specific spanner		Set	1
72		Tube expansion device, tube cutting device, hole enlarger, tube stopper and tube expander tool			1
73		Tube expander		Set	1
74		Expansion pole		Nos	1
75		Expansion end		Nos	1
76		Scraper		Set	1
77		Hole enlarger		Set	1
78		Tube stopper		Nos	1
79	Turbine (feed water pump)	Special spanner		Set	1
80		Bridge gage		Set	1
81		Bushing dismantle tool		Set	1
82		Steam cylinder guiding tool		Set	1
83		Rotor hoisting tool		Set	1
84		Cylinder hoisting tool		Set	1
85	Condensate pump	Draw wrench		Nos	1
86	HP heater	Specific dismantle tool for manhole		Set	1
87	Turbine bypass	Dismantle tool		Set	1
88		Steam blowing protection device		Set	1
89	Platen exchanger	Spanner for plate replacement		Nos	1

Sl No.	System/sub-system	Description	Spec	Unit	Qty.
90	Computerized supervision system	Protection calibration device		Set	1
91		Laptop for commissioning		Set	1
92		Specific tool box		Set	1
93	6KV auxiliary power changeover device	Flashboard		Nos	1
94	UPS	Screw driver			1
95		Open spanner			1
96	Main transformer	Torque spanner		Set	1
97		Position hammer drill		Set	1
98	HV auxiliary transformer	Torque spanner		Set	1
99		Position hammer drill		Set	1
100	Startup transformer	Torque spanner		Set	1
101		Position hammer drill		Set	1
102	Enclosed busbar	Torque spanner		Nos	1
103	6KV auxiliary power cabinet	Trolley extension rail		Nos	1
104		F-C cabinet extension rail		Nos	1
105		Trolley crank		Nos	1
106		Earthing switch crank		Nos	1
107	Gas fireproof system	Nitrogen fill-in tool		Set	1
108		Specific joint		Set	1
109		Tee joint		Set	1
110	Gas fireproof system	High pressure hose		Set	1
111		Pressure meter		Set	1
112		Washer		Set	1
113		Specific inner cross pressure wrench		Set	1
114		Socket spanner		Set	1
115		Torque spanner		Set	1

DWG. NO. K7V12-000-DWG-I-001 REV.

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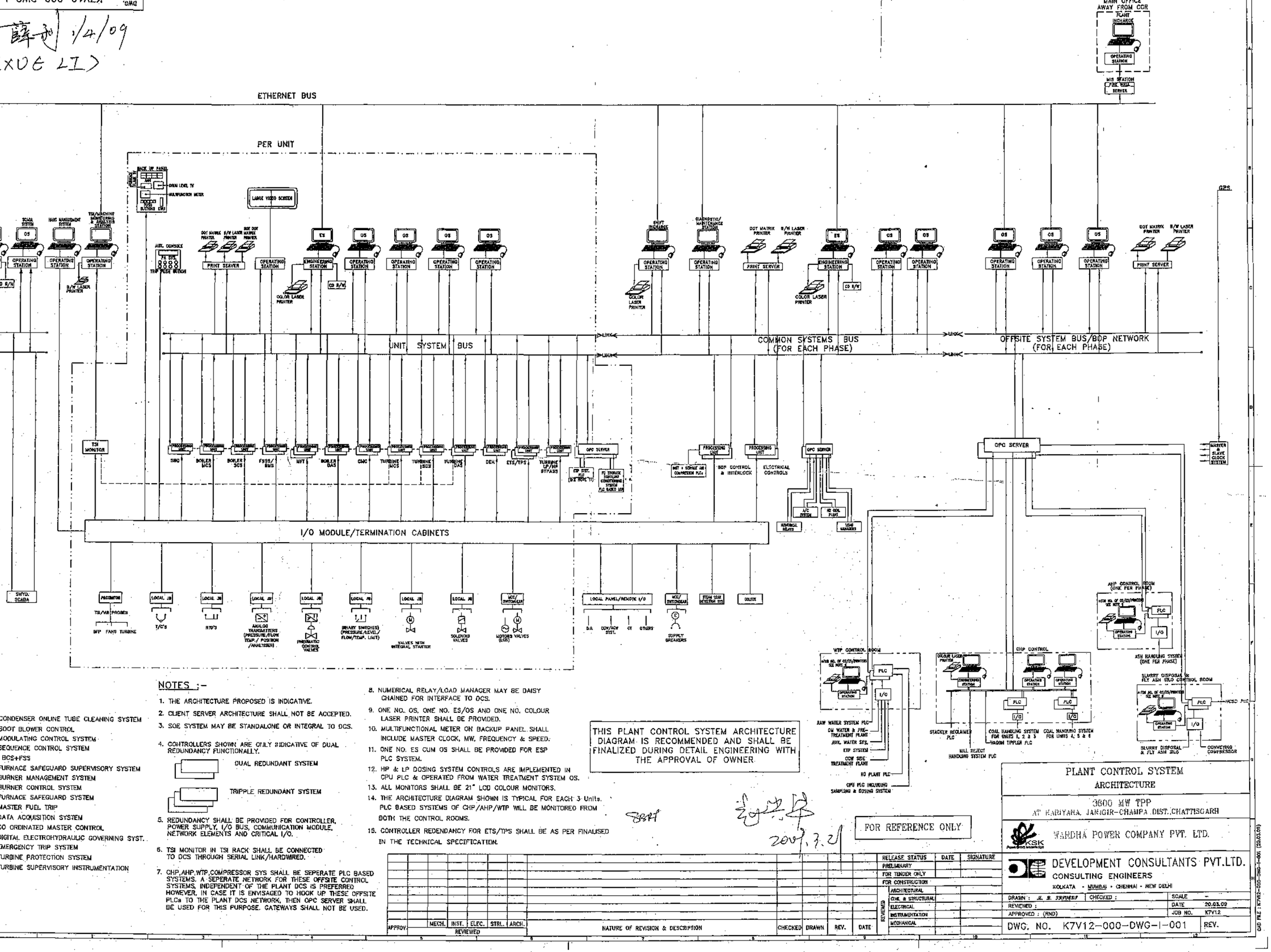
CXUE LI)

CENTRAL CONTROL ROOM

CONTROL EQPT. ROOM

FIELD / LOCAL CONTROL ROOM



COLTCS –CONDENSER ONLINE TUBE CLEANING SYSTEM
SBC –SOOT BLOWER CONTROL
MCS –MODULATING CONTROL SYSTEM
SCS –SEQUENCE CONTROL SYSTEM
FSSS/BMS= BCS+FSS
FSSS –FURNACE SAFEGUARD SUPERVISORY SYSTEM
BMS –BURNER MANAGEMENT SYSTEM
BCS –BURNER CONTROL SYSTEM
FSS –FURNACE SAFEGUARD SYSTEM
MFT –MASTER FUEL TRIP
DAS –DATA ACQUISITION SYSTEM
CMC –CO ORDINATED MASTER CONTROL
DEH –DIGITAL ELECTROHYDRAULIC GOVERNING SYST.
ETS –EMERGENCY TRIP SYSTEM
TPS –TURBINE PROTECTION SYSTEM
TSI –TURBINE SUPERVISORY INSTRUMENTATION

NOTES :-

1. THE ARCHITECTURE PROPOSED IS INDICATIVE.
2. CLIENT SERVER ARCHITECTURE SHALL NOT BE ACCEPTED.
3. SOE SYSTEM MAY BE STANDALONE OR INTEGRAL TO DCS.
4. CONTROLLERS SHOWN ARE ONLY INDICATIVE OF DUAL REDUNDANCY FUNCTIONALLY.
   DUAL REDUNDANT SYSTEM
   TRIPPLE REDUNDANT SYSTEM
5. REDUNDANCY SHALL BE PROVIDED FOR CONTROLLER, POWER SUPPLY, I/O BUS, COMMUNICATION MODULE, NETWORK ELEMENTS AND CRITICAL I/O.
6. TSI MONITOR IN TSI RACK SHALL BE CONNECTED TO DCS THROUGH SERIAL LINK/HARDWIRED.
7. CHP,AHP,WTP,COMPRESSOR SYS SHALL BE SEPERATE PLC BASED SYSTEMS. A SEPERATE NETWORK FOR THESE OFFSITE CONTROL SYSTEMS, INDEPENDENT OF THE PLANT DCS IS PREFERRED HOWEVER, IN CASE IT IS ENVISAGED TO HOOK UP THESE OFFSITE PLCs TO THE PLANT DCS NETWORK, THEN OPC SERVER SHALL BE USED FOR THIS PURPOSE. GATEWAYS SHALL NOT BE USED.
8. NUMERICAL RELAY/LOAD MANAGER MAY BE DAISY CHAINED FOR INTERFACE TO DCS.
9. ONE NO. OS, ONE NO. ES/OS AND ONE NO. COLOUR LASER PRINTER SHALL BE PROVIDED.
10. MULTIFUNCTIONAL METER ON BACKUP PANEL SHALL INCLUDE MASTER CLOCK, MW, FREQUENCY & SPEED.
11. ONE NO. ES CUM OS SHALL BE PROVIDED FOR ESP PLC SYSTEM.
12. HP & LP DOSING SYSTEM CONTROLS ARE IMPLEMENTED IN CPU PLC & OPERATED FROM WATER TREATMENT SYSTEM OS.
13. ALL MONITORS SHALL BE 21" LCD COLOUR MONITORS.
14. THE ARCHITECTURE DIAGRAM SHOWN IS TYPICAL FOR EACH 3 Units. PLC BASED SYSTEMS OF CHP/AHP/WTP WILL BE MONITORED FROM BOTH THE CONTROL ROOMS.
15. CONTROLLER REDENDANCY FOR ETS/TPS SHALL BE AS PER FINALISED IN THE TECHNICAL SPECIFICATION.

THIS PLANT CONTROL SYSTEM ARCHITECTURE DIAGRAM IS RECOMMENDED AND SHALL BE FINALIZED DURING DETAIL ENGINEERING WITH THE APPROVAL OF OWNER.

SBRT

2009.3.20

FOR REFERENCE ONLY

APPROV.	MECH.	INST.	ELEC.	STRL.	ARCH.	NATURE OF REVISION & DESCRIPTION	CHECKED	DRAWN	REV.	DATE
	REVIEWED									

RELEASE STATUS	DATE	SIGNATURE
PRELIMINARY		
FOR TENDER ONLY		
FOR CONSTRUCTION		
REVIEWED: ARCHITECTURAL		
REVIEWED: CIVIL & STRUCTURAL		
REVIEWED: ELECTRICAL		
REVIEWED: INSTRUMENTATION		
REVIEWED: MECHANICAL		

PLANT CONTROL SYSTEM ARCHITECTURE

3600 MW TPP
AT HARIYANA, JANJGIR-CHAMPA DIST.,CHATTISGARH

WARDHA POWER COMPANY PVT. LTD.

DEVELOPMENT CONSULTANTS PVT.LTD.
CONSULTING ENGINEERS
KOLKATA - MUMBAI - CHENNAI - NEW DELHI

DRAWN : M. S. SRIVASTAV	CHECKED :	SCALE : -
REVIEWED :		DATE : 20.03.09
APPROVED : (RND)		JOB NO. K7V12

DWG. NO. K7V12-000-DWG-I-001 REV.

CAD FILE : K7V12-000-DWG-I-001 (20.03.09)

Minutes of Meeting between WPCPL, SEPCO-I held at Hyderabad on 8th January 2009

01.04.2009
(KIRAN PANDA)
WPCPL

SEPCO-
chi Ying Mei
2009.04.01

MOM between WPCPL and SEPCO

Dated on 08th Jan 09 at Jinan

WPCPL - 3600 MW, Chhattisgarh, India - Pending Points with SEPCO

DCPL Comments Description (Resolution dated 25th to 28th sept '08 at DCPL office)	*SEPCO clarification vide mails dt 10.10.08 & 15.10.08 post meeting*	*DCPL comments on SEPCO*	*Subject*	*Latest status 25.12.08*	*Reply from SEPCO dt 31.12.08*	*WPCPL Reply 03.01.09*
Mechanical						
Bidder to indicate his confirmation against each item of Sec-IV (Scope of Work) of Volume-II of Bid Specification.The section is attached herewith for bidders ready reference. It should also be noted that Green Belt plantation/land scaping is excluded from Bidder's Scope. However, grading of the area within Green Belt shall be part of EPC bidder's scope(Refer Annexure-E for resolution on Scope of supply.	*Civil work for ash dyke development & plant maintenance workshop included by SEPCO in their scope with additional price implication.*	Noted	Scope	SEPCO to confirm all the scope as per Section-IV is included in their offer.	We confirm all scope as per Section-IV is included in our offer.	closed
Vendors List format is attached which shall be filled up by the Bidder. This will be discussed mutually for approval. Vendors list for Balance of plant items also shall be furnished (SEPCO will provide vendor list by 27.09.08).	Vendor list furnished as per mail dt 10.10.08	As per DCPL reply, vendor lists attached by SEPCO are not inline with the discussions on 25th to 28th September	Vendor list	Revsied Vendor List shall be submitted based DCPL's comments dated 25-28.9.2008	We suggest that Certain minor Bop vendors can be finalized on detail engineering stage. We have listed the vendors for major BOP equipments.	Accepted & closed.

8/1/09

(G.P.RAO)

SN	DCPL Comments/Description (Resolution dated 25th to 28th sept 08 at DCPL office)	SEPCO position as per side mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Subject	Latest status 25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
26	Please cofirm the following feature for turbine initial pressure regulator and unloading gear "The turbine shall be provided with an initial pressure regulator to start closing the steam control valves when the main steam pressure falls below a predetermined low value and the turbine shall be completely unloaded when the pressure falls to a further preset low point and it shall admit only sufficient steam to keep the machine running at full speed on house load. Provision shall be made to adjust or bypass this initial pressure regulator at start up condition to facilitate starting with low steam pressure. Contacts shall be	As per Annexure-J (unresolved issues)of MOM, SEPCO to get written details from the manufacturers about technical non-feasibility of house load condition operations by 15.10.08. However as per mail dt 15.10.08, SEPCO not agreed to confirm before contract.	*DCPL insisted to confirm feasibility of house load operation before finalisation of contract.*	*Steam Turbine*	*SEPCO to confirm that Units can operate at House load.*	As the House Load condition is not available in China, we don't have more confidence to conduct an experiment.	SEPCO expressed that they can design the plant for 15 minutes of House load operation. WPCPL reiterated that it is not adequate and SEPCO shall further study & revert for compliance to the requirement by 17.1.09
7	The Following criteria for furnance sizing shall be followed and confirmed by Bidder 1. Max Net Heat Input(NHI) / Unit Plan area of Furnace - 5 x 10^6 Kcal/Hr/Sq.Meter 2. Maximum Volumatric Heat liberation Rate - 1.1 x 10^5 Kcal/Hr/CUM	As per mail dt 15.10.08, SEPCO has not agreed for restriction of Max. NHI to CEA regulations. No reply on VHLR value.	*As per DCPL reply, Actual Max. NHI per burner from Boiler supplier's data to be furnished by SEPCO*	*Boiler*	*SEPCO shall confirm the compliance of CEA norms on Boiler furnace sizing.*	*As the interaction we had with the manufactures, they don't agree to comply with CEA standards.*	SEPCO agreed for compliance to the requirement.

DCPL Comments Description (Resolution dated 25th to 28th Sept '08 at DCPL office)	SEPCO Clarification vide mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Subject	Latest status 25.12.08	Reply from SEPCO at 31.12.08	DCPL Reply 05.01.09
WPCPL comments on bar chart as per MOM (SEPCO will furnish revised Barchart by 10.10.08)	Revised barchart furnished as per mail dt 10.10.08	As per DCPL reply, project completion schedule has been shifted by 4 months. Commented to maintain completion schedule as	Schedule	*SEPCO to confirm that the first Unit COD shall be done in 36 months. SEPCO to revise & submit it for all units.*	*We revised and submitted the completion schedule for all units with the first Unit COD being done in 40 months after considering the stone blasting work.*	Not acceptable. SEPCO to confirm that the first Unit COD shall be done in 36 months. SEPCO to revise & submit it for all units.
LAYOUT						

DCPL Comments Description (Resolution dated 25th to 28th sept'08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Subject	Latest status 25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
The Overall plot plan shall be developed/planned incorporating the latest contour survey drawing forwarded through Amedment-1. It should also show ash dyke area and space behind the construction space upto the Boundary. It is observed that the proposed Plot plan does not meet fully the VASTU requirement, which is the most important consideration. The VASTU rectangle of power plant block in the proposed layout will be from W-100 to E-1300 (1400 m) and N-000 to N-1500 (1500 m). Hence the centreline of this Vastu rectangle will be E-600 and N-750 which will form four quadrants and centre-line of main plant raod. In such case, the const. space shall be located outside this VASTU rectangle. To follow VASTU principles the	*Revised layout furnished as per mail dt 10.10.08*	*DCPL confirmed that the revised layout has taken into consideration comments & discussions of meeting at vashi office. Few corrections were highlighted by DCPL in point no. B-3 a to f of their mail.*	Plant Layout/ Vastu Requirement	*SEPCO to revise the Plot Plan incorporating the balance comments of DCPL dated 16.10.08 & submit.*	*We will revise the Plot Plan incorporating the balance comments.*	*Noted*
Please indicate and include ash disposal area of 100 Ha for Bottom ash suitable for 25 years and 95 Ha of fly ash suitable for fly ash disposal (for 5 years and 50% utilisations). Please also indicate ash bund, roads, green belt and other relevant details.(As per Annexure-J attached to issues of MOM. SEPCO	*Revised layout furnished as per mail dt 10.10.08*	*Noted by DCPL. However piping arrangement scope inclusion not pointed out by sepco*	Plant Layout	*SEPCO to confirm complete piping (upto & inside Ash Dyke) is part of their scope.*	*We confirm complete piping (upto&inside Ash Dyke) is part of our scope.*	*closed*

DCPL Comments/Description (Resolution dated 25th to 28th sept '08 at DCPL office)	SEPCO clarification vide mail dt 10.10.08 & 13/10/08 post meeting	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
Ash silo area around 100 m radious shall be completely paved; each silo unloading shall be suitable for unloading into two trucks (closed/open), one railway (pnumatically operated ash feeding arragement over railway line) and feeding HCSD system. Space provision for movement of trucks shall be provided. One spare unloding connection with valve suitable for railway wagon feeding	*Revised layout furnished as per mail dt 10.10.08*	*DCPL to verify in the revised layout*	Plant Layout	*Our comments on Ash Silo Layout are pending from our side*		*Our comments on Ash Silo Layout are pending from our side*
Please locate borewells all around ash dump area for monitoring ground water table. It should be atleast twelve (12) and evenly space around fly ash and bottom ash bund.(As per Annexure-J (unresolved issues)of MOM, SEPCO	*Revised layout furnished as per mail dt 10.10.08*	*DCPL to verify in the revised layout*	Plant Layout	*Our comments on Layout are pending from our side*		do
Please provide location of Service/ Instrument air compressor house.(As per Annexure-J (unresolved issues)of MOM, SEPCO agreed to	*Revised layout furnished as per mail dt 10.10.08*	*DCPL to verify in the revised layout*	Plant Layout	*Our comments on Layout are pending from our side*		do
Please note that width and number of roads shall be followed as indicated in the drawings. It is observed that roads between Boiler & bunkers, ESP & ID Fan, CW pipes & Transformer bay is not provided. Please provide the same.(As per Annexure-J (unresolved issues)of MOM, SEPCO agreed to incorporate	*Revised layout furnished as per mail dt 10.10.08*	*DCPL to verify in the revised layout*	Plant Layout	*Our comments on Layout are pending from our side*		do

DCPL comments/Description (Resolution dated 25th to 29th Sept 08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08/post meeting	DCPL comments on SEPCO	Subject	Latest status 25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
Please reroute approach road to material gate (2) around N-1450. Please note that approach roads from NH-200 is in the scope of Bidder.(As per Annexure-J (unresolved issues)of MOM, SEPCO	*Revised layout furnished as per mail dt 10.10.08*	*DCPL to verify in the revised layout*	Plant Layout	*Our comments on Layout are pending from our side*		do
Please locate Hydrogen generation plant close to the boundary, away from plant area for ensuring safety.(As per Annexure-J (unresolved issues)of MOM, H2	*Revised layout furnished as per mail dt 10.10.08*	*To check in Revised layout submitted by SEPCO for compliance.*	Plant Layout	*Our comments on Layout are pending from our side*		do
Bidder to note that the Turbine Heat rate indicated is on higher side. Bidder to optimise, check and confirm the same.(As per Annexure-J (unresolved issues)of MOM, SEPCO to revert on optimized heat	*Turbine heatrate revised from 1980.3 Kcal/kwhr to 1950 Kcal/kwhr as per mail dt 15.10.08*	*DCPL noted*	Guaranteed data	*closed*		closed
Bidder to note that aux. power consumption is on the higher side. Bidder to optimise and reconfirm the value. Aux. power consumption shall be calculatied as follows : Gross power measured at Generator terminals minus power evacuated at 400 kV outgoing bus.(As per Annexure-J unresolved issues)of	*Not replied by SEPCO*	*Not pointed out by DCPL*	Guaranteed data	*SEPCO to confirm revised / optimized Guaranteed Aux. power consumption.*	We confirm that the auxiliary power consumption for each unit will be 7%.	Without MDBFP, it shall be less than 6.5%. SEPCO agreed & will furnish the revised guarantee Value.
Steam generator. Steam Trubine gurantee curves as well as Correction curves shall be	-	-	Guatantee Curves		agreed	closed
Bidder to provide list of equipments which will be sourced from India and from third country (other than China	-	-	Vendor List	*List of items to be sourced from India &*	We will submit the same after award of the contract.	Closed

DCPL Comments Description (Resolution dated 25th to 28th Sept'08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08post meeting	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
Contractor shall include all the consumables till completion of Reliability tests in their scope. Except for the following four (4) inputs from the Owner which shall be supplied free subjected to guaranteed cap (for quantities). • Coal in MT • LDO/HFO in kilo litres • Raw Water in cu.m • Start up power in kWh and peak in kVA. For considering the total bid price these quantities will be evaluated at the following rates and added with the Bid price. Any excess consumption beyond guaranteed quantities shall be recovered from the bidder at the following rates. • Coal at the rate of Rs. 900/MT at Track hopper • LDO/HFO at the rate of Rs. 40000/kl at Fuel oil tanks • Raw Water at the rate of Rs.	*As per mail dt 10.10.08, only coal consumption(4,70,000 T) figure upto successful reliability test was furnished. Fuel oil, raw water & startup power consumption not furnished and informed as "provided on preliminary design stage".*	*Insisted by DCPL to furnish other utility consumption also for commercial evaluation.*	Consumables	*SEPCO to furnish the remaining details of consumables.*	We will furnish the remaining details of consumables on commercial discussion.	Noted
Please provide break-up of auxiliary power consumption (During Detailed Engineering)	-	-	Aux. Power	*Break-up of Aux. Power consumption is*	During Detailed Engineering	Noted

BHEL Comments Description (Resolution dated 25th to 28th Sept'08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
Please funish all the parameters in the data sheet for other conditions also. The offer indicates the data for BMCR condition only.(As per Annexure-J (unresolved issues)of MOM, SEPCO to resubmit the revised HMBDs after optimizing the heat cycle by 10.10.08. SEPCO will furnish Data sheets during detailed	HMBD not furnished by SEPCO	Not pointed out by DCPL	Steam Generator	Revised HMBDs are pending from SEPCO	During Detailed Engineering	Revised HMBDs for TMCR, VWO & BMCR shall be submitted now & balance to be submitted during detailed Engg. SEPCO agreed to submit the HMBDs of TMCR, VWO & BMCR before signing contract.
Bidder to confirm margin is available as specified in BMCR flow offered.(SEPCO has provided 5 % margin over TMCR. VWO and BMCR flow is same, no margin is provided over VWO.)	As per mail dt 10.10.08, SEPCO maintained that BMCR flow is same as VWO flow and VWO flow is 105% TMCR.	DCPL accepted based on their observation form SEPCO datasheet figures that a	Steam Generator	SEPCO to confirm BMCR flow is 102% of VWO flow requirement and VWO flow is 105% of	We maintained that BMCR flow is same as VWO flow and VWO flow is 105% TMCR.	Not acceptable, BMCR should be 102 % of VWO. SEPCO confirmed to comply with CEA gudelines.
Kindly specify margion over capacity and head at VWO condition. Please confirm one standby pump for CW pump house of every three units as shown in layout(Sepco not agreeing for VWO condition)	As per Email dt 15.10.08, Head margin considered is 0.5m. When one pump is out of service, other pump meets	Capacity margin to be indicated. 5% margin is required for under-	CW Pumps	SEPCO to confirm provision of standby pump & 5% margin on head to	agreed.	closed
Bidder to confirm that CW pumps should be sized for VWO condition heat load and with minimum 5% over the required capacity.(WPCPL informed margin and head at TMCR condition shall be 5%. SEPCO to check and revert on technical infeasibility by 10.10.08. Otherwise SEPCO to include.	As per Email dt 15.10.08, Head margin considered is 0.5m. When one pump is out of service, other pump meets 60% load requirement. No mention about	Capacity margin to be indicated. 5% margin is required for under-frequency operation	CW Pumps	SEPCO to confirm the pump sizing for VWO condition Heat load with 5% margin on head to meet under frequency	agreed.	closed

DCPL Comments Description (Resolution dated 25th to 28th sept '08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08/post meeting	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
It is observed that Natural ventilation is provided for TG Hall. Bidder to note that Roof exhausters shall be provided for TG Hall as specified in the Bid documents. Bidder to also confirm that the ventilation system meets the stipulation "TG hall internal temperature is not more than	*As per mail dt 15.10.08, TG hall internal temp is maintained not more than 3 deg. C above ambient temp.*	*noted and confirmed compliance*	HVAC Turbine Hall Ventilation	*closed*		closed
Bidder to provide elaborate notes on this along with back-up operating cata on the equipments offered instead of brief write-up provided in	*Not furnished by SEPCO*	*Not pointed out by DCPL*	Availability, Reliability	*Detailed write-up on the equipment offered is*	During Detailed Engineering	Noted
Bidder shall comply with Main Specs & all amendments issued till date except for the deviations approved by Owner in writing.(SEPCO to revert on confirmation by 10.10.08)	*SEPCO to explicitly confirm to this point.*	*Not pointed out by DCPL*	General	*SEPCO to confirm the compliance with Main Specs & all amendments issued till date*	agreed	closed
Velocity of operating medium in all the systems shall not exceed the limits specified in the Bid specs.(SEPCO to revert on confirmation by 10.10.08)	*Not replied by SEPCO*	*Not pointed out by DCPL*	General	*SEPCO to confirm the compliance with Main Specs & all amendments issued till date*	agreed	closed

DCPL Comments Description (Resolution dated 25th to 29th Sept'08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
Bidder to provide clause wise compliance on VOLUME-VI " DESIGN REQUIREMENT" and VOLUME-VII " REDUNDANCY REQUIREMENT".(Other than accepted deviation, other clauses shall be as per bid specification.	*SEPCO to explicitly confirm to this point.*	*Not pointed out by DCPL*	General	*SEPCO to confirm the compliance with Main Specs & all amendments issued till date*	agreed	closed
TECHNICAL DEVIATIONS						
The specification shall be followed.(SEPCO will check with mill manufacturer and confirm by 10.10.08)	As per mail dt 15.10.08, SEPCO not agreed to supply coal mills based on loading not to exceed 80% of design load of mill	DCPL insisted to follow as per spec. Additional power consumption	Coal mills (based on loading not to	*SEPCO to confirm the compliance with CEA guide lines on Mills.*	Coal mills (based on loading not to exceed 90% of the design load of mill)	SEPCO agreed for compliance to CEA guide lines.
Points/clarifications pending to be	Target	agency resp		Latest Status		
Technical						
Construction Equipment and manpower mobalisation schedules	10.10.08	SEPCO		pending from SEPCO	We provided the schedule on 10.10.08	WPCPL has not received Construction equipment and manpower mobilisation schedules from SEPCO. SEPCO furnished the docs on 8.1.2009
Revised Proj sch in MSP/P6 incorporating all comments		SEPCO		-	We provided the schedule on 10.10.08	SEPCO will provide in Primavera format during execution stage.
provision of Double suction type of ID fan		SEPCO		SEPCO yet to confirm	To be discussed.	SEPCO agreed to provide double suction ID fans.

BOPL comments Description (Resolution dated 25th to 28th sept-08 at DGPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08 post meeting	DGPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
7 Provision of wet steam washing for HP,IP turbine				yet to confirm	Turbine manufactures don't supply the provision.	It needs to be incorporated in the Steam piping. It is nothing to do with Turbine. SEPCO sought a reference sketch for the above and agreed to provide this feature.
8 SEPCO agreed for Dense phase conveying system only				SEPCO to confirm Vacuum conveying system upto Buffer hopper. If required,		SEPCO agreed to provide Vacuum system upto buffedr hopper.
Annexure A-1						
All P&I Diagrams and system drawings to be furnished with the offer specifically – Steam, Condensate, Fuel oil, Compressed air, Fire fighting system, HVAC, CW and ACW systems, CHP, AHP, Waste Water, TSI scheme etc.	10.10.08	SEPCO		All P&IDs are pending from SEPCO.	During the detail engineering.	Noted. If so, SEPCO shall incorporate all comments from WPCPL on such P&IDs submitted post award of contract, without any price implication. SEPCO agreed for the above.

	DCPL Comments/Description (Resolution dated 25th to 28th sept'08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
	QPs should be submitted for major equipments/ plants.		SEPCO		QPs are pending vfrom SEPCO	During the detail engineering.	WPCPL's QPs are attached. SEPCO to confirm the same. SEPCO agreed with WPCPL's QPs & the CHPs indicated in them. Material specs (based on Tender specs) shall be filled during detailed enginerring stage.
	Other points						
1	SEPCO has not signed the following Annexures of the MOM held at DCPL, Vashi from 25th Sept 2008 to 28th Sept 2008. This need to be taken up with SEPCO. a. Annexure-G : CW Pump House Schematic b. Annexure-H : List of Building and Structures c. Annexure-I : ETP and DM Plant Schematic				SEPCO to furnish signed copies of MOM.	agreed.	closed
2	SEPCO shall confirm that they would source all Boilers, Turbines, Generators & their auxiliaries from only one OEM (SEC / DEC / HEC).				SEPCO to confirm the source of BTG & Aux.	We confirm that all units will be same combination of BTG & AUX	SEPCO shall furnish the Boilers, Turbines, Generators & their auxiliaries from one OEM SEC / DEC / HEC WPCPL agreed for the above.

DCPL Comments Description (Resolution dated 25th to 28th Sept '08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 15.10.08 pertaining	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
SEPCO shall offer an optional differential price between 400 kV (current offer) & 765 kV Power evacuation system.				SEPCO to confirm & provide optional differential price	On commercial discussion.	Noted. SEPCO to furnish Plot Plan with 765 kV Switchyard. SEPCO will study the technical details of 765 kV switchyard & SIPAT switchyard opeartion.SEPCO will send their team by 12.1.2009 to India for the above.
AHP Points						
Railway tracks to be provided below Fly ash silos for rail tankers filling from Main/final silos.(In addition to Road Trucks loading)				Refer to sketch attached.	Railway shall be provided by Owner.	SEPCO to design the space below silos to accommadate Railway tracks i.e wagon movement.Tracks shall be by owner. SEPCO agreed.
Unloading arrangement from silo to Ash bulkers/tankers to be provided in such a way that simultaneous filling to minimum two bulkers can be done					agreed	closed
SEPCO-1 have offered two silos for three units. In this case if one silo has a breakdown then ash of all three units will go to second silo. So the evacuation rate of silo shall be such that it will able to handle the					agreed	closed
Intermediate silos capacity to be indicated. Earlier it was indicated 4 hours capacity but it is quite low. It should be of higher capacity like 8-				In case of Vaccum + Pressure system - this	agreed	closed

Comments/ Description (Resolution dated 25th to 28th Sept'08 at DCPL office)	SEPCO clarification vide mails dt 10.10.08 & 25.10.08 post meeting:	DCPL comments on SEPCO	Subject	Latest status25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
Flow diagram of Pressure conveying system and capacity of pressure conveying system for intermediate silos to main (Final silos) is required				In case of Vaccum + Pressure system - this	agreed	closed
Vent fan provided at silo shall be designed to take care of one unit to three units. Multiple Fans(one per					agreed	closed
Recovery water system to Provided to cater to MoEF requirements.(If DRYCON is offered - this point is not					agreed	closed
Dry bottom ash conveying system upto ash Dyke shall be offered.					by truck?	SEPCO to offer dry bottom ash handling system from Boiler to intermediate Silo and pneumatic conveying system from ash silo to ash dyke. SEPCO study mail dated [illegible]
intermediate silos also to be provided with the arrangement for emergency unloading to trucks in case of system				In case of Vaccum + Pressure	agreed	closed
ents on VII-C- Datasheets for control and instrumentation						
PRDS control						SEPCO to provide PRDS control as per P&ID; accepted. WPCPL, SEPCO agreed
Soot Blower Control						SEPCO to confirm soot blower control system DCS SEPCO agrees

CPL Comments Description Resolution dated 25th to 26th ept' 08 at DCPL office]	SEPCO clarification vide mails dt 30.10.08 & 06.11.08 post meeting	DCPL comments on SEPCO	Subject	Latest status 25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
nplementation platform for mill ontrol						SEPCO to indicate operation philosophy of mill control. SEPCO agreed to provide Maintenance platforms. SEPCO agreed to provide Mills operation philosophy.
Dedicated station for MIS						SEPCO to confirm. SEPCO agreed.
/O Module redundancy						SEPCO to confirm redundant modules for critical I/Os. Critical I/Os shall be approved during detail engineering.SEPCO agreed.
Type of link for offsite PLCs						SEPCO to confirm on connectivity between Offsite PLCs and DCS and also to indicate how the same shall be achieved. SEPCO agreed to provide Fibre optical connectivity.
Large Video Screen						SEPCO to confirm 5Nos of Large Video Screens per unit. SEPCO agreed to provide 3 No. Large Video screens per each unit.

DCPL Comments/Description (Resolution dated 25th to 28th Sept '08 at DCPL office)	SEPCO clarifications vide mails dt 10.10.08 & 15.10.08 post meeting	DCPL comments on SEPCO	Status	Latest status 25.12.08	Reply from SEPCO at 31.12.08	WPCPL Reply 03.01.09
For process pressure above 40 bar, two drain valves are to be provided for transmitters/switches/gauges						SEPCO to confirm. SEPCO agreed.
Training Simulator						SEPCO to confirm. SEPCO agreed.
Vacuum Breaker						SEPCO to confirm DC operated Vacuum Breaker. SEPCO agreed to provide DC solenoid operated pneumatic vacuum breaker valve alongwith local air receiver & one NRV in the air filling line to receiver.
On-line degassed Cation Conductivity Analyser						SEPCO to confirm. SEPCO agreed.

Minutes of Meeting held at SEPCO, China on 21st and 22nd January 2009.

Minutes of Meeting between WPCPL and SEPCO at Jinan between 21 Jan 09 to 22 Jan 09

Members Present:

WPCPL	SEPCO
1. Mr. MVV Rao	1. Mr. Yin Shiji
2. Mr. G P Rao	2. Mr. Chen Guangli
3. Mr. T K Banerji	3. Mr. Xue Li
4. Mr. R Durgadoss	4. Mr. Yuan Ming
5. Mr. M Saratchandran	5. Mr. Chi Yingwei
6. Mr. Pranav Komerwar	6. Mr. Su Zhanshan
	7. Mr. Ma Kezheng
	8. Mr. Zhao Hongan

1. The revised HMBD for TMCR & VWO conditions ~~will be~~ are submitted to WPCPL ~~by~~ on 23.1.09 & balance before signing the contract.
2. Revised schedule for Guarantee Parameters refers to attachment. (600 II 3-V Guaranteed Data, 600 ... guaranteed parameters)
3. Revised plot plan refer to attached. (layout of KSK6×600MW)
4. HOUSE LOAD:

After consulting with the manufacture and experts, we still keep that we can design the plant for 15 minutes of House load operation considering the turbine stress and expansion which will reduce the life of turbine. SEPCO will prove the plant for at most 15 minutes of House load operation after PG test.

5. Dry bottom ash conveying system

SEPCO agreed the dry bottom ash system and transportation system, but it is costly for this total system. Accordingly the water recovery system for the plant is not required. WPCPL is required to furnish the schematic drawing for this system.

6. Wet steam washing :

After investigating in China, though this technique appears in several years before, this can not be extended in turbine washing. And after discussing with design institute and manufacture, the main problem of the wet washing system is how to completely ensure there is no water to enter the turbine in this process, so we suggest we keep the interface for this system to you if you want this system in strongly desire, the C&I and electrical facilities can be matched in detail design. SEPCO agree to provide the interface stubs at the MS and HRH line for this system, and the dimensions of stubs will be decided during the engineering design stage.

7. Ash yard storage capacity figure should be provided. We calculated the same, the bottom ash and fly ash volume required by Owner will be 9220,000Cu.m and 4150,000Cu.m. WPCPL is required to furnish the standard and criteria for design and calculating the cost. WPCPL is required to furnish the schematic drawing for ash yard.

8. Pending Electrical and C&I Quality Plans

We strongly suggest Owner to use our QP FORMAT, refer to annexure- QP FORMAT.

WPCPL informed that the quality plans furnished by WPCPL shall be accepted.

SEPCO agreed in principle.

9. Agreed Vendor list refer to attached—Final VENDOR LIST-090115.

10. The total 40 months in L1 schedule fully considered all the factors in project process based on our EPC organization experience, so we insist our schedule.

SEPCO agreed for 38 months project schedule for guarantee and 36 months project schedule best efforts basis.

11. List of Unit assemblies SG PKG (2), please refer to attachment- List of Unit assemblies SG PKG (2).

12. SEPCO confirmed that the fly ash silos shall be able to discharge ash into rail wagons also.

13. SEPCO will furnish the relevant data/ document based on similar projects involving BTG of same rating on next discussion on the availability and reliability of the plant.

14. Points related to Boiler are attached as '**ANNEXURE-1**"

15. WPCPL have furnished the information of 'DRYCON' (Dry Bottom Ash Conveying System) of MAGALDI, Italy & CLYDE BURGMAN, UK. SEPCO agreed to adopt DRYCON system.

16. WPCPL have furnished details of Ash Dyke construction

17. WPCPL have informed SEPCO to consider 2 Nos. of Track Hoppers & 2 Nos of Stacker / Reclaimers to minimise their offer price. Track Hopper holding Volume shall be 6500 tonnes per each.

18. SEPCO agreed to furnish revised offer (Considering the reduction in scope) including Ash Dyke and Revised Project Schedule by 3rd Feb 2009

19. SEPCO agreed to revert on acceptance of "Reliability Run Test" Clause of Contract by 3rd Feb 2009. WPCPL has furnished NTPC procedure for reference.

20. SEPCO agreed to Confirm the dates for the discussion with Chinese Exim Bank & China Construction Bank by 3rd Feb 2009.

VOLUME II – COMMERCIAL AND TECHNICAL

SECTION 3 – TECHNICAL PART

V –GUARANTEED DATA

1	Guaranteed Net output of the total plant	:	3366MW for 6×600MW
2.	Guaranteed gross heat rate of each unit based on design fuel at site conditions	:	2228kcal/kwh
3.	Maximum continuous output of the boiler unit with design fuel	:	2100t/h *
4.	Efficiency of the steam generating unit at 100% MCR with design fuel (Based on gross calorific value)	:	87.5% based on HHV basis
5.	Main steam temperature and pressure at the outlet of super heater	:	540℃ 17.5 MPa
6.	Reheat steam temperature and pressure at the outlet of Re-heater	:	540℃ 3.802 MPa
7.	Guaranteed Coal Consumption based on GCV of 3800 kcal/kg	:	378t/h for worst coal 341t/h for design coal
8.	Minimum output upto which super heater outlet temperature indicated above is effective	:	later
9.	Combustion Control range for Boiler Automatic Control		later
10.	Oxygen content at deaerator outlet, ppm.	:	later
11.	Steam purity at super heater outlet of boiler unit, ppm.	:	Later
12. a)	Performance correction curves for deviation from rated conditions furnished?		later
b)	Total auxiliary steam consumption in steam generation plant (give break up) with pressure and temperature		later
13.	Guaranteed rated power output of steam turbine at generator terminals		600MW

14. Guaranteed Turbine Heat Rate in kCal/kW hr where
Heat rate is defined as follows

$$HR = \frac{M1xH1+M2x(H3-H2)-M3xH4+MmxHm-MsxHs+Mrx(H3-Hr)}{Pt}$$

where HR : Heat Rate kcal/kWHr

M1 : Live steam entering the turbine stop valve including any live steam supplied to valve stems, ejectors etc. kg/h

M2 : Steam flow from turbine to reheater kg/h

M3 : Final Feed water Flow at final Feed water HTR Outlet kg/h

Mm : Make up Flow to Condenser kg/h

Ms : Super heater Spray Flow kg/h

Mr : Reheater Spray Flow kg/h

H1 : Enthalpy of live steam kcal/kg

H2 : Enthalpy of cold reheat steam kcal/kg

H3 : Enthalpy of hot reheat steam kcal/kg

H4 : Enthalpy of feed water at final feed water heater outlet kcal/kg

Hm : Enthalpy of Make up Water kcal/kg

Hs : Enthalpy of Super heater Spray Water kcal/kg

Hr: Enthalpy of Re heater Spray Water kcal/kg

Pt: Electrical power generated Kw at generator terminals.

15 Steam consumption (at rated output) : 1916.5 t/h *

16	Main Steam pressure before stop valve (at rated output)	:	16.7MPa
17	Main steam temperature before stop valve (at rated output)	:	538℃
18	No. of extractions	:	8
19	Flow rate/pressure/temperature of each extraction	:	Refer to heat balance diagram
20	Exhaust flow	:	1245.58 TMCR *
21	Exhaust pressure	:	10.3KPa TMCR
22	Exhaust temperature	:	46.4℃ TMCR
23	Performance correction curves for deviation from rated conditions furnished?	:	later
24	Total auxiliary steam consumption in the Turbine Generation Plant (give break up) with pressure and temperature	:	later
25	Quantity of demineralised water required for the plant	:	190t/h for phase I 190t/h for phase II
26	Guaranteed Sox, Nox, CO & particulate matters emission at maximum output	:	SO2 698.6ppm for design coal NOX 262 ppm CO 100 ppm particulate matters emission 50mg/Nm^3
27	a) Guaranteed Efficiency of ESP	:	More than 99.9% (ESP+FF)
	b) Guaranteed particulate emission	:	50mg/Nm^3 (ESP+FF) with one field out of service in each gas path.
28	Guaranteed maximum Auxiliary Power Consumption		6.5% *
	a. Boilers & Auxiliaries including ESP	:	later
	b. Steam Turbine Plant Auxiliaries	:	later
	c. Coal Handling System	:	later
	d. Ash Handling System	:	later
	e. Fire Protection System	:	later
	f. Ventilation & Air Conditioning System	:	later
	g. Fuel oil System	:	later
	h. Cooling Water System & Treatment plant	:	later
	i. Compressed Air System	:	later
	j. Boiler Feed Pump	:	later
	k. Condensate Extraction pump	:	later
	l. Chemical feed system	:	later
29.	Guaranteed Cooling water consumption for		later

	STG Condenser	:	later
	L.O. Coolers of STG	:	later
	Generator air Coolers – STG	:	later
	Other applications (air compressor, ventilation system, A/C system, etc.)	:	later
30	Guaranteed temperature rise across condenser	:	8.8℃
31	Re-cooled water temperature at the outlet of CT	:	33℃
32	Guaranteed coal conveying capacity	:	Phase I 2×1700 t/h Phase II 2×1700 t/h
33	Guaranteed fly ash evacuation rate/hr from ESP & other Ash Hoppers of Boiler	:	136 t/h for worst coal each unit
34	Guaranteed Noise emission for		
	a. Steam Turbine Generator Building at one meter from turbine enclosure.	:	90 dB(A)
	b. Control Room and Office	:	50 dB(A)
	c. Outside building but within the power station	:	85 dB(A)
	d. Measured at any point at the plant boundary	:	Residential areas located near the site boundary(At 400m distance) 50 dB(A), continuous and within 60 dB(A) for occasional intermittent noise.
35	Guaranteed maximum waste water production at 100% base load operation at site conditions	:	later
36	Guaranteed commissioning dates from date of ordering	:	Two (2) months for one unit
37.	Guaranteed Plant availability	:	90%
38.	Requirement of operating personnel	:	later

* SEPCO to revise the values based on guaranteed HMBD at TMCR condition

Date: 22/01/2009

VOLUME II – COMMERCIAL AND TECHNICAL

SECTION 3 – TECHNICAL PART

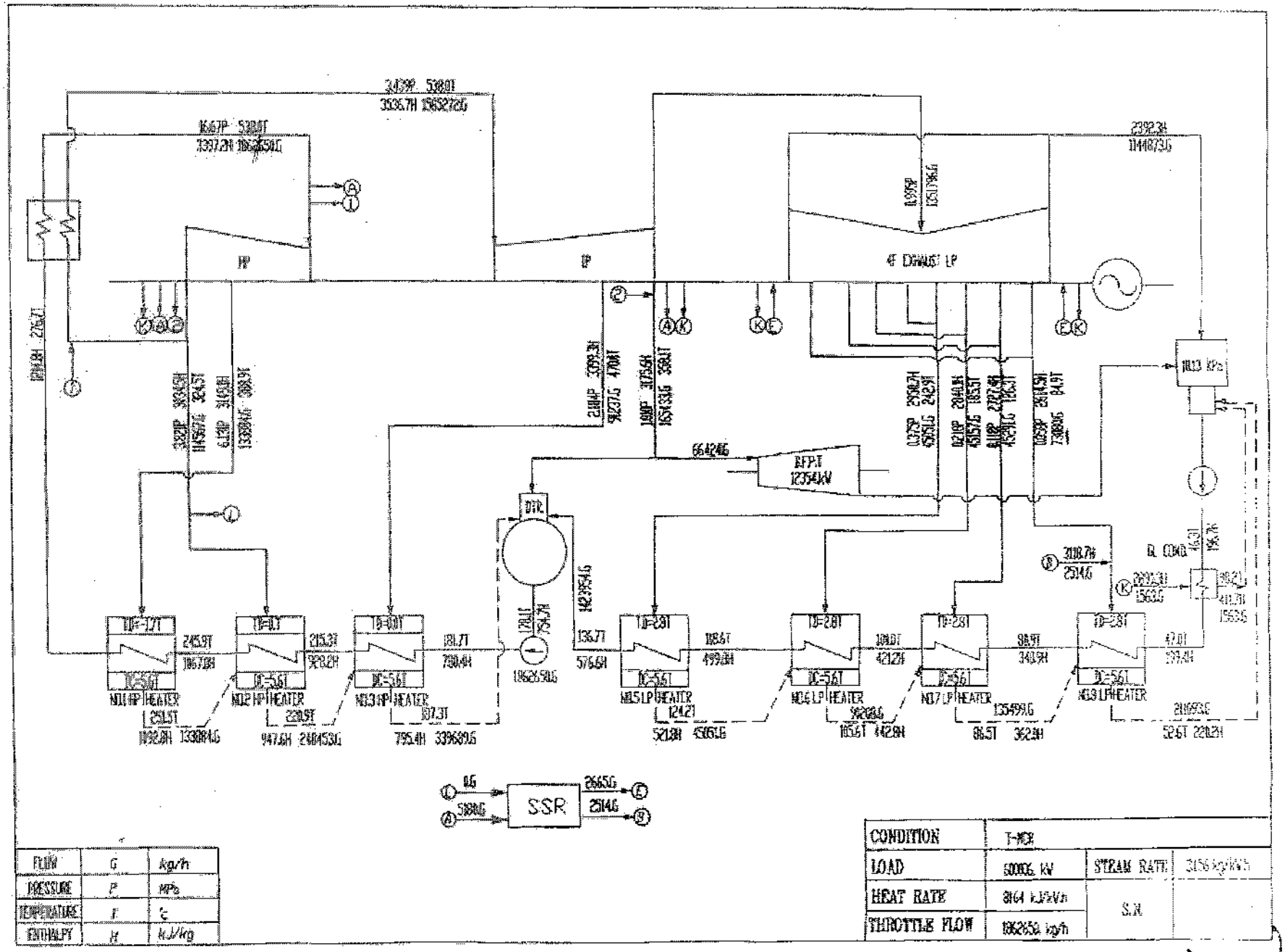
VI – SCHEDULE FOR GUARANTEED PARAMETERS

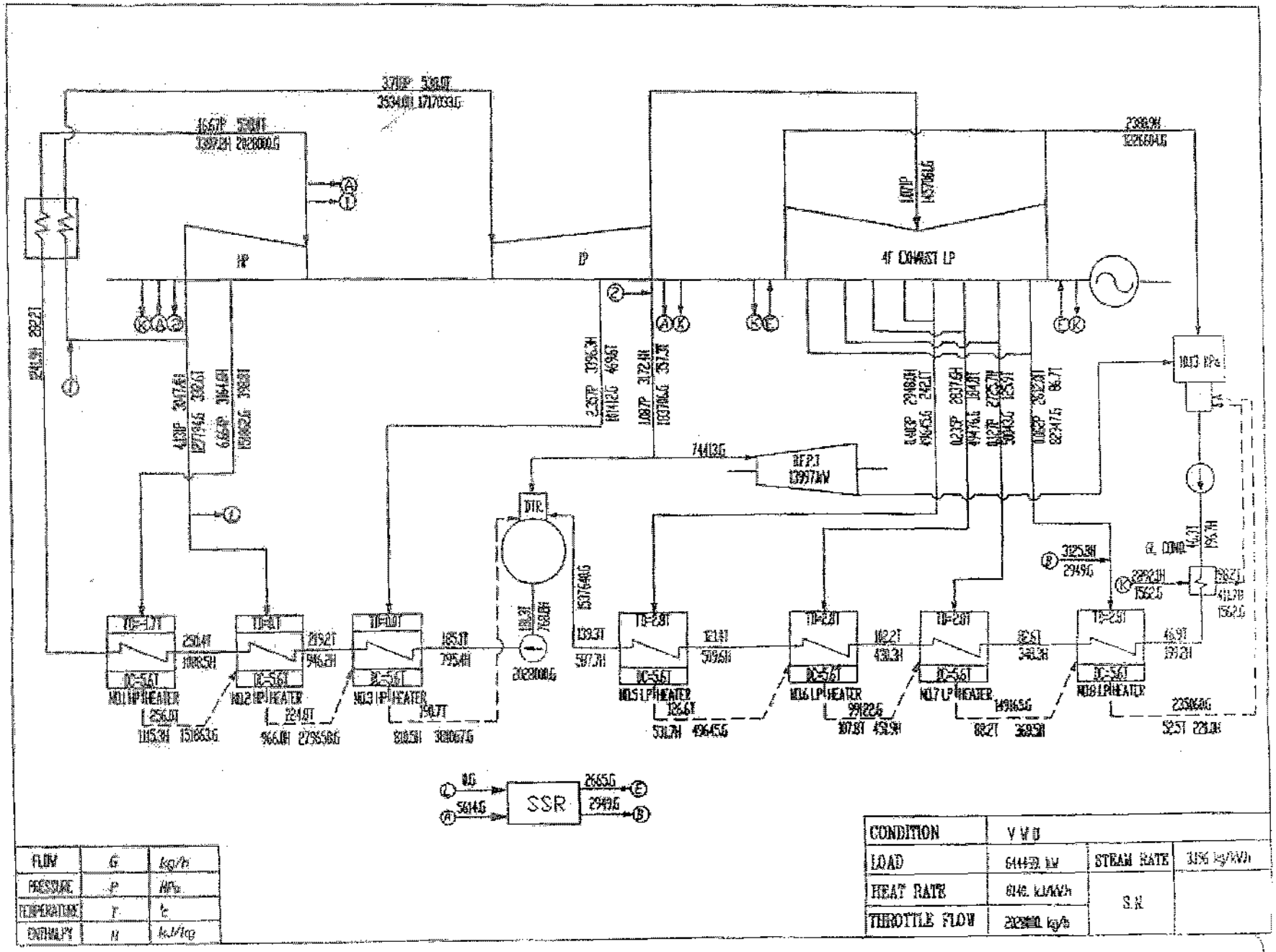
Bidder hereby confirms the following Guaranteed Parameters.

i)	Guaranteed Auxiliary Power Consumption for One Unit	:	39000 kW
ii)	Minimum Guaranteed Gross Turbine Heat Rate	:	1950 kCal/kWh
iii)	Efficiency of Steam Generator	:	87.5 % based on HHV basis
iv)	Steam Generator Guaranteed Steam Flow	:	2100.Te/h
v)	Guaranteed Dust Emission at ESP outlet		
	a) With one field out in each gas path	:	50.mg/Nm^3
	b) With all fields in service	:	50.mg/Nm3
vi)	Capacity of TG at Generator Terminals:	:	600. MW
vii)	Unburnt combustibles in fly ash by weight	:	2 % *

* SEPCO will reduce the guaranteed value after studying the data from the operating plants with similar coal analysis, before commencement of next meeting

Date: 22/01/2009


HP
IP
4F EXHAUST LP
BFPT
12354kW
NO1 HP HEATER
NO2 HP HEATER
NO3 HP HEATER
NO5 LP HEATER
NO6 LP HEATER
NO7 LP HEATER
NO8 LP HEATER
SSR
FLOW G kg/h
PRESSURE P MPa
TEMPERATURE t ℃
ENTHALPY H kJ/kg
CONDITION THA
LOAD 600000 kW
STEAM RATE
HEAT RATE 8164 kJ/kWh
S.N.
THROTTLE FLOW 1882650 kg/h



FLOW	G	kg/h
PRESSURE	P	MPa
TEMPERATURE	T	℃
ENTHALPY	H	kJ/kg

CONDITION	V.W.O		
LOAD	644939 kW	STEAM RATE	3156 kg/kWh
HEAT RATE	6146. kJ/kWh	S.R.	
THROTTLE FLOW	2829861 kg/h		

Boiler points as per Volume II, Sec 3 - VII A - M1 discussed on 21 and 22 Jan 2009

Annexure - 1

① Refer page 491 - Tilting tangential PC burners arranged at 4 corners. Sepco was requested to have tilting facity for ± 30 deg.

② Refer page 492 - 2.1 Furnace width = 18.542 m — agreed.

2.2 — " — depth = 17.448 m — agreed.

2.3 Height from top of furnace bottom ash Ropper to furnace roof — 68.670 m — agreed

Break up of 68.67 is as follows

a) Height from top of furnace bottom ash Ropper to bottom coal burner ..... = 5.6 m

b) Bot coal burner to OFA centre line = 18.5 m

c) OFA centreline to bottom of Division panel SH = 25.5 m

d) Height of Division Panel SH ..... = 19.0

2.4 Plan area ..... 323.52 m^2 — agreed

2.5 EPRS area ..... 9435.5 m^2 at FEP (Nose tip vertical line) — agreed.

③ Refer to page 527 - Flue gas actual temperature

3.1 FEGT (a in 527 of 1003) - = 1098 °C at vertical plane - outlet of Final SH.

3.2 gas temp at exit of Economiser = 345 °C - agreed.

3.3 gas temperature at exit of AH = 135 °C Uncorrected, 128 °C corrected } agreed

④ Refer to page 363 - Total mills = 6 (5+1 at BMCR with worst coal) - does not meet 55 M Kcal/Hr/burner

- Sepco requested to offer also 8 mills (7+1 at BMCR with worst coal) — agreed

- Maximum mill loading not to exceed - 80 % — agreed

- Heat load for one coal burner not to exceed - 55×10^6 kcal/Hr/burner — agreed

- wide range coal Nozzle/burner to be provided for better coal flame stability } — agreed.

- Front mill layout is to be changed to side mill layout. Sepco agreed.

⑤ BMCR flow is 2100 t/h — agreed.

⑥ Refer to page 925 of 1003 — Life of all wear parts in all wearable equipments as furnished in page 925 and elsewhere is agreed.

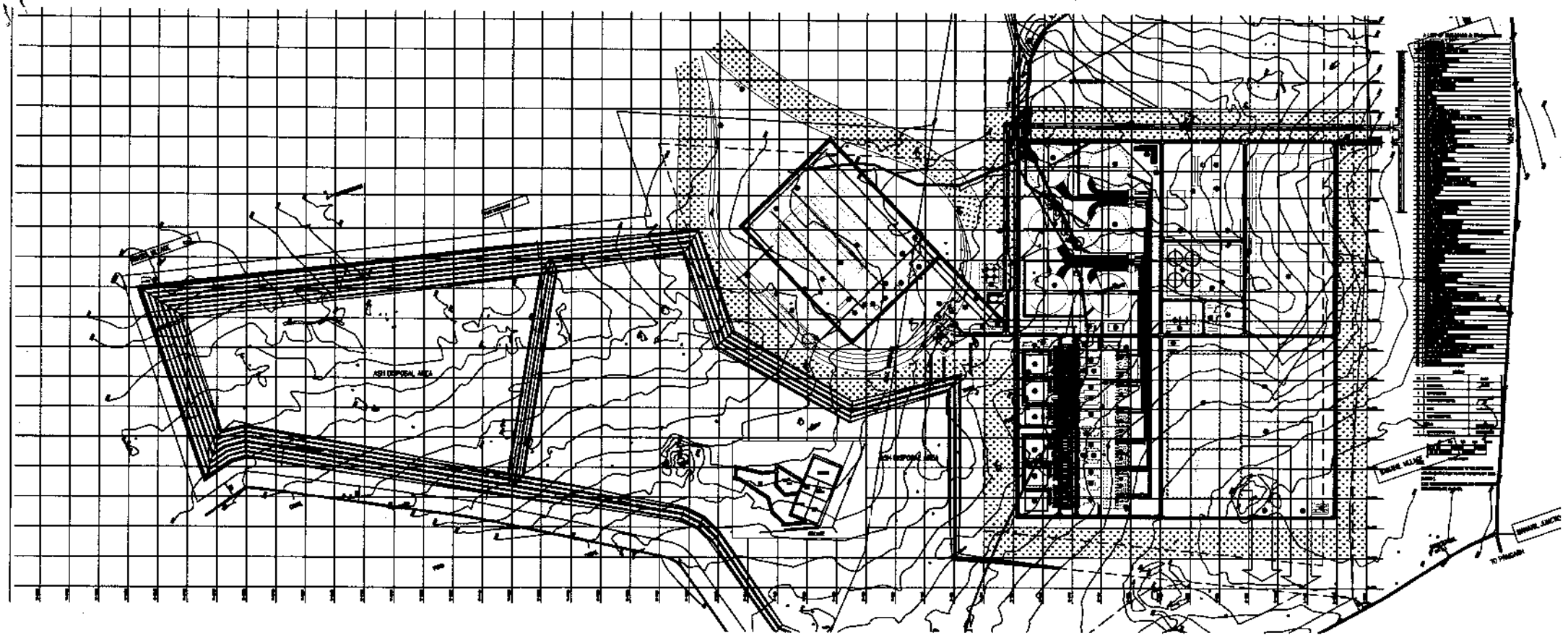
⑦ Refer to page 363 — Unburned losses - 0.5% - agreed by KSK. Sepco will revert.

SEPCO

(CHI YING WEI)

KSK 22.1.2009

R. Durgadoss.



Minutes of Meeting held at KSK, Hyderabad on 4th to 6th February 2009.

Pending points with SEPCO till Dtd:04-02-09		
	MOM on TECHNICAL PENDING POINTS in between WPCPL & SEPCO at HYDERABAD	
Sl. No.	**Description of Pending Points**	**Resolution on Dtd: 06-02-2009**
	MECHANICAL:	
1	SEPCO to furnish the list of vendors for all pending items in the approved vendor list where LATER is written	SEPCO will furnish the list of vendors & their choice of sub-contractors by 15.2.09.
2	SEPCO have furnished new plant layout incorporating all WPCPL comments , to be checked by WPCPL for comments like incorpration of borewell locations, showing separate entry road in the plant etc	WPCPL requested SEPCO to incorporate the following in the revised Plot Plan- 1. 2 No. Track Hoppers & Stacker Reclaimers (instead of 3 No.) 2. Dry Bottom Ash Conveying system upto Ash Dyke (and delete the items related to Wet bottom ash conveying system) 3. Ash Dyke construction as agreed in meeting dated 22.1.09 4. Raw water reservoir (12 lac cub m capacity) as quoted 5. Coal Handling Plant considering Side mills arrangement for each Boiler 6. Plant layout (to have garland canals for each area) considering 2 different finished ground levels for Main Plant & Coal yard 7. Location of Bore holes around Ash Dyke
3	On 21-01-09, WPCPL had submitted details of ash dyke construction. SEPCO to submit the revised ash dyke plan incorporating in the plot plan.	SEPCO will submit the revised dyke plan after the award of the contract. Commercial offer includes the Ash Dyke as per specification.
4	SEPCO to confirm on the no. of IA/SA compressor house required for both phases. SEPCO to confirm one Compressor house for each phase (3 units).	SEPCO confirm one Compressor house for each phase.
5	SEPCO to confirm whether MDBFP is included in the auxiliary consumption of the plant guaranteed by them.	SEPCO confirmed that MDBFP is not included in guarnateed Aux. Power consumption.
	SEPCO to explain methodology of demonstrating the unit wise Aux. Power. Consumption of the plant .	To be discussed during preliminary design stage.
6	SEPCO to confirm agreement to CEA guidelines as agreed on 08-01-09 meeting	SEPCO comply with CEA guidelines.
7	SEPCO to furnish relability & availability related data/documents for similar rating and model of plants supplied by them	SEPCO will furnish the same after the award of the contract. However WPCPL requested to provide available information at the earliest.
8	SEPCO manpower mobilisation chart shows less manpower.	SEPCO clarify that the manpower mobilisation chart only show the arrangement of chinese engineers. WPCPL requested SEPCO to indicate the Min to Max. No. of other manpower to be deployed in addition to Chinese engineers.
	SEPCO to confirm responsibility of VISA / permits of their manpower shall be in SEPCO scope.	SEPCO confirmed.

9	In case of fly ash conveying, SEPCO to reconfirm vacuum conveying system from different collection hoppers of each unit to the buffer hopper.	SEPCO confirmed.
10	SEPCO to confirm that in case they are submitting P&IDs post contract, they have to incorporate all comments from WPCPL on such P&IDs without any price implication.	SEPCO confirmed.
11	SEPCO agreed for WPCPL's proposal for provision of dry bottom ash handling system from Boiler to intermediate silo and belt conveyor system from intermediate ash silo to dyke. SEPCO to revert on changes in layout and scheme including removal of slurry disposal system, water recovery system etc.	SEPCO confirmed provision of Dry bottom ash conveying system and they would incorporate its layout in the new Plot Plan to be submitted.
12	SEPCO shall confirm that they would source all Boilers, Turbines, Generators & their auxiliaries from only one OEM (SEC / DEC / HEC). SEPCO agreed for the above.	SEPCO agreed to supply BTG as per their offer.
13	SEPCO to provide PRDS control as per P&IDs approved by WPCPL. SEPCO agreed as per 08-01-09 meeting.	SEPCO agreed. WPCPL expalined that both the control valves in Steam line & Spray water line shall be of Pneumatic control valves.
14	SEPCO to reconfirm provision of dedicated station for MIS as agreed in 08-01-09 meeting	SEPCO confirmed.
15	SEPCO to reconfirm redundant modules for critical I/Os. Critical I/Os shall be approved during detail engineering. SEPCO agreed.	SEPCO agreed.
16	SEPCO to reconfirm on connectivity between Offsite PLCs and DCS and also to indicate how the same shall be achieved. SEPCO agreed to provide Fibre optical connectivity.	SEPCO confirmed.
17	SEPCO to provide 5Nos of Large Video Screens per unit. SEPCO agreed to provide 3 No. Large Video screens per each unit.	SEPCO confirmed.
18	SEPCO agreed to provide two drain valves for all transmitters/switches/gauges for process pressure above 40 bar on 08-01-09 meeting. To reconfirm	SEPCO confirmed.
20	SEPCO agreed to provide DC solenoid operated pneumatic vacuum breaker valve alongwith local air receiver & one NRV in the air filling line to receiver during 08-01-09 meeting. To reconfirm the same.	SEPCO confirmed.
21	SEPCO agreed to provide on-line degassed Cation Conductivity Analyser. To reconfirm	SEPCO confirmed.
22	As agreed on 08-01-09 meeting, SEPCO to provide operation philospohy of mills control and provision of maintenance platforms.	SEPCO confirmed.
23	Details under SL no: 9-12 of guarantee schedule (annexure 2 of Vol III of tender spec) yet to be furnished.	See the revised HMBDs please
24	SEPCO to confirm : Annexure-2 Vol III - * marked data –"to be revised based on Guaranteed HMBD.	See the revised HMBDs please. WPCPL would study the same & revert.
25	Schedule VI of Vol -I, SEPCO to furnish reduced figure for unburnt carbon.	SEPCO confirmed that unburnt cabon shall be guaranteed as 1% max.

27	In page no. 363 of SEPCO technical offer, they have given an unburnt percentage of 0.5 %. SEPCO to confirm whether it is on the basis of Mass or Heat value.	SEPCO confirmed that unburnt cabon shall be guaranteed as 1% max.
26	HMBDs for TMCR and VWO are given. HMBD of VWO shall be revised & balance HMBDs are to be furnished.	See the revised HMBDs please. WPCPL would study the same & revert.
28	SEPCO to reconfirm the no. of agreed hours of warranty for each wear parts and the basis for the same.	SEPCO to furnish the basis after collection of data from OEM.
	SEPCO to provide back to back guarantees from OEMs for major equipment sourced by them.	SEPCO confirmed
	CIVIL:	
31	SEPCO to confirm that Raw water reservoir of 12 lac Cub M is of RCC construction	Refer to Commercial. SEPCO's present offer considered earthen reservoir with HDPE lining. WPCPL requested SEPCO to confirm the optional price for RCC reservoir.
	SEPCO to confirm inclsion of main plant boundary wall in their scope.	SEPCO confirmed.
	ELECTRICAL:	
32	Class-C protection in generator for house load operation to be included.	SEPCO confirmed. House load conditions can be conducted in accordance with MOM dated on 22nd Jan 09.
33	Hydrogen cooling by ACW water is not acceptable . The purity of hydrogen will go low and frequenct charging of generator with H2 will be required. It shall be with DM water as per standard practice. SEPCO to confirm.	As per our actual experience and discussion with generator manufacturer, the ACW will be used for hydrogen cooling and the DM water will be used for stator cooling, also the purity of hydrogen will not go low. WPCPL again reinsisted that for both Hydrogen cooling and Stator cooling, DM water only to be used. SEPCO to revert
34	SEPCO to furnish revised offer considering reduced scope including ash dyke by 5thd Feb 2009.	SEPCO furnished the revised offer including the ash dyke cost on Dtd: 06-02-09
35	BOILER DIMENSION	The dimension of boiler is not exact before finalizing the preliminary design of OEM. During detailed engg. Stage, the Boiler dimensions will be exactly decided by making minor adjustments to the dimensions as agreed in the meeting dated 22.1.09 at Jinan.

OTHER POINTS

1	SEPCO to confirm their Boiler efficiency includes piping losss from Boiler to Turbine inlet	
2	In the VWO HMBD submitted by SEPCO on Dtd: 06-02-09, again figures are not matching with agreed figures like MS flow is 2028 TPH in place of 2060 TPH. SEPCO to furnish the revised one.	

Minutes of Meeting held at KSK, Hyderabad on 26th February 2009

3600 MW WARDHA POWER COMPANY PRIVATE LIMITED

MINUTES OF MEETING BETWEEN SEPCO AND WPCPL AT KSK OFFICE, HYDERABAD ON 26-02-2009

Members Present:

SEPCO	WPCPL
Mr. Sun Lianming	Mr. S. Kishore
Mr. Yin Shiji	Mr. Anil Kumar Kutty
Ms. Wang Chuntao	Mr. M V V Rao
Mr. Wang Chengcai	Mr. G P Rao
Mr. Zheng Lihu	Mr. Pranav Komerwar
	Mr. Kiran Panda

Points Discussed:

1. Review of MoM dated 21.2.09: The following changes have been agreed to be effected.
   a) **Point – 1**: The following text is changed. ".....~~WPCPL~~ SEPCO shall submit the same for WPCPL's approval ...."
   b) **Point – 9 (bullet 2)** : In case the delay in payment of first advance with respect to 'Offshore Supplies', 'Onshore Supplies' & 'Construction' contracts continues for 30 days beyond 7 working days period then the contract price and completion schedule shall be renegotiated. In cases of all other advances, the contract price and completion schedule shall be eligible for renegotiation provided the delay continues for 90 days beyond 7 working days period.
   c) **Point – 9 (bullet 4)** : In case of delay in handing over of the area within boundary wall to SEPCO for project execution within 6 months from the Zero date, WPCPL agreed for extension of completion schedule of the project by such period.
   d) **Point – 10**: In case of delay in handing over of the letter signed by banker on debt finance tie up to SEPCO within 5 months from the Effective date, WPCPL agreed for extension of completion schedule of the project by such period.
   e) **Point – 11**: The following text is appended. ".....Such interest will be paid in USD upto an amount equal to 'LIBOR plus 200 basis points' and the balance amount in INR."
   f) **Point – 12**: If the test data for the preliminary soil investigation (BTG area) can not be provided within 2 months from Zero date, the Completion Schedule shall be extended by the same period of the delay in providing such data.
2. Discussion and finalisation of ABG & PBG formats: Discussed and agreed on the final formats. Final copy of ABG & PBG format is attached with this MOM .
3. SEPCO to furnished the guaranteed cap values of the major consumables upto successful completion of RRT as follows:

S. No.	ITEM	QTY. (For Three Units)	UNIT	Required for
1	Design Coal	1650000	tons	Testing, commissioning & up to the successful completion of RTT.

2	LDO	13770	tons	Testing, commissioning & up to the successful completion of RTT.
3	HFO	21000	tons	Testing, commissioning & up to the successful completion of RTT..
4	Raw Water	9900000	Cu.m	Testing, commissioning & up to the successful completion of RTT.
5	Startup Power (**from grid**)	126000000	kWh	Testing, commissioning & up to the successful completion of RTT.

4. O&M assistance post RRT of respective units: SEPCO agreed to provide expert advice free of charges as and when required to the O&M personnel of WPCPL on any problems that may arise in the units handed over for commercial operation as long as SEPCO's commissioning / operational manpower is available at project site.
5. Training modality: SEPCO agreed to furnish a breakup schedule of training to be imparted in China to WPCPL personnel keeping the total man months (43 man-months) and breakups specified in the technical specification. Within the limit mentioned above, . SEPCO agreed for providing training to the WPCPL personnel in multiple batches and the details are to be finalised mutually later.
6. Soil investigation: WPCPL explained that WPCPL shall place the order as per the terms discussed & agreed by SEPCO with the contractors for soil investigation and WPCPL's engineers will supervise the site work under the guidance of SEPCO engineer. SEPCO agreed to furnish the soil investigation specification documents by 2nd March 2009. Construction contract price shall be deducted by the payments done by WPCPL against the above order.
7. 3D modeling: SEPCO agreed in principle to provide the same provided SEPCO's design institute (NEPDI) prepares the same. However the details will be finalised during technical meeting to be held next week between SEPCO & WPCPL.
8. Techno-commercial impact of 765 kV Vs 400 kV Transformers & switch yard and power evacuation system: WPCPL clarified that in future there may be a requirement of changing the specification of transformers & switchyard from 400 kV to 765 kV. SEPCO agreed to depute their experts to India next week for studying the feasibility of providing the above. SEPCO shall obtain & furnish the offers from the same subcontractors for both 400 kV & 765 kV Transformers & Switchyard equipment for identifying the difference cost.
9. List of documents required to be submitted along with invoices / bills for clearance: Attached.
10. Handing over of draft contract for offshore contract: It is agreed by both the parties that draft contract of 'Offshore Supplies' will be finalized on 2-03-09 for the purpose of submitting to SEPCO's bankers. However the same will be finalized later with minor changes in the text retaining all the commercial agreements reached so far unchanged. The applicable Indian taxes are calculated based on the prevailing tax rates as on Dtd: 21-02-2009 and the agreed Contract Price includes the taxes & duties accordingly as indicated in the respective contracts.
11. It is agreed that Bottom ash of 14,000,000 m^3 & Fly ash of 4,150,000 m^3 is considered to be quantities for designing total Ash Dyke. Whereas, SEPCO's scope consists of Ash Dyke to store one third of the above quantities. SEPCO shall design & construct the Ash Dyke in the area adjoining the Main Plant and make provision for future expansion towards the West side.

SEPCO

WPCPL

Format of Performance Bank Guarantee

Date:

Guarantee No.:

To: Wardha Power Company Private Limited
8-2-293/82A/431/A
Road No. 22, Jubilee Hills
HYDERABAD – 500 033, India

Dear Sirs,

WHEREAS, M/s. SEPCO Electric Power Construction Corporation, a company incorporated under the laws of People's Republic of China, having its registered office at No. 150, Jinger Road, Jinan, Shandong, China (hereinafter referred to as the "Party" which expressions shall include its successors and permitted assigns) has in terms of Contract No..... entered between you and the said Party, contracted to perform the Works and services as stated in the Contract.

AND WHEREAS, as per provision of the said Contract, the Party is required to furnish to you a Bank Guarantee for USD..... (Say US Dollar ..... only) towards due and faithful performance of the Party's obligations under the Contract.

Now, we ..... (name of the bank) hereby irrevocably agree and undertake as follows:

1. We hereby irrevocably guarantee to pay to you the sum in aggregate not exceeding USD ..... (Say US Dollar .....only), merely on the first written demand signed by your duly authorised representative stating that the amount claimed is due by reasons of breach by the said Party of any of the terms or conditions contained in the said Contract or by reasons of the

Party's failure in performance of the Contract. Your written demand shall be accompanied by a certificate issued by the project consultant as appointed by you (Beneficiary, i.e. Wardha Power Company Private Limited) to prove that the Party is in breach of his obligation(s) under the contract and stating the respect in which the Party is in breach. Any such demand made on us shall be conclusive as regards the amount due and payable to you by us under this guarantee.

2. This guarantee shall come into force from date on the successful completion of Reliability Run Test of the _____ Unit and shall remain in full force and effect up to and including_____ (Date) at the counters of_____, _____Branch or the earlier date upon which we have received a written notice from you and the Party jointly stating that the Contract has been terminated and no claim against the Party is outstanding. Should it be necessary to extend the validity of this guarantee beyond the said date, we undertake to extend the period of the guarantee till such time as may be mutually agreed between you and the Party.

3. All banking charges occurred in India are to the account of Wardha Power Company Private Limited.

4. Notwithstanding anything contained hereinabove our liability under this guarantee is restricted to USD..... (Say US Dollar .....only). This guarantee shall remain valid up to..... (Date) at the counters of , Branch.. Unless a claim in writing is lodged with us within a period of 60(sixty) days from the date of expiry of the guarantee i.e_____ up to and including..... (Date) at the counters of____,_____Branch, all your rights under this guarantee shall stand forfeited and we shall be released and discharged from all liabilities under this guarantee whether or not this document shall have been returned to us.

5. The amount of Performance Bank Guarantee shall be reduced prorated Unit wise on completion of the Warranty Period of the respective Unit, upon receipt of the certificate to that extent from you.

6. We further agree that you shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said contract with the Party.

7. This Guarantee shall not be affected by any change in your constitution / management / or of Party / or the Bank by absorption with any other body, corporation or otherwise and this Guarantee will be available for enforcement by such body or corporation.

THIS GURANTEE SHALL BE SUBJECT TO THE UNIFORM RULES FOR DEMAND GURANTEES,ICC PUBLICATIONS NO.458.

(AUTHORISED SIGNATORY OF BANK)

YIN SHIJI

G.P. RAO
WPCPL

Format of Advance Payment Bank Guarantee

Date: _____

Guarantee No.:

Dear Sir,

To:

Wardha Power Company Private Limited
8-2-293/82/A/431/A,
Road No.22, Jubilee Hills,
Hyderabad – 500 033, India

WHEREAS, in consideration of your agreeing to pay to M/s. SEPCO Electric Power Construction Corporation(SEPCO), a company incorporated under the laws of People's Republic of China and having its registered / principal office at No.150,Jinger Road, Jinan, Shandong, P. R. China, (hereinafter referred to as "Party" (which expressions shall include its successors and assigns permitted by us) a sum of US Dollar _____,(say US Dollars _____ only) as and by way of Advance Payment in terms of your LOA reference No. _____ dated_____ and the Contract Agreement NO. _____ with the Party (SEPCO) dated _____ (hereinafter referred as the "Contract") for the fulfillment of obligations such as supply to be carried out by the Party under the said Contract on furnishing a Bank Guarantee of equivalent value in the manner hereinafter contained, we, Agriculture Bank of China, Shandong Branch do hereby covenant and agree with you as follows:

1. We hereby undertake and bind ourselves irrevocably and unconditionally to pay to you the sum in aggregate not exceeding US Dollar _____ (Say US_____ Dollars) representing the Advance Payment made by you to the "Party" as aforesaid, without delay or demur, merely on the first written demand signed by your duly Authorised Signatory stating that the amount claimed is due by way of loss or damage caused to or would be caused to you by reason of default or defaults on the part of the "Party" in discharging any of its obligation under the said "Contract". Your written demand shall be accompanied by a certificate issued by the project consultant as appointed by you (Beneficiary, i.e. Wardha Power Company Private Limited) to prove that the Party is in breach of his obligation(s) under the contract and stating the respect in which the Party is in breach. Any such demand made on us shall be conclusive as regards the amount due and payable to you by us under this guarantee.

2. Notwithstanding anything to the contrary, your decision as to whether the "Party" has made any such default or defaults under the aforesaid Contract and the amount or amounts to which you are entitled by reason thereof, will be binding on us and we shall not be entitled to ask you to establish your claim or claims under this guarantee but will pay you the sum promptly on first written demand made by you without any protest or demur forthwith.

3. This guarantee shall come into force simultaneously with receipt of the corresponding advance payment by "Party" and shall remain in full force and effect up to and including _____ (herein called the expiry Date) at the counters of Agriculture Bank of China, Shandong Branch. Should it be necessary to extend the validity of this guarantee beyond the said date, we undertake to extend the period of the guarantee on your request till such time as may be mutually agreed between you and the "Party".

4. The amount of this guarantee shall be upon the receipt of your approval on the Party's application, progressively reduced on quarterly basis in proportion to the value of progress payment received by the Party.

5. All Banking Charges occurred in India are to the account of Wardha Power Company Private Limited.

6. We further agree that you shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said "Contract" and/or to extend the time for performance by the "Party" from time to time.

7. We, Agriculture Bank of China, Shandong Branch, also undertake not to revoke this guarantee during its currency and until the discharge Certificate is issued by you in writing through your Bank.

8. Notwithstanding anything contained hereinabove, our liability under this guarantee is restricted to US Dollar _____ (say US Dollar _____ only) This guarantee shall remain valid up to _____ at the counters of Agriculture Bank of China, Shandong Branch. Unless a claim in writing is lodged with us within a period of 60 days (sixty days) from the date of expiry of the guarantee i.e. up to and including _____ (Date) at the counters of Agriculture Bank of China, Shandong Branch, all your rights under this guarantee shall stand forfeited and we shall be released and discharged from all liabilities under this guarantee whether or not this document shall have been returned to us.

THIS GURANTEE SHALL BE SUBJECT TO THE UNIFORM RULES FOR DEMAND GURANTEES,ICC PUBLICATIONS NO.458.

SIGNED AND DELIVERED this - - - - - - - -

For and on behalf of

Bank: Agriculture Bank of China, Shandong Branch

Address: Agriculture Bank of China, No.

(AUTHORISED SIGNATORY OF BANK)

YIN SHIJI

Minutes of Meeting held at SEPCO, China on 16th February 2009 to 21st February 2009

Minutes of Meeting between SEPCO & WPCPL held at Jinan from 16.2.09 to 21.2.09

SEPCO

1. Mr. Huang Xiaoxuan
2. Mr. Sun Lianming
3. Mr. Yin Shiji
4. Mr. Xue Li
5. Ms. Wang Chuntao
6. Mr. Zhang Dezhi

WPCPL

1. Mr. S Kishore
2. Mr. K A Sastry
3. Mr. G P Rao
4. Mr. Pranav Komerwar PVK

21/2/09

Scope adjustment to technical proposal for KSK 6X600MW Project

Note : With reference to scope described in Tender specs, only the following changes are agreed in addition to those already agreed in the earlier MoMs.

No.	Items	SEPCO' proposal	Requirement by the Owner	Resolution
1	Zero Discharge	without ROS	ULTRA FILTRATION AND REVERSE OSMOSIS SYSTEM	Ultra Filtration and Reverse Osmosis system shall be provided to meet 'Zero discharge' requirements.
2	ID fan	Axial fan with adjustable static blade connected to DCS. (2 sets of blades + one rotor assembly shall be taken as spares for total plant – To be discussed along with spares)	coupling required from voith	Axial fan with adjustable static blade connected to DCS shall be provided. (2 sets of blades + one rotor assembly shall be taken as spares for total plant – To be discussed along with spares)
3	CW PUMP	without standby	1no./Phase will be provided	CW pumps shall be provided with 1 no. Pump as standby per phase (3 units).

(YIN SHIJI) (XUE LI)

PVK (PRANAV) (G.P.RAO)

No.	Items	SEPCO' proposal	Requirement by the Owner	Resolution
4	ELECTRICAL EQUIPMENT	Chinese equipments and delete Backup Panel	RTU equipments, Switch Yard equipments from ABB/SIEMENS/AREVA, Indian make Battery, Hard wiring for Backup Panel	RTU equipments, Switch Yard equipments from ABB / SIEMENS / AREVA make, Indian make Battery, Hard wiring for Backup Panel shall be provided.
5	PERFORMANCE CALCULATION AND OPTIMIZATION SYSTEM	not required (same can be incorporated later)	Required	Performance calculation & Optimization system need not be provided. SEPCO confirmed that it is possible to incorporate the same later & integrate with DCS. WPCPL agreed.
6	MECHANICAL VIBRATION MONITORING AND ANALYZING SYSTEM	not required (Diagnostic analysis for Turbine & TDBFP are provided as normal scope. For other major rotating equipment online vibration monitoring system on DCS is provided)	required	Mechanical Vibration monitoring & analyzing system (Diagnostic analysis) for Turbine & TDBFP is provided as part of normal scope. For other major rotating equipment online vibration monitoring system on DCS is provided.
7	HIGH PRESSURE INSTRUMENTS	not required (double drain valves will be provided for all instruments with pr >40 bar)	flow nozzle for main steam flow ; >=4Mpa double drain valve required	SEPCO agreed to provide double drain valves for all instruments with pr >40 bar. Flow nozzle will be provided in Feed water line & it will not be provided in Main steam line. Main steam flow quantity will be considered equal to Feed water Flow quantity with zero blow down condition in PG Test.
8	CW PUMP AND RAW WATER PUMP MODULE TEST, CHIMNEY AND COOLING TOWER WIND TUNNEL TEST	not required (CFD analysis will be done for CW Pump house only. Wind Tunnel test not required for Chimneys. Wind Tunnel test not required in	required	Physical model test for CW pump house is not required, but CFD analysis shall be carried out for the same. Wind Tunnel test is not required for Chimneys & IDCTs.

No.	Items	SEPCO' proposal	Requirement by the Owner	Resolution
		case of IDCTs)		
9	Ash handling system (2.5KM)	SEPCO will provide the dry bottom ash to ash silo for each unit, and the dry bottom ash from each silo can be transported to ash dyke by truck.		Dry Bottom ash conveying system shall be provided and the dry bottom ash from each silo shall be transported to ash dyke by dry ash disposal system.
10	Coal Yard	7 days	15days.Additional:track hoper 1no,stacker and reclaimer 1no,impeller coal feeder2nos.dust evacuation system 1 set	Coal storage yard shall be provided with concrete paving (as per tender specs) for 15 days requirement. 2 No. Track Hoppers & 3 No. Stacker Reclaimers shall be provided.
11	MILL REJECTION VIBRATION CONVEYOR SYSTEM	not required (Hydraulic system will be provided for conveying mill rejects to silo along with water recycling)	TUNNEL 72X6=432m	Vibration conveyor system need not be provided for Mill rejects conveying. Instead, Hydraulic system shall be provided for conveying mill rejects to silo along with water recycling.
12	HART OPERATION STATION	not required	Separate Station required	Separate HART operation station shall be provided.
13	LARGE SCREEN DISPLAYER	not required (Finally, reduce 3 to 2 screens per unit)	Additional: Total 6sets	2 No. Large Video screens per each unit shall be provided.
14	UNIT FUNCTION	not required (House load test shall be done without extra cost)	House load for 15 min	Unit shall be capable of operating on House load for 15 min. and same shall be demonstrated during PG test without extra cost.
15	Raw water Reservoir capacity	12 lacs cu.m capacity reservoir (SEPCO agreed for 6 lac cu.m capacity earthen reservoir with HDPE lining to be constructed	12 lac cu m capacity. To be done in two phases but, rock blasting to be done for total area in one attempt.	SEPCO agreed to provide 6 lac cu.m capacity earthen reservoir with HDPE lining. Rock blasting shall be completed in full area (required for 12 lac capacity reservoir) in one attempt.

No.	Items	SEPCO' proposal	Requirement by the Owner	Resolution
		+ Rock blasting in full area (12 lac cap)		
16	Ash Dyke	Savings will be 216 INR/kW (for total ash Dyke its I 534 INR/kW) excluding ST.	To execute only one third area of the Ash Dyke by SEPCO & confirm corresponding savings. WPCPL agreed SEPCO's confirmation of savings.	SEPCO agreed to execute Ash Dyke only for one third capacity of that indicated in the tender specs.
17	Cooling Towers	SEPCO agreed to provide IDCTs with back to back arrangement (with one standby cell) & layout will be submitted for WPCPL approval. SEPCO confirmed Aux. Power consumption for IDCTs will be 3100 kW per unit. SEPCO to indicate cost savings by 19.2.09 morning.	IDCTs in place of NDCTs	SEPCO agreed to provide IDCTs (in lieu of NDCTs) with back to back arrangement (with one standby cell) & layout will be submitted for WPCPL approval. SEPCO confirmed Aux. Power consumption for IDCTs will be 3100 kW per unit. SEPCO shall furnish revised Plot plan with above arrangement. WPCPL agreed.
18	No. of Coal Mills, Bunkers, Steel Structures	To comply with CEA guide lines on Heat Flux (55 x 10^6) 8 mills are required. WPCPL agreed for 7 mills (90% loading with 6W+1S in BMCR & Worst coal) with Front arrangement. There would be 28 burners per Boiler. SEPCO will confirm the cost savings on 19.2.09 morning. Also SEPCO to	7 Mills instead of 8 mills & corresponding reduction in other items.	WPCPL agreed for 7 Bowl mills (6W+1S, 90% loading in each mill, during BMCR condition with Worst coal) with Front arrangement. There would be 28 burners per Boiler. SEPCO shall furnish revised Plot plan with above arrangement. With the above, SEPCO confirmed that max. Heat Flux density per burner will not exceed 65 X 10^6 kcal/hr/ burner.

No.	Items	SEPCO' proposal	Requirement by the Owner	Resolution
		confirm Heat Flux density per burner		
19	Mills arrangement - Front instead of Side	SEPCO to confirm the savings along with layout on 17.2.09	Front mills arrangement instead of Side arrangement	SEPCO agreed to provide 'Front mills arrangement' instead of Side arrangement. SEPCO shall furnish revised Plot plan with above arrangement
20	Optimization of coal conveyors	In view of Fire hazard 3 x 1800 tph is ruled out. SEPCO will not be able to source 4000 tph system from India.	3 x 1800 tph conveyors instead of 4 x 1800 tph. Alternately – 2 x 4000 tph instead of 4 x 1800 tph.	SEPCO agreed to provide 4 x 1800 tph coal conveyors to Boilers, as per tender specs.
21	Wet Steam washing	Not required (SEPCO agreed to provide pipe stubs with blind flange on Main steam & reheat steam inlet pipes to Turbine)	Required	SEPCO agreed to provide pipe stubs with flange & blind flange on Main steam & Reheat steam inlet pipes to Turbine. WPCPL may arrange Wet steam washing equipment later.
22	Architectural finish of Miscellaneous Non-Plant buildings	Concrete floor, Steel doors & windows (SEPCO agreed to withdraw deviation & follow tender specs)	As per Tender specs	SEPCO agreed to withdraw their deviation in their offer & follow tender specs for architectural finish details of all buildings & structures.
23	Track Hoppers & Stacker-Reclaimers	SEPCO's offer currently considered 2 Track Hoppers & 2 Stacker-Reclaimers. (SEPCO agreed to increase Satcker Reclaimers to 3 (instead of 2 as quoted). Track Hoppers remain as 2 No.)	2 Track Hoppers & 2 Stacker-Reclaimers	2 No. Track Hoppers & 3 No. Stacker Reclaimers shall be provided.

Other Points discussed & agreed between SEPCO & WPCPL at Jinan from 16.2.09 to 18.2.09

1. WPCPL furnished & explained the sample Quality Plans (QP) of WTP, CHP & AHP with minimum quality requirements for guidance of SEPCO. SEPCO shall follow the same & prepare similar QPs of other equipment of BOP. WPCPL shall submit the same for WPCPL's approval within 45 days from LOA. SEPCO shall float enquiries to Sub-vendors only with approved QPs.
2. WPCPL also furnished & explained the sample Field Quality Plans (FQP). SEPCO agreed to submit the filled up FQPs for WPCPL's approval within 45 days from LOA. SEPCO shall float enquiries to Sub-contractors only with approved QPs.
3. WPCPL already furnished & explained the KSK's Quality Plans (QP) for Boilers, Turbines & Generators. SEPCO agreed to follow the same with minor changes, which shall be discussed & agreed after LOA.
4. SEPCO offered the Plant layout with one 'Common Control Room' for each phase & WPCPL agreed for the same.
5. WPCPL explained the discrepancies in SEPCO's Project Schedule and SEPCO agreed to revise the same accordingly. Mainly, it is explained to stagger the supplies & their erection unit wise to the extent possible. That would in turn stream line the Cash Flow.
6. SEPCO submitted the revised manpower deployment chart. It indicates peak manpower of 347 engineers (358 in earlier chart) in 42nd month. WPCPL pointed out that it is very much inadequate manpower for 6 X 600 MW power plant execution. SEPCO clarified that the manpower indicated is mainly engineers & supervisors and balance manpower would be sourced from India. They further clarified that they have projected the manpower based on their past experience in India (BALCO - 4 x 135 MW – Peak 200 people & total 6000 people). However, SEPCO assured that they will augment additional manpower on need basis.
7. WPCPL explained that they would be carrying out the vendor evaluation for the sub-vendors of SEPCO through a third party for approving the Vendor list. SEPCO agreed to extend the necessary help / coordination by informing those sub-vendors for facilitating the evaluation process.
8. Reliability Run Test (**RRT**) :
   - RRT of unit-1 shall start not later than 37.5 months from NTP (Notice To Proceed) date. RRT of subsequent units shall start at 4 months gap (like 41.5 m for unit-2, 45.5 m for unit-3 ... etc)
   - Each unit RRT shall be conducted with 14 days of operation. Each RRT shall consist of 72 hours of continuous operation at full load (or any other load at owner's discretion) and further demonstrate operation at various other loads like 80%, 60%, 40% or any other load mutually agreed. Any minor failure of aux. equipment (which shall be set right immediately), which does not force the unit shut down, will not be treated as failure of RRT.
   - Each RRT may have max. two shut downs of unit with total hours of interruption not exceeding 8 hours.
   - In case total No. of hours of interruption of operation exceed 8 hours, such RRT shall be treated as unsuccessful.
   - If RRT of any unit is not successful based on above criteria, SEPCO shall repeat the RRT. In case SEPCO could not conduct RRT successfully within 38 months, SEPCO shall be liable for LD on account of delay.

- However, in case SEPCO could not conduct RRT successfully within 38 months, Owner would permit one additional RRT without levying LD. In case of major shut down due to 'Boiler tube leakage' in any unit, the repeat RRT shall start immediately after repair but not later than 36 hours from the time of unit shut down.
- In the event such repeat RRT is also not successful, Owner may permit one more additional RRT without levying LD. In case of major shut down due to 'Boiler tube leakage' in any unit, provided the repeat RRT starts immediately after repair but not later than 36 hours from the time of unit shut down. **But, in any unit not more than two additional RRTs are permitted**.
- In any case, all the additional RRTs for the total six units shall not exceed 8 tests. The cost of consumables in such additional tests shall be borne by Owner.

9. Effective Date or Zero date : Date of issuing LOA from WPCPL shall be treated as 'Notice To Proceed' (**NTP**) date, subject to following.
   - SEPCO shall submit ABG within 30 days from the date of LOA.
   - WPCPL shall pay advance within 7 days from receipt of swift message for ABG by WPCPL's bank (If confirmation of ABG or PBG needed, that shall be arranged by WPCPL). In case, of delay of payment of advance beyond 7 working days, project schedule will be extended by corresponding no. of days. *(SEPCO request that if such delay continued for 30 days, then the Contract Price and Completion Schedule shall be renegotiated. This shall be discussed later)*
   - However, it is agreed that WPCPL would pay 4.95 million USD within 48 hours from date of LOA to make it as Effective date. The delay of such payment shall also cause the corresponding extention on Completion Schedule.
   - *All the area within the boundary wall shall be handed over to SEPCO within 6 months from Zero Date with the formal confirmation letter from Owner. Failing on doing that, the Completion Schedule for the project shall be extended by the same period of such delay.(to be confirmed later)*
10. SEPCO enquired about project finance. It is agreed that WPCPL will furnish the letter signed by their banker within 5 months from 'Effective date' that debt finance has been tied up. *The completion schedule shall be extended by the same period of the delay of such furnishing.to be confirmed later)*
11. Invoice Payment : On receipt of complete set of required documents, Owners' Engineers shall process the documents within 7 working days. Any delay in approval / comments from Owners' Engineers within 7 working days, same shall be treated as approval for payment. On approval from Owners' Engineers, WPCPL shall release the payment within 14 working days. In case of delay in payment of any undisputed invoice beyond the above payment schedule, WPCPL agreed to pay interest at the rate of 7% (seven percent) per annum on such amount.
12. Preliminary soil investigation shall be done in the Main Power Block (including chimney area) area by WPCPL at the cost of SEPCO, under the supervision of the Engineers deputed by SEPCO. The SEPCO engineers will be away from the site and, with the guidance of SEPCO engineers, WPCPL engineers shall supervise the work being carried out by the agency appointed by WPCPL. It shall be completed within 2 months from NTP date. The agency appointed by WPCPL shall be the agency chosen by SEPCO and the terms

thereof shall be decided mutually with the agency. The payment made by WPCPL will be reimbursed by SEPCO, by deduction on the contract value. *If the test data for the preliminary soil investigation can not be provided within 2 months from Zero Date, the Completion Schedule shall be extended by the same period of the delay in providing such data.(to be confirmed later)*

13. WPCPL confirmed the 'Highest flood level' of Lilagarh river (the nearest river) as 243 m +MSL to enable SEPCO to establish site Benchmark higher than that. WPCPL shall provide topographical survey map with the scaling of 1:1000 within 10 days from NTP for SEPCO to plan the site levelling work.
14. HMBDs :
    - SEPCO confirmed that the HMBDs for TMCR & VWO conditions submitted on 6th February 2009 as corrected & Final. SEPCO agreed to furnish the HMBDs of balance operating conditions after LOA.
    - SEPCO confirmed that the LOAD (power generated) indicated in the diagrams are net (after considering internal mechanical and generator losses).
    - SEPCO confirmed that BMCR flow is equal to 1.02 times VWO flow. VWO flow is equal to min 1.05 times TMCR flow.
    - SEPCO guaranteed Turbine cycle Heat Rate as 1950 kcal/kWh. SEPCO agreed to guarantee Gross Unit Heat Rate as 2239.77 kcal/kWh, considering (minimum) 99.5% piping efficiency. However improved piping efficiency shall be considered later based on the actual Main steam parameters measured during PG Test. Formula to be used for calculating piping efficiency shall be { 1 – $((i_B-i_T)/i_B \times 100)$ }, where i_B, i_T are values of enthalpy of main steam at Boiler outlet & Turbine inlet respectively. SEPCO indicated that piping loss is not considerred on BE calculation. The unit heat rate shall be calculated by the formula, UHR=THR/BE/PE.
15. Payment Terms and Cash Flow

    The payment Terms and Cash Flow are mutually agreed and attached (refer Annexure-1&4).
16. ~~The format for BGs is agreed and is attached (refer Annexure-5)~~
17. Performance Parametter to be guarantteed is attached. (refer Annexure-2)
18. LD for Performance is agreed and attached. (refer Annexure-3)
19. The draft copies for all commercial contracts have been provided to WPCPL on Feb. 21, 2009 by e-mail (Offshore Supply already agreed by both parties), after revewing of WPCPL and mutual discussion, such copy shall be fixed and attached to LOI.
20. The contract price has been discussed and the per kW price is mutually agreed based on the following.
    - All variation risk for exchange rate between USD and RMB shall be borne by WPCPL with the basis, 1USD=6.82RMB (USD buying rate published by People's Bank of China).
    - No spares are included, except commisioning spares.
    - For calculation purpose, INR48=USD1 has been used.

Annexure-1

PAYMENT TERMS

The payment terms for offshore supplies shall be as follows

A) Offshore Supply Contract:

Subject to any deductions/adjustment from the Contract Price as per Contract the Supplier shall be entitled to receive the Contract Price in the following manner:

1. Supply of Plant & Equipment

1.1 8% Advance against submission of Advance Bank Guarantee (ABG) of equal amount

1.2 3.5% Advance against submission of Advance BG of equal amount at the end of sixth month from Zero date

1.3 3.5% Advance against submission of Advance BG of equal amount at thend of twelfth month from Zero date.

2. 65% against despatch of offshore supplies FOB Chinese port on pro-rata basis as per shipping schedule.

3. 5 % against receipt of offshore supplies at site on pro-rata basis as per shipping schedule.

4 5% of the Contract Price against first synchronization (prorated for each Unit)

5 5% against successful completion of Reliability Run Test (prorated for each Unit)

6 5% against successful completion of PG Test (prorated for each Unit)

Subject to the other details in this MOM, WPCPL shall release any advance payment against ABGs within 7 working days from receipt of ABGs by WPCPL. All the other payments under this contract shall be made by telegraphic transfer within 21 days from the date the payment becoming due and receipt of complete & correct documents. SEPCO shall furnish Performance Bank Guarantee (PBG) for 10% of contract value 30 days before completion of Reliability Run Test of first unit, valid upto Warranty period completion of the last unit. The amount of this performance guarantee shall be reduced prorated unit wise on completion of the warranty period of the respective unit. The ABGs & PBG shall be submitted from any of the following banks.

1. Industrial & Commercial Bank of China
2. Bank of China
3. Agricultural Bank of China
4. Construction Bank of China

B) Offshore Service Contract:

month from Zero Date

1.2 75% against receipt for onshore supplies at site on prorata basis as per a billing schedule to be approved by the WPCPL.

1.3 5% against first synchronization (prorated for each Unit)

1.4 5% against successful completion of Reliability Run (prorated for each Unit)

1.5 5% against successful completion of PG test (prorated for each Unit)

Subject to the other details in this MOM, WPCPL shall release any advance payment against ABGs within 7 working days from receipt of ABGs by WPCPL. All the other payments under this contract shall be made by telegraphic transfer within 21 days from the date the payment becoming due and receipt of complete & correct documents. SEPCO shall furnish Performance Bank Guarantee (PBG) for 10% of contract value 30 days before completion of Reliability Run Test of first unit, valid upto Warranty period completion of the last unit. The amount of this performance guarantee shall be reduced prorated unit wise on completion of the warranty period of the respective unit. The ABGs & PBG shall be submitted from any of the following banks.

1. Industrial & Commercial Bank of China
2. Bank of China
3. Agricultural Bank of China
4. Construction Bank of China

D) Onshore Service Contract:

2.1 10% Advance at site against submission of Advance Payment Guarantee of equal amount at the end of ninth month from Zero Date.

2.2 10% on completion of the first layer of boiler structure lifting (prorated for each Unit)

2.3 10% on boiler drum lifting (prorated for each Unit)

2.4 10% on placement of generator stator (prorated for each Unit)

2.5 10% on turbine box up (prorated for each Unit)

2.6 10% on boiler hydro test (prorated for each Unit)

2.7 15% on Boiler light up (prorated for each Unit)

2.8 10% on back charging of Station Transformer and 6.6KV switchyard

2.9 5% against first synchronization (prorated for each Unit)

2.10 5% against successful completion of Reliability Run Test (prorated for each Unit)

2.11 5% against successful completion of PG test (prorated for each Unit)

Subject to the other details in this MOM, WPCPL shall release any advance payment against ABGs within 7 working days from receipt of ABGs by WPCPL. All the other

1.13 5% against successful completion of PG test (prorated for each Unit)

Subject to other details in this MOM, WPCPL shall release any advance payment against ABGs within 7 working days from receipt of ABGs by WPCPL. All the other payment under this Contract will be released on milestone basis against submission of invoices and certification of progress with protocols duly certified by Owner or Owner's Representative by telegraphic transfer within 21 (twenty-one) days of the payment becoming due. SEPCO shall furnish Performance Bank Guarantee (PBG) for 10% of contract value 30 days before completion of Reliability Run Test of first unit, valid upto Warranty period completion of the last unit. The amount of this performance guarantee shall be reduced prorated unit wise on completion of the warranty period of the respective unit. The ABGs & PBG shall be submitted from any of the following banks.

1. Industrial & Commercial Bank of China
2. Bank of China
3. Agricultural Bank of China
4. Construction Bank of China

Annexure-3

LIQUIDATED DAMAGES FOR NON-PERFORMANCE AND DELAY IN SCHEDULE

Reliability Run Test completion schedule:

In the event of completion of Reliability Run Test is delayed beyond guaranteed completion Date, SEPCO shall pay as liquidated damages and not as a penalty, a sum equal to 0.5 % (Zero point five percent) of the Contract value of each unit, for each week [7 days] of delay in completion of Reliability Run Test or part thereof, up to an aggregate maximum of ten percent (10%) of the Contract value.

Performance Liquidated Damages

Sr. No.	Variation Factor	Liquidated Damages for shortfall in performance
1.	UNIT GROSS HEAT RATE:- Unit gross heat rate heat rate in kcal / kWh at rated steam parameters & 0.1 ata as exhaust pressure, with zero percent make up, at TMCR condition and at reference ambient parameters as per specs.	Unit Gross Heat rate – USD 4,00,000 per kcal / kWh or part thereof of increase in heat rate from guaranteed value.
2.	Total auxiliary power consumption of all auxiliaries at TMCR condition (%)	Rs. 1,00,000 per kW (or part thereof) of increase in guaranteed value.
3.	Gross electrical power output at Generator terminals (MW)	Rs 1,00,000 for every kW or part thereof by which output determined during the tests falls short of guaranteed rated output
4.	Boiler steaming capacity at BMCR condition (tph)	USD 60,000 for each one tonne/hr. or part thereof decrease in steam generating capacity.
5.	Unburnt Carbon in fly ash by weight (%)	Rs 200 lacs for every 1% (or part thereof) increase of unburnt Carbon in fly ash beyond the guaranteed value. For Ex. Guaranteed value is 1.5%. Actual value is 1.9%. LD value shall be = (1.9-1.5) X 200 lacs = Rs 80 lacs

WPCPL may reject the Equipment under the following circumstances:

1.) Output: Shortfall in excess of 5% in guaranteed output (of all major equipment and Full Plant)

2.) Auxiliary power Consumption: In excess of 5% over the guaranteed auxiliary power consumption value.

3.) Unit Gross Heat Rate : In excess of 5% over the guaranteed value.

4) Emission Level : In excess of guaranteed Emission level value.

5) **Unburnt Carbon in fly ash % by weight** : in excess of 2%

35	64.31%	80.00%	69.62%	74.58%	40.83%	64.31%
36	66.91%	80.00%	70.92%	77.50%	45.00%	67.07%
37	69.69%	80.83%	74.05%	77.50%	45.00%	69.14%
38	72.98%	80.83%	75.17%	79.17%	45.83%	71.93%
39	75.68%	83.33%	77.67%	82.50%	55.83%	75.30%
40	77.92%	83.33%	78.97%	84.17%	58.33%	77.47%
41	80.53%	84.17%	82.10%	84.17%	58.33%	79.42%
42	83.32%	84.17%	82.93%	85.83%	59.17%	81.83%
43	85.63%	86.67%	85.42%	89.17%	69.17%	84.93%
44	87.49%	86.67%	86.74%	90.83%	71.67%	86.80%
45	89.88%	87.50%	88.41%	90.83%	71.67%	88.57%
46	90.34%	87.50%	89.24%	92.50%	72.50%	89.27%
47	92.86%	90.00%	91.74%	95.83%	80.83%	92.40%
48	93.37%	90.00%	93.05%	95.83%	83.33%	92.99%
49	94.13%	90.83%	93.05%	95.83%	83.33%	93.56%
50	94.17%	90.83%	94.17%	97.50%	84.17%	93.94%
51	95.63%	93.33%	96.00%	98.33%	90.83%	95.70%
52	95.63%	93.33%	95.83%	98.33%	93.33%	96.91%
53	96.36%	94.17%	96.83%	98.33%	93.33%	96.45%
54	96.36%	94.17%	96.67%	98.33%	94.17%	96.52%
55	97.81%	96.67%	97.50%	99.17%	97.50%	98.02%
56	97.81%	96.67%	98.33%	99.17%	98.33%	98.09%
57	98.54%	97.50%	98.33%	99.17%	98.33%	98.63%
58	98.54%	97.50%	99.17%	99.17%	99.17%	98.71%
59	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The cumulative cash flows in any month shall not exceed the respective month values mentioned above.

Minutes of Meeting between WPCPL, SEPCO-I and DCPL held at DCPL, Vashi between 25nd Sept 08 to 28th Sept 08.

Minutes of Meeting between WPCPL, SEPCO-I and DCPL held at DCPL, Vashi between 25nd Sept 08 to 28th Sept 08

Members Present:

WPCPL	SEPCO-I	DCPL
1. Mr. Anil Kumar Kutty (Part)	1. Mr. Xu Gang, NEPDI	1. Mr. I. A. Mukaddam
2. Mr. G.P. Rao	2. Mr. Lu Zhen, NEPDI	2. Mr. B. G. Zarbade
3. Mr. M.V.V. Rao	3. Mr. Li Jin Suo, NEPDI	3. Mr. M. S. Prabhudesai
4. Mr. V. Reddy	4. Mrs. Liushan, NEPDI	4. Mr. P. Banerjee
5. Mr. Pranav Komerwar	5. Mrs. Zhou Yufon, NEPDI	5. Mr. H. Chowdhury
6. Mr. Kiran Kumar Panda	6. Mrs. Wang Haihe, NEPDI	6. Mr. R.N.Das
7. Mr. G. Shankar	7. Mr. Pei Yu Feng, NEPDI	7. Mr. R. E. Karanjkar
8. Mr. S.B.R. Prasad	8. Mr. Li Gingshan, NEPDI	8. Mr. Niraj Jaiswal
9. Mr. Pravin Kumar (Part)	9. Mr. Liu Hongyuan	9. Mr. Sameer Domb
10. Mr. N. Muralidharan	10. Mr. Xue Li	10. Mr. Rohan Barge
11. Mr. M. Saratchandran	11. Mr. Su Shanoshan	11. Mr. D. Shinde
12. Mr. K.V. Kiran Kumar (Part)	12. Mr. Li Kaoxin	
13. Mr. C. Narsimha	13. Mr. Zhao Xinghua	
14. Mr. Ganesh Kumar Boloor		
15. Mr. Nagarajan Ganesan (Part)		

1. WPCPL handed over commented Vendor list to SEPCO for their confirmation. SEPCO to revert by 10.10.08.

2. SEPCO to confirm by 10.10.08 that there are not any other deviations on Bid Specification except mentioned in the offer and discussed in this meeting.

3. SEPCO to revise layout inline with comments attached and submit revised layout showing complete power plant, Ash disposal area.

4. Resolution on comments, clarification, deviations , etc are attached in different annexure as follows :

a.	Annexure-A1 and A2	: Resolution on Mechanical, Layout, Vastu and General Comments
b.	Annexure-B1 to B7	: Resolution on Electrical Comments
c.	Annexure-C1 to C3	: Resolution on Instrumentation Comments
d.	Annexure-D	: Resolution on Civil, structural Comments
e.	Annexure-E	: Resolution on Scope of supply
f.	Annexure-F	: Resolution on Technical Deviations
g.	Annexure-G	: CW Pump House Schematic
h.	Annexure-H	: List of Building and Structures
i.	Annexure-I	: ETP and DM Plant Schematic
j.	Annexure-J	: Unresolved Issues.
k.	Annexure-K	: Typical Drawing Submission and Approval procedure
l.	Annexure-M	: Design Water Analysis

5. WPCPL informed that all the resolution on comments/ clarification and deviation, etc. as discussed for 6 x 600 MW Sub-Critical Power Plant in this meeting shall be applicable for 5 x 660 MW Super-critical Power Plant. However, Capacities for BOP plant shall be suitably selected as requirement of 5 x 660 MW Power plant.

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COMMENTS ON PLANT LAYOUT

1. SEPCO to revise routing of overhead line going toward north for meeting VASTU requirement . This line will pass over the raw water reservoir so that it shall come out of the power block after Grid N-750.
2. SEPCO to shift Material road near Grid N-1450 and provide security gate for this road at entry.
3. SEPCO to indicate 4 m wide road between coal mills and boiler for maintenance purpose.
4. SEPCO to shift weigh bridge near Grid N-800 and E-050.
5. SEPCO to indicate third track hopper and relevant CHP system.
6. SEPCO to indicate following equipments/structures in the layout.
    a. RO Plant for Waste water recovery.
    b. Guard Pond (Central effluent monitoring basin)
    c. Bottom and Fly ash disposal area
    d. HCSD system and pipeline to ash disposal area
    e. Bottom ash slurry sump
    f. Bottom ash Water tank
    g. Fly ash Intermediate silos
    h. Ash water recovery system from bottom ash disposal area.

27-09-08

MEETING ON 27.09.08 FOR BID CLARIFICATION FOR 6x600 MW or 5x660MW POWER PLANT AT NARIYARA, CHATTISGARH

Sr.No	WPCPL's Comments on SEPCO's Project Completion Schedule vs Bar Chart	Resolution
1	The barchart does not reflect all the milestones of the 'Project Completion Schedule' (these miletones are indicated by blank cells Annexure-1). SEPCO-1 should indicate all the milestones in the Project Completion Schedule in the bar chart.	SEPCO will furnish revised Barchart by 10.10.08
2	The barchart should reflect the start and finish dates of the activities.	SEPCO will furnish revised Barchart by 10.10.08
3	The barchart should cover all packages. SEPCO to Confirm	SEPCO will furnish revised Barchart by 10.10.08
4	When the activities of the Project Completion Schedule are compared with those of barchart, time difference is found (these are highlighted in blue colour) - Annexure-1	SEPCO will furnish revised Barchart by 10.10.08 matching with project completion schedule
5	Supply of Mandatory Spares on 56th month not acceptable. Mandatory Spares for each unit shall be scheduled to be delivered before successful completion of the reliability the respective unit.	sepco confirmed
6	Equipment Mobilisation for the total Contract period to be provided.	SEPCO will furnish revised Barchart by 10.10.08
7	Manpower Mobilisation for the total Contract period to be provided.	SEPCO will furnish revised Barchart by 10.10.08
8	Estimated BOQ to be provided for Planning Purpose	sepco will give in 4 months from contract award date
9	Project Schedule will be delivered in Primavera Format	sepco confirmed
10	SEPCO to provide monthly, weekly progress report formats for finalisation	SEPCO to provide monthly, weekly progress report
11	Each day in the Project Schedule shall constitute of 24 hours. SEPCO-1 to Confirm	sepco confirmed
12	SEPCO-1 has stated that the schedule is based on general soil condition and the schedule will be extended if piling or rock blasting becomes essential as per soil investigation. This is not acceptable.	SEPCO will furnish revised Barchart by 10.10.08 considering blasting requirements as required
13	SEPCO stated that The schedule is efective under the condition that contract shall be signed between march1, 2009 to july 31st 2009. In case the contract is to be signed between 1st august 08 and feb 28th 2009 the schedule shall be extended 2 to three months due to monsoon in India.	Considering order finalisation before november 2008, SEPCO will furnish revised Barchart by 10.10.08
14	Bidder to confirm that the completion of a delivery activitiy means receipt of materials at site.	sepco confirmed
15	Milestone I101012 Base Design Completed should be read as "Base Design submitted for review"	sepco confirmed
16	Bidder has indicated the start and completion of BOP activties common for all the units under erection & commissioning. Bidder to clarify.	SEPCO will furnish revised Barchart by 10.10.08
17	Bidder has indicated 230KV Switchyard instead of 400 KV. Bidder to rectify.	SEPCO will furnish revised Barchart by 10.10.08

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MEETING ON 27.09.08 FOR BID CLARIFICATION FOR 6x600 MW or 5x660MW POWER PLANT AT NARIYARA, CHATTISGARH

Sr.No	WPCPL's Comments on SEPCO's Project Completion Schedule vs Bar Chart	Resolution
18	Bidder to indicate switchyard commissioning activity in the barchart	SEPCO will furnish revised Barchart by 10.10.08
19	Bidder to indicate Startup/Standby boiler commissioning activity in the barchart	SEPCO will furnish revised Barchart by 10.10.08
20	Bidder to indicate engineering, Procurement & manufacturing activity for distribution transformer.	SEPCO will furnish revised Barchart by 10.10.08
21	Bidder to indicate engineering, Procurement & manufacturing activity for cable trays & cables.	SEPCO will furnish revised Barchart by 10.10.08
22	Bidder to elaborate activites under " Other Electrical system installation"	SEPCO will furnish revised Barchart by 10.10.08
23	Bidder to elaborate activites under " Other I&C system installation"	SEPCO will furnish revised Barchart by 10.10.08
24	Bidder to indicate engineering, Procurement & manufacturing activity for " Other Electrical system installation".	SEPCO will furnish revised Barchart by 10.10.08
25	Bidder to indicate engineering, Procurement & manufacturing activity for " Other I&C system installation".	SEPCO will furnish revised Barchart by 10.10.08
26	Bidder to note that Aux. turbine foundation getting completed in 24th month while Aux. turbine installation getting started in 22nd month. Bidder to elaborate.	SEPCO will furnish revised Barchart by 10.10.08
27	Bidder to note that material acceptance by the Owner at site should be considered while considering the duration between material delivered at site & its erection	SEPCO will furnish revised Barchart by 10.10.08
28	Activity I104070 CHP Civil design drawing has planned period of 9 months which is on the higher side.	SEPCO will furnish revised Barchart by 10.10.08
29	Activity I102370 Purchase Order for HP - "HP" to be elaborated.	SEPCO will furnish revised Barchart by 10.10.08
30	The duration indicated for activity I202520 & I202580 does not meet the graphically represented period	SEPCO will furnish revised Barchart by 10.10.08
31	There is zero lag between the Completion of 2nd, 3rd, 4th, 5th boilers last despatch steel structure and the starting of supply of 3rd, 4th, 5th and 6th boilers last despatch steel structure. However there is 30 days lag between Completion of 1st boiler's last despatch steel structure and the starting of supply of 2nd despatch steel structure. Bidder to check the possibility of reducing this lag to zero	SEPCO will furnish revised Barchart by 10.10.08
32	There is 90 days lag between the start of boiler steam water separating device of 4th & 5th unit. However there is 120 days lag between start of boiler steam water separating device of 5th & 6th unit. . Bidder to check the possibility of reducing this lag to 90 days	SEPCO will furnish revised Barchart by 10.10.08

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MEETING ON 27.09.08 FOR BID CLARIFICATION FOR 6x600 MW or 5x660MW POWER PLANT AT NARIYARA, CHATTISGARH

Sr.No	WPCPL's Comments on SEPCO's Project Completion Schedule vs Bar Chart	Resolution
33	There is 90 days lag between the start of boiler other parts & equipment to site for 4th & 5th unit. However there is 120 days lag between start of start of boiler other parts & equipment of 5th & 6th unit. . Bidder to check the possibility of reducing this lag to 90 days	SEPCO will furnish revised Barchart by 10.10.08
34	There is 60 days lag between the start of 2nd, 3rd, 4th, 5th ESP Foundations. However there is 180 days lag between start of 1st & 2nd ESP foundation and 120 days lag between 5th and 6th ESP Foundation. Bidder to check the possibility of reducing this lag to 60 days.	SEPCO will furnish revised Barchart by 10.10.08
35	There is 60 days lag between the start of 1st, 2nd, 3rd, 4th, 5th Boiler aux Foundations. However there is 90 days lag between start of 5th & 6th Boiler Aux foundation. Bidder to check the possibility of reducing this lag to 60 days.	SEPCO will furnish revised Barchart by 10.10.08
36	There is 60 days lag between the start of 1st, 2nd, 3rd, 4th, 5th Boiler Foundations. However there is 90 days lag between start of 5th & 6th Boiler foundation. Bidder to check the possibility of reducing this lag to 60 days.	SEPCO will furnish revised Barchart by 10.10.08
37	There is 30 days lag between the start of 2nd, 3rd, 4th, 5th and 6th units' cable instrumentation manufacture and delivey to site. However there is 180 days lag between start of 1st & 2nd cable instrumentation manufacture and delivey to site. Bidder to clarify	SEPCO will furnish revised Barchart by 10.10.08
38	There is 0 days lag between the start of 2nd, 3rd, 4th, 5th and 6th units' Other pipeing & pipe fittings manufacture and delivery to site. However there is 75 days lag between start of 5th & 6th Other pipeing & pipe fittings manufacture and delivery to site. Bidder to Clarify.	SEPCO will furnish revised Barchart by 10.10.08
39	There is 60 days lag between the start of 2nd, 3rd, 4th, 5th and 6th units' MS HR CR FD pipe manufacture and delivery to site. However there is 135 days lag between start of 5th & 6th MS HR CR FD pipe manufacture and delivery to site. Bidder to Clarify.	SEPCO will furnish revised Barchart by 10.10.08
40	There is non - uniformity in time lag between the supplies of CW Pump and CWP for the 6 units. Bidder to Clarify.	SEPCO will furnish revised Barchart by 10.10.08

27-09-08

MEETING ON 27.09.08 FOR BID CLARIFICATION FOR 6x600 MW or 5x660MW POWER PLANT AT NARIYARA, CHATTISGARH

Sr.No	WPCPL's Comments on SEPCO's Project Completion Schedule vs Bar Chart	Resolution
41	There is 6 month gap between the completion of procurement and start of manufacture of 1st Unit mill. Bidder to clarify.	SEPCO will furnish revised Barchart by 10.10.08
42	There is 330 days gap between the completion of procurement and start of manufacture of 1st Transformer . Bidder to clarify.	SEPCO will furnish revised Barchart by 10.10.08
43	The above note is applicable for project schedule of Supercritical Power Plant also.	SEPCO will furnish revised Barchart by 10.10.08
44	WPCPL informed SEPCO to provide construction and erection philosophy along with laydown area, fabrication and storage yard duly marked in site plan	SEPCO will furnish by 10.10.08

Annexure – I

PROJECT COMPLETION SCHEDULE vs BAR CHART AS IN SEPCO's OFFER

Sr. No.	Activity	S/F		Unit-1 600 MW		Unit-2 600 MW		Unit-3 600 MW		Unit-4 600 MW		Unit-5 600 MW		Unit-6 600 MW	
				PCS	Bar Chart	PCS	Bar Chart	PCS	Bar Chart	PCS	Bar Chart	PCS	Bar Chart	PCS	Bar Chart
A.	**Boiler**														
1	Commencement of Boiler Supplies	S		12	13	16	17	20	21	24	25	28	29	32	33
2	Commencement of Boiler erection	S		13	13	17	17	21	21	25	25	29	29	33	33
3	Boiler Drum lifting	F		21	20	25	24	29	28	33	32	37	36	41	40
4	Hydraulic Test – Drainable	F		29	29	33	33	37	37	41	41	45	45	49	49
5	Hydraulic Test - Non drainable														
6	Completion of Boiler Supplies	F		24	25	28	28	32	30	36	33	40	36	44	40
B.	**Turbine & Generator**														
1	Commencement of TG Supplies	S		14	14	18	17	22	21	26	25	30	29	34	33
2	Commencement of Condenser Erection	S		20	22	24	26	28	30	32	34	36	38	40	42
3	Commencement of Main TG/ Pump Erection	S		24	24	28	28	32	32	36	35	40	39	44	43
4	Stator Lifting	S		24		28		32		36		40		44	
5	Completion of leveling & alignment of cylinders	F		26		30		34		38		42		46	
6	Completion of centering of rotor	F		28		32		36		40		44		48	
7	Boxing up of Turbine	F		31	31	35	35	39	39	43	43	47	47	51	51
8	Boxing up of Generator			30		34		38		42		46		50	
9	Oil flushing start	S		31	31	35		39		43		47		51	
10	Oil flushing complete	F		33	33	37		41		45		49		53	
11	Completion of Governing system & Barring Gear	F		34		38		42		46		50		54	
12	Completion of TG Supplies	F		23	23	27	27	31	31	35	35	39	39	43	43
C.	**Commencement of Civil Works**			5		5		5		5		5		5	
D.	**Balance of Plant systems**														
1	Commencement of Supply of Balance of Plant Systems and Equipment	S		15		15		15		15		15		15	
2	Commencement of Erection of Coal Handling Plant	S		25	24	23		23		23		23		23	
3	Commencement of Erection of Ash Handling Plant	S		30	29	30		30		30		30		30	
4	Commencement of Erection of Water Supply and Treatment Plant	S		22	22	22		22		22		22		22	
5	Commencement of Erection of CW and ACW System	S		23	23	23		23		23		23		23	
6	Commencement of Erection of Air Conditioning and Ventilation System	S		25		25		25		25		25		25	
7	Commencement of Erection of Fuel Oil Handling Plant	S		27	27	27		27		27		27		27	
8	Commencement of Erection of Compressed Air Plant	S		22	22	22		22		22		22		22	
E.	**Commissioning Activities**														

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Annexure-1

Sr. No.	Activity	S/F		Unit-1 600 MW		Unit-2 600 MW		Unit-3 600 MW		Unit-4 600 MW		Unit-5 600 MW		Unit-6 600 MW	
1	Commissioning of Water Supply and Water Treatment Systems	S		27	28	27		27		27		27		27	
2	Commissioning of Fuel Oil System and Compressed Air System	S		30	30	30		30		30		30		30	
3	Commissioning of Coal Handling System	S		30	30	30		30		30		30		30	
4	Boiler Light up	S		33	33	37	37	41	41	45	45	49	49	53	53
5	Alkali Boil out and acid cleaning			33		37		41		45		49		53	
6	Steam Blowing			33		37		41		45		49		53	
7	Safety valve floating			35		39		43		47		51		55	
8	Rolling of Turbine	S		34		38		42		46		50		54	
9	Unit Synchronisation	F		35	35	39		43		47		51		55	
10	Coal Firing			35		39		43		47		51		55	
11	Commissioning of Ash Handling System	S		33	33	33		33		33		33		33	
12	Commissioning of Waste Water Handling and Treatment System	S		32		32		32		32		32		32	
13	Trial Operation	F		36		40		44		48		52		56	
14	PG Test of Boiler, Turbine, Generator & other packages	F		39		43		47		51		55		59	
F.	**Mandatory and Recommended Spares**														
1	Completion of Supply	56 vs ?													

S - Starting from
F - Finishing by

Note:
1. The barchart does not reflect all the milestone of the 'Project Completion Schedule' (these miletones are indicated by blank cells). SEPCO-1 should indicate all the milestones in the Project Completion Schedule.
2. The barchart should reflect the start and finish dates of the activities.
2. When the activities of the Project Milestone are compared with those of barchart, time difference is found (these are highlighted in blue colour).

BID CLARIFICATION FOR 3600 MW COAL BASED POWER PROJECT AT NARIYARA, CHHATISGARH

TECHNICAL BID FOR 6 x 600 MW SUB CRITICAL UNIT

Bidder's Name & Address :SEPCO-I

ANNEXURE-A1
DATE : 27-09-08

MECHANICAL AND GENERAL TECHNICAL COMMENTS-I

Discipline - Mechanical

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
1	Volume-II, Section-3-III	-	Scope of supply	Please confirm that grading of entire area including green belt area is included in their scope.	As per Annexure-C, description of Scope of supply, SEPCO confirmed grading of entire area including green belt area included in their scope.
2	Volume-II, Section-3-III	-	Zero Discahrge	Please provide the water balance for the complete plant showing zero discharge condition. Scheme for Waste water treatment system shall be furnished. In this connection, it shall be noted that the total water supply system (Pre-treatment plant, CT-makeup etc.) equipments/plants shall be rated for power plant operation considering RO Plant out of operation.	SEPCO undestood the requirement and agreed.
3	Volume-II, Section-3-III	-	Vendors List	The vendors list shall be furnished by the Bidder. Vendors of plant items also shall be furnished.	SEPCO will provide vendor list by 27.09.08
4	Volume-II, Section-3-III	Cl.3.1.2, Pg. No.361	CHP operational Hours	CHP operation hours per days shall be maximum 16 hrs instead of 20 hrs.	SEPCO agreed to provide 1800 TPH CHP capacity for each phase which will meet 16 hrs opration requirement.
5	Volume-II, Section-3-III	Cl.3.2.1, Pg. No.361	Min. Load Without Oil Support, Type of Boiler	Minimum load without oil support shall be 30% as per specification instead of 45%. The boiler is indicated as natural circulation type. For 600 MW rating assisted circulation is expected. SEPCO tc check & confirm.	SEPCO confirmed to provide minimum load without oil support of 40%. SEPCO also informed that boiler is natural circulation type.
6	Volume-II, Section-3-III	Cl.3.2.2, Pg. No.363	Unburnt Carbon loss	Max. Unbrunt carbon loss of 0.5% in Fly ash shall be reconfirmed. Please refer Sec-V, Cl. F-6, Pg.3 of 18 for calculation of unburnt carbon.	SEPCO confirmed 0.6% of maximum unburnt carbon in fly ash.
7	Volume-II, Section-3-III	-	Coal Combustion System	The flame scanner shall be able to detect both coal flame and discriminating flame at all the burner levels.	SEPCO agreed.
8	Volume-II, Section-3-III	Cl.3.2.3, Pg. No.363	Mills	Please confirm that one stand-by mill is available during worst coal firing at BMCR load.	SEPCO agreed.

27/9/08

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
9	Volume-II, Section-3-III	Cl.3.2.3, Pg. No.363	Mills	Please indicate the type of mill envisaged / offered. The mills shall be suitable for handling worst coal of moisture upto 15% and HGI of 45. Mills shall be designed for the inlet coal of (-) 20 mm size and excersion of 10% upto (-) 25 mm coal size. The mills shall be designed accordingly.	SEPCO confirmed provision of MPS (Vertical Spindle) bowl mill . SEPCO agreed.
10	Volume-II, Section-3-III	Cl.3.2.3, Pg. No.363	Mills	Wear life of grinding component of the Mill shall be not less than 8000 hrs. Pulverised fuel handling system shall include safety features as per NFPA guidelines.	SEPCO agreed.
11	Volume-II, Section-3-III	Cl.3.2.3, Pg. No.363	Coal pipe	Velocity in the coal pipe shall be limited to 15 to 22 m/sec, as specified.	SEPCO confirmed that velocity in the coal pipe shall be 22 -28 m/sec with Ceramic lining inside coal pipe bends and 2D length on the downstream, if space is available.
12	Volume-II, Section-3-III	Cl.3.2.4, Pg. No.362	FD Fan Capacity	Each fan capacity shall be 60% BMCR capacity, as specified.	SEPCO agreed.
13	Volume-II, Section-3-III	Cl.3.2.4, Pg. No.363	ID Fan Capacity	Each fan capacity shall be 60% BMCR capacity, as specified.	SEPCO agreed.
14	Volume-II, Section-3-III	Cl.3.2.4, Pg. No.363	PA Fan Capacity	Each fan capacity shall be 60% BMCR capacity, as specified. The capacity shall be adequate to take care of the transient condition when a standby mill is changed to working mode.	SEPCO agreed.
15	Volume-II, Section-3-III	Cl.3.2.4, Pg. No.363	PA/FD/ID Fan	PA/FD/ID Fans shall be provided with Blade pitch control/ Hydraulic coupling or VFD for capacity control at verrying loads. In Case of Hydraulic coupling it should be Voith, Germany make only.	SEPCO confirmed blade pitch control for PA/FD fans. WPCPL insisted for radial fans (low speed) with VFD for speed control in place of stator vane control ID fans as specified by SEPCO. SEPCO agreed. SEPCO to revert on provision of double suction type of ID fan.
16	Volume-II, Section-3-III	Cl.3.2.4, Pg. No.363	Min. Load on Coal with Oil Support	Minimum load firing coal with oil support shall be 40% as per specification. i.e. first mill shall be introduced at 20% in cold start.	SEPCO agreed.
17	Volume-II, Section-3-III	Cl. 3.2.5.5, Pg. No.363	Hoist and Lift	Please confirm provision of motorised hoisting equipment of weight above 1 Te instead of above 2 Te.	SEPCO agreed.
18	Volume-II, Section-3-III	Cl. 3.2.5.5, Pg. No.363	Hoist and Lift	Passenger cum goods elevator for each Boiler, Stack elevator for each stack, admin building elevator, two elevator for TG building and one capsule lift for control room shall be provided as per scope of supply of specification. Besides, elevators shall be provided for crusher houses and the transfer tower before bunker.Please indicate the capacity of each lift offered.	SEPCO agreed except for elevator in crusher house and transfer tower.
19	Volume-II, Section-3-III	Cl. 3.3.1, Pg. No.363	EOT Crane	Please confirm the EOT cranes provided within TG building can safely lift even the heaviest componet of TG (except Generator Stator) & Generator Tansformer during maintenance.	SEPCO agreed to provide three (3) numbers EOT cranes for 6 x 600 MW.
20	Volume-II, Section-3-III	Cl. 3.3.1, Pg. No.365	Steam Turbine	Exhaust hood spray system to be provided for LP Turbine.	SEPCO agreed.

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	Volume/Section/ Part/ Chapter no	Clause no / Page no			
21	Volume-II, Section-3-III	Cl. 3.3.1, Pg. No.365	Steam Turbine	Exhaust hood shall be equipped with pressure relief bursting diaphragms to limit the exhaust hood pressure within safe margin.	SEPCO agreed.
22	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	Provision for wet steam washing to be kept for HP & IP Turbine.	As per the standard practice of manufacturer
23	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	Please also confirm 60% HP & LP bypass capacity is provided.	SEPCO agreed.
24	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	If Bolt heating is required for Turbine casing parting plane Bolts, Bolt heating equipment shall be included in the Special tools to be supplied alongwith TG (one per each phase).	SEPCO agreed.
25	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	Please confirm two (1W + 1S) Exhaust Fans shall be provided for Gland Steam Condenser.	SEPCO agreed.
26	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	[illegible] main steam pressure. The [illegible] turbine shall be completely controlled when the pressure falls to a further preset low point and it shall admit only sufficient steam to keep the machine running at full speed on house load. Provision shall be made to adjust or bypass this initial pressure regulator at start up condition to facilitate starting with low steam pressure. Contacts shall be provided on the initial steam pressure regulating gear for signaling pressure unloading gear operation and pressure unloading gear reset."	SEPCO shall revert by 27.09.08
27	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	For non-return valves of extraction lines hydraulic actuators instead of pnumatic actuators is preffered for quick actuation. Please check.	SEPCO shall revert by 27.09.09
28	Volume-II, Section-3-III	Cl. 3.3.3, Pg. No.365	Condenser	It is indicated that the condenser is with 'Once through sea water cooling system' which is not applicable here. Debris filter need not be provided. Only, online condenser Tube cleaning system is required.	SEPCO agreed.
29	Volume-II, Section-3-III	Cl. 3.3.3, Pg. No.365	Condenser	LP casing shall be fitted with rupture disc. The condenser design shall be as per HEI of USA.	SEPCO agreed.
30	Volume-II, Section-3-III	Cl. 3.3.3, Pg. No.365	Condenser	Please confirm the hot well capacity shall be minimum 3 minutes of CEP discharge capacity as specified in Sec-II, S-V, Page.15.	SEPCO agreed.
31	Volume-II, Section-3-III	Cl. 3.3.3, Pg. No.365	Condenser Vacuum Breaker	Vacuum breaker permitting rapid reduction of vacuum in condenser with remote operation shall be provided. The valve shall be of gate type with provision of sealing against leakage of air.	SEPCO agreed.

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	Volume/Section/ Part/ Chapter no	Clause no / Page no			
32	Volume-II, Section-3-III	Cl. 3.3.3, Pg. No.365	Condenser	Tube material for condenser and air ejecto· condenser shall be of Stainless Steel.	SEPCO agreed to provide SS material for condenser tubes. However as 2 x 100% vacuum pumps are provided, ejector is not applicable.
33	Volume-II, Section-3-III	Cl. 3.3.4, Pg. No.365	ACW/ECW System	Type and no. of heat exchangers for closed loop DM ACW system shall be indicated.	Plate type heat exchangers shall be provided
34	Volume-II, Section-3-III	Cl. 3.3.4, Pg. No.365	ACW/ECW System	Please confirm plate type heat exchangers shall be provided for each unit separately with 100% standby. (2 x 100%)	SEPCO agreed.
35	Volume-II, Section-3-III	Cl. 3.3.5, Pg. No.365	BFP	Motor driven BFP shall be of 50% Capacity as specified instead of 30% as this is required as both startup and standby	SEPCO agreed.
36	Volume-II, Section-3-III	Cl. 3.3.5, Pg. No.365	BFP	Hydraulic coupling for Boiler feed pump shall be of Voith, Germany make only. No other alternative is acceptable.	SEPCO agreed.
37	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	Please provide flow sheet/ P &ID of the system offered for clarification regarding scope of supply. Please elaborate the system provided.It appears that only LDO system is offered. As clarified during the pre-bid meeting, both HFO and LDO system shall be offered.	SEPCO agreed.
38	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	2 x 100% unloading system shall be provided instead of 2 x 50% for HFO and LDO from rail wagons unloading system.	SEPCO agreed.
39	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	Four (4) x 2000 m3 HFO tanks and Two (2) x 1000 m3 LDO tanks shall be provided, as specified.	SEPCO agreed.
40	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	HFO and LDO transfer pumps shall be provided with suction strainers, heaters for HFO system steam tracing shall be provided.	SEPCO agreed.
41	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	Please confirm provision of drain oil pit and relevant system of oil recovery.	SEPCO agreed.
42	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	It shall be noted that oil tanks as well as dyke volume shall be designed with 20% margin as per INDIAN PETROLEUM RULES and CCOE guidelines.	SEPCO agreed.
43	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	HFO heating and pressurising system, HFO day and main tanks heating, transfer system to be elaborated.	SEPCO agreed to provide day oil tank for HFO handling one for each phase. In case of LDO , no day oil tank is provided, it shall be directly pumped from bulk storage LDO tank.
44	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	The capacity of HFO / LDO oil unloading, transfer and supply pumps to be indicated.Drive motor of HFO/LDO pumps shall be flame proof.	SEPCO agreed.
45	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	Condensate collection tank and pumps shall also be provided for Heavy Fuel Oil system.	SEPCO agreed.
46	Volume-II, Section-3-III	Cl. 3.4.1, Pg. No.366	Fuel Oil System	Required control valves to be provided for temperature control of oil tanks and heaters.	SEPCO agreed.

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	Volume/Section/ Part/ Chapter no	Clause no / Page no			
47	Volume-II, Section-3-III	Cl. 3.4.3, Pg. No.366	Inst/ Service Compressed Air system	Please provide flow sheet/P&ID of the system offered. It is presumed that each of two phases are provided with 2 x 50% air compressor without standby. One standby compressor for each phase shall be provided. Separate compressor and compressed air system shall be provided for Coal handling and Ash handling system.	SEPCO agreed to provide compressed air system as per Bid specification and One standby compressor for each phase. SEPCO also agreed to provide separate compressor for CHP and AHP.
48	Volume-II, Section-3-III	Cl. 3.4.3, Pg. No.366	Inst/ Service Compressed Air system	Please elaborate the type of compressor and capacity of each compressor, dryer and air receiver as explained in the Specifiacations. Please note that adsorption type air dryer with desiccator shall be provided.Heatless type air dryer is not acceptable.	SEPCC agreed to provide all instrument air compressors will be oil free screw type. For Service air, oil lubricated screw type air compressor will be provided.
49	Volume-II, Section-3-III	Cl. 5.0, Pg. No.373	Coal handling system	Please provide three (3) track hopper, each shall be of 4500 Te capacity. Please provide suitable interconnection at discharge from two stacker reclaimers. However, Two conveying streams each with 100% standby conveyors are acceptable.	SEPCO agreed.
50	Volume-II, Section-3-III	Cl. 5.0, Pg. No.374	Coal handling system	Please indicate the bunker storage of each unit is provided as 8 hrs. It should be minimum 10 hrs as per specification.	SEPCO agreed.
51	Volume-II, Section-3-III	Cl. 5.0, Pg. No.374	Coal handling system	Please provide interconnection with reversible conveyors between two conveying systems before boiler bunkers. Each stream shall feed 3 units 600 MW each. Minimum 1800 TPH capacity of CHP shall be provided for both phases. The stacking & reclaiming capacity for both stacker/reclaimer shall be minimum 1800 TPH.	SEPCO agreed to provide interconnection at discharge side of two stacker reclaimer. SEPCO agreed to provide CHP capacity of minimum 1800 TPH for each phase with 100% standby stream
52	Volume-II, Section-3-III	Cl. 5.0, Pg. No.374	Coal handling system	Bidder to confirm that CHP is suitably designed for operation of all equipments on continuous basis. In addition, Bidder should also confirm operation of both the streams of Phase-I and Phase-II at a time in case of emergency.	SEPCO agreed.
53	Volume-II, Section-3-III	Cl. 5.0, Pg. No.375	Coal handling system	For volume calculation, belt sizing coal density of 800 kg/cu.m shall be considered.Density of 1100 kg/Cu.m shall be considered for structural design of CHP.	SEPCO agreed.
54	Volume-II, Section-3-III	Cl. 5.0, Pg. No.375	Coal handling system	Bidder to confirm 1 m walkways on both sides and between both the conveyors shall be provided, as specified.	SEPCO agreed.
55	Volume-II, Section-3-III	Cl. 5.0, Pg. No.375	Coal handling system	Lifts shall be provided one each in crusher house and one number in the interconnecting TPs before bunkers.	Not required
56	Volume-II, Section-3-III	Cl. 5.0, Pg. No.375	Coal handling system	Stacker reclaimer shall be associated with reversible conveyors. Stockyard shall be provided with 15 days coal storage instead of 7 days as mentioned in offer.	SEPCO agreed.
57	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Stacker reclaimer shall be provided with one belt scale to control the feed rate as per operation requirement.	Not required
58	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Height of shed over track hopper shall be suitable to receive electric locomotive.	SEPCO agreed.

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	Volume/Section/ Part/ Chapter no	Clause no / Page no			
59	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Crusher shall be designed for coal outlet size of (-) 25 mm with excursion upto 10% for (-) 30 mm. Metal detectors shall be provided before Bunkers and Crushers.	SEPCO agreed.
60	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Coal settling pond shall be provided with adequate capacity pumps & piping to ensure proper evacuation	SEPCO agreed.
61	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Track hopper shall have three(3) escape routes for safety of personnel.	SEPCO agreed.
62	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Ventilation and drainage along with sump pumps to be provided for track hopper, crusher house and all transfer tower.	SEPCO agreed.
63	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	All Tunnels should have escape points on each end.	SEPCO agreed.
64	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Device for detection of longitudinal tear of belt to be provided for each belt.	SEPCO agreed.
65	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Belt scales shall be provided at the outlet of Track hoppers and inlet of Bunkers.	SEPCO agreed.
66	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Belt scale shall have totalizer & flow indicator monitoring. Accuracy level shall be max. +/- 0.2%. One spare belt scale shall be provided.	SEPCO agreed.
67	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	On line Rail weigh bridge (2 nos of 120 Te capacity) to be provided, as specified for each track hopper.	SEPCO agreed to provide two rail weigh bridge of 120 Te capacity for each track hopper (total 6 numbers)
68	Volume-II, Section-3-III	Cl. 5.0, Pg. No.374-378	Coal handling system	Maintenance hoists to be provided at all suitable/ required location in the Coal handling system .	SEPCO agreed.
69	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	All chutes shall be provided with Door for Cleaning & poking	SEPCO agreed.
70	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Clear Height of conveyor gallery & tunnel everywhere shall be minimum 3.0 m after accommodating ventilation & fire protection system.	SEPCO agreed.
71	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Fluid coupling shall be provided for conveyor with motor rating more than 30kW. Hydraulic motors (Without any gear drive) shall be provided for CHP equipments and auxiliaries such as Paddle feeder, Bucket wheel drive of stack/reclaimer etc.	SEPCO agreed except for paddle feeder
72	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Galleriers with windows and translucent sheet for proper lighting shall be provided.	SEPCO agreed.
73	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	All surfaces of the chutes liable to come into contact with coal shall have sufficient lining to assist free flow of coal to minimize wear.	SEPCO agreed.
74	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Medium Velocity Spray system shall be provided as protection measure in conveyor galleries.	SEPCO agreed.
75	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Emergency emptying system for raw coal bunkers shall be provided.	SEPCO agreed.

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
76	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	Bunker coal level indicators (Radar non-contact type) shall be provided.	SEPCO agreed.
77	Volume-II, Section-3-III	Cl. 5.0, Pg. No.376	Coal handling system	As received auto sampling arrangement shall be provided over the railway track hopper.	SEPCO agreed.
78	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please note that Coarse ash system shall be desiged considering 10% of total Fly ash. (5% for economiser and 5% for air preheater) as specified.	SEPCO agreed.
79	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please provide Vacuum cum pressure conveying of fly ash from ESP to buffer vessel as per specification instead of pressure conveying.	SEPCO agreed for dense phase pneumatic system.
80	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please provide fly ash hopper storage capacity as 8 hrs.	SEPCO agreed.
81	Volume-II, Section-3-III	Cl. 6.2.2, Pg. No.380	Mill reject system	Mill reject system shall be designed considering 1% of total coal at worst condition.Mill reject conveying is proposed by fork lift truck which is not acceptable. Please provide dense phase pnumatic conveying or by conveyor system as per tender specification.The mill reject shall be transported upto mill reject silo-separate for each unit.	SEPCO agreed. SEPCO shall provide vibration conveyor system
82	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please confirm provision of HP and LP ash water pumps, seal water pumps, fly ash silo floor washing pumps, refractory cooling water pumps, drainage pumps for Ash handling pump house area as per specification.	SEPCO agreed.
83	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please confirm that all the pumps and ash handling system will be located in enclosed buildings.	SEPCO agreed.
84	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please provide bottom ash over flow clarification, pumping system including tube settler, overflow sump pumps, sludge pumps etc. Please indicate method system envisaged for maintaining temp of bottom ash cooling water.ACW system may be utilised for this purpose.	A) SEPCO confirmed to provide bottom ash slurry pumps for dumping ash to ash dump yard including piping. B)Clarification and tube settler is not required. C) Ash water recovery pumps and water tank (civil works) will be provided
85	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please provide ash water recirculating system from ash dyke area as per specification. The ask dyke also shall be included in scope. Refer attached Ash Dyke calculation sheet. Bidder shall provide Ash Dyke drg. with cross section.	SEPCO agreed. SEPCO shall provide optional price for complete ash dyke civil works.
86	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please provide separate ash water pumps for HCSD system alongwith water sump.	SEPCO agreed.
87	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please confirm ash water storage tank shall have minimum 60 minutes of required ash water firing worst coal.	SEPCO agreed for 20 minutes capacity.
88	Volume-II, Section-3-III	Cl. 6.0, Pg. No.377	Ash handling system	Please confirm ash silos are suitable for holding 12 hrs of ash generated by all units while firing worst coal instead of design coal as per specification	SEPCO agreed.

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
89	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	The submerged conveyor system is not acceptable. Bidder shall provide water impounded hopper with feed gate. clinker grinder and Jet pump system having 100% standby as explained in the Bid Specs. Please ensure that entire bottom ash handling system shall be above ground.	SEPCO agreed to provide bottom ash system as asked by WPCPL. Bottom ash hoppers shall have 8 hours of storage capacity.
90	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	Please indicate the size reduction achieved in the primary clinker grinder. It shall be less than 25 mm.	SEPCO agreed.
91	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	Please note that secondary Clinker grinder is not required in this system.	SEPCO agreed.
92	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	Please indicate the BA slurry concentration for design of slurry pumping system.	SEPCO agreed for 15 to 20 % by weight
93	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	Description of the BA slurry pumps (type, capacity and head) to be provided. Bidder shall provide GA drg incldng & upto ash dyke alongwith water recovery system.	During detail engineering
94	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	Please provide the BA slurry sump capacity in terms of hours storage.	SEPCO agreed for 20 minutes capacity of slurry sump.
95	Volume-II, Section-3-III	Cl. 6.0, Pg. No.378	Bottom Ash system	Please indicate the major parameters of HP pumps and LP pumps (Rated capacity, head, motor rating and materials).	SEPCO agreed.
96	Volume-II, Section-3-III	Cl. 6.0, Pg. No.379	Fly Ash system	Please provide the rate of collection of ash (t/h) from all ash hoppers.	SEPCO agreed.
97	Volume-II, Section-3-III	Cl. 6.0, Pg. No.379	Fly Ash system	Fly ash silos shall be provided with regular staircase.	SEPCO agreed.
98	Volume-II, Section-3-III	Cl. 6.0, Pg. No.379	Fly Ash system	Evacuation time for ash removal from ash hopper to be indicated. Please design the evacuation system considering 8 hrs hopper storage at BMCR with worst coal to be evacuated in 4 hrs.	Evacuation rate of the system shall be 200TPH for fly ash
99	Volume-II, Section-3-III	Cl. 6.0, Pg. No.379	Fly Ash system	Fluidising air requirement and number of fluidizing blowers may be indicated.	SEPCO agreed. Number to provided at detailed engineering stage.
100	Volume-II, Section-3-III	Cl. 6.0, Pg. No.379	Ash dyke	Ash Dyke shall be designed as per Bid specs. Bidder to provide Boreholes in the Ash Dyke area for monitoring the ground water quality. (12 Nos.)	SEPCO to quote optional price for ash dyke.
101	Volume-II, Section-3-III	Cl.VII-A, M11, Pg. No.675	NDCT	Design approach in the data sheet is mentioned as 8.8 Deg.C. Please note that APPROACH= Cold Water Temp. -WBT. Please check whether 8.8 Deg.C is temp difference between Cold Water Temperture and Hot Water Temperature.	SEPCO confirmed Approach shall be optimised during detailed engineering
102	Volume-II, Section-3-III	Cl. 7.5.3, Pg. No.385	NDCT	Please confirm thermal design of NDCT will be as per WBT of 28 Deg.C, 60% RH, Approach = 5.0 Deg.C.	SEPCO confirmed thermal design of NDCT will be as per WBT of 28 Deg.C, 60% RH, Approach shall be optimised during detailed engineering. This approach/cooling water temperature difference/rise shall be demonstrated during plant performance trials

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
103	Volume-II, Section-3-III	Cl. 7.1, Pg. No.380	Raw water system	Water requirement of 7625 m3/hr for 6 x 600 MW seems to be less. Please note that the water supply pumps & treatment equipment are to be sized considering no water recovery from RO Plant.Total capacity for two phases shall be about 2 x 5200 m3/hr. However,waste water treatment and recovery shall be provided, as specified.	SEPCO confirmed raw requirement as 9000 cu.m/Hr for 6X600MW. The water supply pumps & treatment equipment are to be sized considering no water recovery from RO Plant. However,waste water treatment (RO plant)and recovery shall be provided, as specified. The complete system shall be provided to achieve zero discharge.
104	Volume-II, Section-3-III	Cl. 7.2, Pg. No.380	Raw water system	As per amendment issued, please note that water reservoir capacity should be 12,00,000 Cum.	SEPCO Confirmed
105	Volume-II, Section-3-III	Cl. 7.3, Pg. No.381	Raw water system	Please confirm clarified water storage is of 4 hrs capacity of total water requirement.	SEPCO Confirmed
106	Volume-II, Section-3-III	Cl. 7.3, Pg. No.381	Raw water system	Chlorination system for raw water, pre-treatment and for cooling water system (by chlorine gas from chlorine Tonners) shall be provided.	SEPCO Agreed
107	Volume-II, Section-3-III	Cl. 7.3, Pg. No.381	Raw water system	Please note that dead storage of water in the raw water reservoir shall be adequate for Fire water requirement. The fire water storage shall be as per TAC/LPA recommendation.	SEPCO shall use clarified water and storage capacity sall be as per TAC/LPA recommondation
108	Volume-II, Section-3-III	Cl. 7.3, Pg. No.381	Raw water system	Please provide two overhead potable water storage tanks on TG building each of 50 m3.	The potable water system shall be provided with ground sump and VFD control pumps (2X100%)
109	Volume-II, Section-3-III	Cl. 7.4, Pg. No.383	Waste water Effluent treatment	Please provide UF and RO plant details such as capacity, recovery rate, utilisation of RO reject etc.	During detailed engineering
110	Volume-II, Section-3-III	Cl. 8.0, Pg. No.385-388	Fire fighting system	The capcity of fire water pumps for hydrant system shall be guided by total number of hydrants as per TAC/LPA guidelines. Two motor driven , one diesel engine driven, two jockey pumps (including one standby) shall be provided. The capacity and head for spray system pumps and hydrant system pumps shall be same.	SEPCO Agreed to provide as per TAC/LPA.
111	Volume-II, Section-3-III	Cl. 10.0, Pg. No.428	DM plant	Please confirm Three (2 W+1S) streams, capacity of each stream shall be of 216 TPH and regeneration time less than of 4 hrs.	SEPCO agreed.
112	Volume-II, Section-3-III	Cl. 10.0, Pg. No.429	DM plant	Please note that the revised design water quality forwarded to all Bidders (by Email dated July 17, 2008) shall be cosidered for water system design. It is reattached herewith for quick reference. Please ignore the water quality provided in your offer.	SEPCO Noted.

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
127	Volume-II, Section-3-III	-	General	All P&I Diagrams and system drawings to be furnished with the offer specifically Steam, Condensate, Fuel oil, Compressed air, Fire fighting system, HVAC, CW and ACW systems CHP AHP, Waste Water, TSI scheme etc.	SEPCO agreed to provide P&I diagram by 10.10.08. SEPCO handed over P&ID for super-critical power plant.
128	Volume-II, Section-3-III	-	General	Please confirm first fill and consumption of requirement of all the equipments of power plant such as lube oil, grease, fire fighting (Dry powder, foam, inert gas etc.), refrigerant, chemicals etc. is in bidders scope upto successful completion of reliability test.	SEPCO agreed.
129	Volume-II, Section-3-III	-	General	Painting, Coating and wrapping specification for piping and equipments to be furnished.	SEPCO agreed.
130	Volume-II, Section-3-III	-	General	All equipment shall conform to the provisions of statutory and other regulations in force in India and / or in the state of Chharisgarh, such as the Indian Factories Act, Indian Electricity (Supply) Act, Indian Boiler Regulations, Indian Explosives Act, etc.	SEPCO agreed.
131	Volume-II, Section-3-III	-	General	Drawing submission and review will be done through software approach supported by hard copy of drawing as under: a) Submission of drawings on FTP server of i) KSK Hyderabad ii) KSK, Chennai (Engg) iii) DCPL, Vashi alongwith One Hardcopy to each. b) Review and Approval will follow the software/ftp server approach. c) Eight hard copies approved drawings for execution will be sent by SEPCO as under : i) Two copies for KSK-Hyd ii) One copy to KSK Chennai iii) One Copy to DCPL Vashi iv) Four copies to KSK Site office.Above copies will be DCPL stamped and signed. d) finally SEPCO will submit Two copies of As built drawings alognwith soft copy on CD with in 1 month before COD. e) Regarding O& M manuals Six hard copies and One soft copy will be submitted. f) Typical drawing approval procedure is separately attached as annexure-K.	SEPCO agreed.
132	ADDITIONAL COMMENTS		BOILER	The superheater and reheater temperature control system shall be designed to maintain the rated steam temperature with HP Heaters out of service from 60% to 100% BMCR.	SEPCO agreed
133			Boiler	The superheater and reheater header shall have provision of nitrogen filling.	SEPCO agreed
134			Boiler	Motorised stop valve to be provided for main Superheater outlet near Boiler.	SEPCO agreed
135			Boiler	Main steam piping material to be indicated.	P91
136			[illegible]	[illegible]	[illegible] SEPCO on Monday 29.09.08

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
137			Boiler	Superheat and Reheat steam temperature control system to be elaborated.	Superheater temperature shall be controlled by two stages spray water desuperheater. Reheater temperature primarily controlled by Burner tilting and on emergency by single stage spray water desuperheater.
138			Boiler	Boiler block insualtion shall be by ribbed Aluminium sheet.	SEPCO agreed
139			Boiler	The sealing plates shall be of 12 mm thk SS type for furnace bottom hoppers.	SEPCO agreed to provide 10 mm thick plate of SS-304 material.
140			Boiler	Gas velocity in Furnace first pass and second pass to be indicated.	SEPCO agreed to provide 12 m/sec flue gas velocity in furnace and 10 m/sec in Economiser.
141			Boiler	Fuel feeders shall be provided with variable frequency drive motor.	SEPCO agreed
142			Boiler	Sealing air piping to be provided for Mills and Coal Feeders.	SEPCO agreed
143			Boiler	Platform and staircase for Boiler shall not be less than 1000 mm wide.	SEPCO agreed to provide 1000 mm wide but wherever there is space constraint 800 mm will be provided.
144			Boiler	All high pressure valves (40 bar and above, 250 mm NB and above) shall have integral bypass valves for pressure equalization. Wherever main valve is motorised bypass valve is also motorised.	SEPCO agreed.
145			Boiler	The start up vent lines shall have one motorised isolating valve and one motorised regulating valve. (This is as per CEA guidelines)	SEPCO agreed as per IBR requirement.
146			Boiler	Start up vents with lowest set spring loaded safety valve on drum superheater and Reheater shall be provided with silencers.	SEPCO agreed.
147			Boiler	The Following criteria for furnance sizing shall be followed and confirmed by Bidder 1. Max Net Heat Input(NHI) / Unit Plan area of Furnace - 5 x 10^6 Kcal/Hr/Sq.Meter 2. Maximum Volumatric Heat liberation Rate - 1.1 x 10^5 Kcal/Hr/CUM 3. Maximum Heat input per burner 55 x 10^6 Kcal/Hr/Burner	WPCPL insisted on these requirement because these are as per CEA regulation. SEPCO to revert by 10.10.08
148			Boiler	[illegible] for each unit.	SEPCO agreed
149			Air Pre Heater	Air Heater shall have one AC motor drive, one emergency DC motor drive and air motor drive.	SEPCO agreed to provide two AC motor and One DC motor / air motor.

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
150			Air Pre Heater	The air pre heaters shall be provided with steam soot blowers as well as sonic soot blowers as per amendment-1.	SEPCO agreed to provide Steam soot blowers.
151			Air Pre Heater	Ash hopper for Air Pre Heater and duct hoppers shall be provided.	As per the Boiler manufacturers practise.
152			Air Pre Heater	Ash hopper slope shall not be less than 60°.	SEPCO agreed.
153			Air Pre Heater	The heating element on the cold end side shall be of corten steel of 1.2 mm thk and hot and intermediate elements of 0.8 mm carbon steel.	SEPCO agreed.
154			Air Pre Heater	Forced lubrication system for APH to be elaborated It shcuild have emergency DC operated pump. (1 oprating and 1 Standby) pumps	SEPCO agreed.
155			Economiser	Economiser shall be bare tube and non steaming type.	SEPCO agreed.
156			Economiser	Minimum temperature of feed water that Economiser can handle safely shall be indicated.	SEPCO confirmed Economiser will be suitable for HP heater out condition.
157			Draft system	Each ID, FD and PA fans shall be provided with lubrication system including 2 x 100% lube oil pumps, 1 x 100% oil coolers and duplex strainers.	SEPCO agreed and cooling water is DM Water.
158			Draft system	Please confirm that silencers are provided at the inlet of FD and PA fans.	SEPCO agreed.
159			Mills	Air flow measurement device to be provided at the inlet of Mills.	SEPCO agreed.
160			Mills	One set of Coal sampling system to be provided at the outlet of Mills for each unit	SEPCO agreed.
161			Mills	Mill maintenance arrangement with hoists shall be included in the scope.	SEPCO agreed.
162			Mills	Each pulveriser shall be provided with lubrication system including 2 x 100% lube oil pumps, 1 x 100% lube oil coolers, duplex filters, etc.	SEPCO agreed and cooling water is DM Water.
163			Mills	Mill hydraulic & lube oil system shall be under closed controlled environment and away from dust generated by mills.	SEPCO agreed.
164			Mills	Coal piping between coal feeder and mill shall be of abrasion resistant stainless steel.	SEPCO agreed.
165			Mills	Ceramic lining of 10 mm thickness (minimum) shall be provided for coal piping at bends (2D length onbend outlet side).	SEPCO agreed.
166			Mills	The guaranteed life of ceramic lining shall be 25,000 hrs.	SEPCO agreed.
167			ESP	[illegible]	SEPCO to revert by 27.09.08
168			ESP	Specific collection area (SCA) of the ESP shall be indicated. It shall be minimum 240 m2/m3/sec.	Not applicable as SEPCO is providing ESP+FF

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
169			ESP	NOx and SOx level at the inlet of chimney shall be indicated.	NOx shall be less than 262 ppm at 6% oxygen and SOx shall be as per sulphur content in the coal, SEPCO agreed
170			ESP	ESP hoppers to be provided with suitable heating arrangement to prevent ash build up.	SEPCO agreed.
171			ESP	Bidder to note that Guillotine type damper for ESP isolation and on line maintenance is to be furnished.	SEPCO has to provide gillotine dampers at the inlet and outlet of each pass of ESP for part maintanance. Sepco to revert by 27.09.08
172			Bag Filter for Dust Removal	Please comply the Bag filter sizing details as follow : • Specific collection area (ESP) – 25 m2/m3/sec • Gas/Cloth - Max 1 m/min • Material – PPS • Fabric filter with bypass for oil firing. Total guaranteed life of bag filter shall be minimum 30000 hrs.	SEPCO agreed.
173			ESP	Discharge electrodes shall be of Stainless Steel.	SEPCO agreed
174	ADDITIONAL COMMENTS		TURBINE	Turbine control oil and it's purification sytem to be elaborated.	Details shall be provided during detail engineering
175			Lube oil system	Turbine lube oil purification system capacity per hour (minimum) to be indicated. It shall be 20 % of the total oil in unit oil system.	SEPCO informed that the system volume is 50000 L , Oil purifier capacity 10000 LPH and System flow rate is 450 KL/H.
176			Lube oil system	Please provide Oil Centifuge to deliver oil with particles of size not higher than 2 microns.	SEPCO agreed.
177			Lube oil system	DC Jack oil pump shall also be provided apart from the AC motor driven jack oil pump.	SEPCO agreed.
178			Lube oil system	Emergency DC motor driven oil pump shall be at least 30% of the main oil pump capacity.	SEPCO agreed.
179			Lube oil system	Two (1W + 1S) Vapor extractors shall be providec for MOT	SEPCO agreed.
180			Condensate Polishing Unit	Please indicate the mode of pnumatic transfer of resins for condensate polishing units : from main plant compressed air system or by dedicated (2 x 100%) blowers.	SEPCO agreed and indicated that air shall be provided from main plant compressed air system.
181			Condensate Polishing Unit	Resin traps to be provided after each Condensate Polishing vessels.	SEPCO agreed
182			Condensate Polishing Unit	[illegible] and regeneration and removing of resins shall be provided.	SEPCO agreed
183			Condensate Polishing Unit	One resin mixing/storage tank to be provided.	SEPCO agreed
184			Condensate Polishing Unit	Water quality at the outlet of CPU, both for normal condition and start-up condition shall be as per the tender specification.	SEPCO agreed

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
185					SEPCO agreed
186			Feed water heaters	HP and LP Heaters shall be provided with inlet, outlet and bypass motorised valves.	SEPCO agreed.
187			Feed water heaters	Necessary level control valves shall be provided for HP and LP Heaters.	SEPCO agreed.
188			Feed water heaters	Deaerator internals shall be of Stainless Steel.	SEPCO agreed.
189			Generator	Details of Hydrogen filling and purging system to be furnished.	Details shall be provided during detail engineering
190			Generator	Details of Hydrogen cooler to be furnished.	Details shall be provided during detail engineering
191			Generator	Erection procedure for Generator stator to be elaborated.	Details shall be provided during detail engineering
192			Fly ash handling system	For Ist field of each ESP, consider one common ash conveying line for two ash hoppers in place of four	SEPCO Confirmed
193			Fly ash handling system	Silo changeover system - Each ash conveying line shall be branched to silos provided with isolation valve for each silo.	SEPCO Confirmed

BID CLARIFICATION FOR 3600 MW COAL BASED POWER PROJECT AT NARIYARA, CHHATISGARH

TECHNICAL BID FOR 6 x 600 MW SUB CRITICAL UNIT

Bidder's Name & Address :SEPCO-I

ANNEXURE-A2
DATE : 27-09-08

PLOT PLAN, VASTU REQUIREMENT, MECHANICAL AND GENERAL TECHNICAL COMMENTS-2

Discipline - Mechanical

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
1	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	[redacted]	[redacted]
2	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	It is observed that CHP conveyor gallery and AHP piperack are going behind chimney. This is not permitted as per VASTU principle. Please reroute them suitably in front of the chimney. Refer DCPL plot plan drawing of Amendment-1.	As per VASTU requirements, there shall not be any equipments located behind chimney (on west side) with in the boundary wall. SEPCO agreed to modify layout accordingly.
3	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	It may be noted that CHP conveyors shall enter power plant VASTU rectangle from fuel quardrant i.e. after N-750. The CHP conveyors may be rerouted accordingly.	SEPCO understood the requirement and agreed.
4	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	Road to CHP is taken directly from power block of VASTU rectagle which is not permitted. Please provide this approach road from material road just after material gate no. '2' by extending the road suitably.	WPCPL explained that there can be only two entry/exit gates from boundary wall of the plant. Accordingly, the road meant for material transport shall be extended towards south and connect with coal yard entry gate. SEPCO understood and agreed.

27/9/08

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
5	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	As shown, three stacker reclaimers will be installed in the plant. The coal stackyard shall be suitable for 15 days storage for 6 x 600MW units.The drawing may be modified accordingly.	SEPCO agreed to provide 15 days coal storage.
6	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide one fly ash silo for each unit near ESP suitable for storage for 4 hrs of ash generated.This silo should feed to ash silo outside power plant.	SEPCO agreed to provided intermediate silos for AHP and number of silo will be decided during AHP discussion.
7	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	AHP piperack is going out of power block in the VASTU rectangle i.e. near N-675. It should be shifted after N-750 (Centre line). Please refer DCPL plot plan issued with Tender Specification.	SEPCO understood the requirement and agreed.
8	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	Main Ash handling silos and pumping system is located at W-100 which is cutting VASTU rectangle. It shall be shifted suitably outside W-100.	SEPCO understood the requirement and agreed.
9	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	Please provide railway wagon filling arrangement for fly ash transportation by wagons from the fly ash silos. Pnumatic conveying system feeding to piping network over railway line may provided.	WPCPL explained that out of four silos, railway unloading arrangement will be provided in two silos. SEPCO understood the requirement and agreed.
10	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	[redacted]	[redacted]
11	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	[redacted]	[redacted]
12	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	Flue gas duct entry from units 1 & 3 into the RCC Chimney shall be from North/South sides directly, at right angle with duct entry for unit-2. As per Vastu requirement the duct entry cannot be from beyond Chimney edge on West side.	SEPCO understood the requirement and agreed.
13	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	[redacted]	[redacted]
14	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide location of Service/Instrument air compressor house.	[redacted]

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
15	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate bottom ash slurry sump. Please confirm its storage capacity shall be 30 minutes minimum.	SEPCO agreed to provide 20 minutes storage capacity.
16	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please also confirm effective storage capcaity of ash water sump is 1 hr (minimum).	SEPCO agreed to provide 20 minutes storage capacity.
17	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate HCSD system and Vacuum conveying system for fly ash handling.	SEPCO agreed to provide HCSD system for flyash diposal. For Vacuum conveying system refer AHP discussion
18	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please refer layout drag. F625KB-Z-01, Guard pond and RO Plant are not located in the drawing. Waste water treatment shall be as per specification drawingno. K7V12-020-DWG-M-FS16 including all components required for Waste treatment resulting in zero discharge (clarifier, Filteres, RO Plant, Chemical dosing, Centrifuge etc.)	SEPCO agreed to provide waste water treatment alongwith Guard Pond, RO Plant and location shall be shown inline with Bid Specification layout drawing near Switchyard.
19	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide minimum distance of D/2 between two adjacent NDCTs as per standard practice. If required please rearrange truck parking area. Please also provide two CW pump houses instead of three i.e. one for each phase. This will reduce the number of operating areas. in such case, one pumps for three units shall be provided standby.	SEPCO confirmed minimum distance of D/2 between two adjacent NDCTs. SEPCO also confirmed provision of one CW pump house for three units with one common standby as per attached Sketch. Further, CW pump houses of both phases shall be joined togather. Pump discharge isolation valves shall be hydaulic actuated and other valves shall be electric operated.
20	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate fire fighting pump house near raw water reservoir and raw water pump house. (Please refer Amendment-1.)	SEPCO informed TSS of design raw water is high which is not suitable for fire fighting system. SEPCO will utilise clarified water for the same.
21	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate Chemical Treatment Building for Water pretreatment plant.	SEPCO agreed to locate in the revised drawing.
22	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please confirm minimum sizes of all non-plant building as per annexure attached.	SEPCO understood the requirement and agreed.
23	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please rotate admin building and canteen by 90° So that majority of the portion shall face water reservoir. Please also show green belt around these buildings.	SEPCO agreed.
24	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please relocate plant amenities and canteen near centre of power plant i.e. near fire station.	SEPCO agreed.

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	Volume/Section/ Part/ Chapter no	Clause no / Page no			
25	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please confirm administation building shall be G + 2 floors suitably designed for managerial and general shift staff such as finance, engineering, library, conference etc of 3600 MW power plant	SEPCO agreed.
26	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please confirm that the amenetie and canteen shall be G+1 floor suitably designed for ground floor for C&M staff and first floor for managerial staff.	SEPCO agreed.
27	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Fire station shall be designed for parking four fire tenders alongwith maintenance equipments, record room operating room for fire tenderers.	SEPCO agreed.
28	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Auto garage shall be designed suitably for maintenace of heavy vehicles also.	SEPCO agreed.
29	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Stores shall be provided with facilities for open as well as, closed storage areas.	SEPCO agreed.
30	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Plant service building shall be G+2 floors suitable for O&M personnel, Inst. Testing and Electrical Laboratory, conference, pantry, maintenace area etc.	SEPCO agreed.
31	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Bulldozer storage shall be designed alongwith maintenance area for the same.	SEPCO agreed.
32	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	First Aid Centre by the side of Plant amenities & canteen shall be provided along with space for two ambulances.	SEPCO agreed.
33	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Two ablution blocks shall be provided. Please locate the second ablution block near fire station i.e. centre of power plant.	SEPCO agreed.
34	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please shift '51' (start-up boiler) near boiler area between N-700 to N-750. Please shift '37' (plant service building) near STG building.	SEPCO agreed.
35	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	[illegible]	[illegible]
36	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide approach at three places with 14 mt wide road to STG building as shown in DCPL layout drawing. Roads along and centre line of Vastu rectangle of power plant shall be 14 mt wide.	SEPCO agreed.
37	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	[illegible]	[illegible]
38	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate Hydrogen generation plant close to the boundary away from plant area for ensuring safety.	[illegible]

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	Volume/Section/ Part/ Chapter no	Clause no / Page no			
39	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please shift '27' (fire station) at the centre i.e. at junction of N-750 and E-600.	Refer Point No.24
40	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Workshop and Stores size seems to be very low. Please follow minimum size as per DCPL layout drawing.	SEPCO agreed for size as per specification.
41	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide railway line for movement of transformers upto the transformer maintenance area. (into maintenance bay of STG Building).	SEPCO agreed
42	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	All the above ground piping shall be carried over the pipe-rack. Aboveground piping on pedestrals or sleepers is not acceptable within the main plant boundary.	SEPCO agreed for pipe-rack height of minimum 8 m at road/rail crossing and 3 m at other locations. SEPCO revert by 26.09.08.
43	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please confirm complete operating floor of STG building shall be of RCC Slab. Opening in the floor are not acceptable except in the unloading bay and for openings (with grilled / Chequered plate covers) for equipment handling.	SEPCO agreed
44	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide one maintenance bay between each two units.	SEPCO provided Five maintenance bays.
45	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide drawing indicating turbine maintenance laydown area on the operating floor.	SEPCO confirmed Turbine Maintenance laydown area for each unit is provided. Detail drawing will be submitted during DBR.

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
46	Volume-II, Section-3-V	-	Guaranteed data	Bidder to note that guaranteed data is partially filled. Bidder to furnished all remaining data also.	SEPCO to provide remaining data by 10.10.08.
47	Volume-II, Section-3-V	-	Guaranteed data	[illegible]	[illegible]
48	Volume-II, Section-3-V	-	Guaranteed data	[illegible]	[illegible]
49	Volume-II, Section-3-V	-	Guaranteed data	[illegible]	[illegible]
50	Volume-II, Section-3-V	-	Guatantee Curves	[illegible]	To be submitted post contract
51	-	-	Procurement	Bidder shall note that the equipment / systems procurement / erection shall be done only after obtaining written approval of the respective drawings / docs.	SEPCO agreed
52	Volume-II, Section-1-V	-	Vendor List	[illegible]	[illegible]
53	Volume-II, Section-3-V	-	Consumables	[illegible]	[illegible]

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
54	Volume-II, Section-5-II	-	P&ID	Bidder to submit all P&ID to Owner for approval before finalisation of EPC contract.	SEPCO agreed
55	Volume-II, Section-5-II	-	P&ID / KEY SLD	1. Bidder shall submit all detailed system P&IDs & Key SLD for approval of Owner before finalizing the EPC contract. 2. In case Bidder chooses to submit the detailed system P&IDs & Key SLD after placement of EPC order, Bidder shall supply the equipment / systems based on the approved detailed system P&IDs & Key SLD at no extra cost. 3. In case Bidder does not comply / supply systems as per the approved detailed system P&IDs & Key SLD, Owner reserves the right to procure the required equipment at Bidder's risk & cost. Bidder shall oblige to erect such equipment also unconditionally. Further, Bidder shall be responsible for the complete system guarantees including the equipment procured by the Owner.	SEPCO agreed
56	Volume-II, Section-3-VII	-	Data sheets	[illegible]	[illegible]
57	Volume-II, Section-3-III	-	Systems Description	[illegible]	[illegible]
58	Volume-II, Section-3-V	Pt.28 Pg.487	Aux. Power	Please provide clear-cut [illegible]	During Detailed Engineering
59	Volume-II, Section-4-V	General	Lab. Equip. List	Bidder to confirm that all the Lab equipments as mentioned in Section-4 Annexure-V will be provided as per specification Vol.II, Sec-21.	SEPCO confirmed that the lab equipments shall be supplied as per specification Vol.II, Sec-21.
60	Specs. Vol. II Sec. III	Cl. 10.00.00	Codes and Standards	[illegible]	During Detailed Engineering
61	-	-	Test & Inspection	Bidder to confirm the wind tunnel test for all NDCT and Chimneys will be carried out.	SEPCO agreed
62	-	-	Test & Inspection	Bidder to submit QAP for major equipments/systems to Owner for approval before finalisation of EPC contract.	SEPCO agreed

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
63	Volume-II, Section-3-XII	-	Environment Monitoring Car	[illegible]	[illegible]
64	Volume-II, Section-4-I	-	Packing and Despatch	Quality assurance/Inspection group of Owner or his representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance, which shall enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor shall also be required to ensure at all stages of shipment that packing of all shipments dispatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site up to its erection. All despatch details and item lists shall be made available to both Owner and site immediately after shipping.	SEPCO agreed
65	Volume-II, Section-3-VII	-	Steam Generator	Please furnish %age load change per minute.	Load between 50%-100% BMCR- load change rate shall be +/- 5% BMCR per minute. Load between 30%-50% BMCR- load change rate shall be +/- 3% BMCR per minute. Load below 30% BMCR - load change rate shall be +/- 2% BMCR per minute.
66	Volume-II, Section-3-VII	-	Steam Generator	Please furnish margin on considered over acid dew point temp.	minimum10 deg C
67	Volume-II, Section-3-VII	-	Steam Generator	[illegible]	[illegible]
68	Volume-II, Section-3-VII	-	Steam Generator	[illegible]	[illegible]

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
69	Volume-II, Section-3-VII	-	Steam Generator	Bidder to confirm that the tolerance on steam outlet parameters will be as specified in the Section-V, J-1 (a), Page 8 i.e. ± 5%.	SEPCO agreed
70	Volume-II, Section-3-VII	Cl. 1.02.02 Data sheet	Steam Generator	[redacted]	[redacted]
71	Volume-II, Section-3-VII	Cl. 1.11.07 Data sheet	Economiser	Please confirm erosion margin of 60% at the design thickness will be provided on economiser tubes.	SEPCO confirmed erosion margin of 1 mm over and above the design thickness will be provided on economiser tubes.
72	Volume-II, Section-3-VII	Cl. 2.01.06 Data sheet	Air preheater	Please check provision of two nos. primary air and two nos. secodary air. Bisector type Air preheater is preffered.	SEPCO indicated that they have considered Trisector airheaters
73	Volume-II, Section-3-VII	Cl. 2.01.06 Data sheet	SCAPH	Please provide four nos. of Steam coil air preheaters.	SEPCO confirmed two nos. of Steam coil air preheaters shall be provided.
74	Volume-II, Section-3-III	-	ESP+FF	Please confirm 5% of filter bags per unit and 10% of Solenoid and Pulse valves shall be provided as mandatory spare for each unit.	SEPCO agreed
75	Volume-II, Section-3-VII	Cl. VII-A Pg.575	BFP	Please confirm margin of capacity and head for BFP shall be as per specification	SEPCO agreed to provide as per tender specification
76	Volume-II, Section-3-III	Cl. 3.2.5.5 Pg.362	APH	Please provide 2 electrical hoist of adequate capacity per unit with basket handling system for APH.	SEPCO agreed
77	Volume-II, Section-3-III	Cl. 3.2.4	PA/FD/ID Fan	PA/FD/ID Fans shall be provided with either Hydraulic coupling or VFD. In Case of Hydraulic coupling it should be Voith. Germany make only.	Refer Mechanical Resolution Point No.15 of Annexure A1
78	Volume-II, Section-3-III	Cl. 3.2.4	PA/FD/ID Fan	Auto isolation dampers (pnumatic/motorised operation) shall be provided in each fan both inlet & outlet to prevent reverse rotation.	SEPCO agreed
79	Volume-II, Section-3-VII	Cl. 1.01.11 Data sheet	Mills	Please confirm introducing 1st mill shall be at 10% instead of 20%. Also, confirm provision to take first mill before unit synchronisation will be provided.	SEPCO indicated they cannot provide below 20%
80	Volume-II, Section-3-VII	Cl. 3.2.3	Mills	Please explain the statement: "The wear and tear index of the coal is very important to select the type of the mill, if the index is more than 5, the type of the mill will be changed."	SEPCO indicated that this statement shall be ignored
81	Volume-II, Section-3-III	Cl. 3.2.5.6 Pg.363	Chimney Elevator	Chimney elevator shall be of capacity sutiable for 6 persons. Chimney shall be provided with lighting and fresh air blower from inside shell.	SEPCO agreed
82	Volume-II, Section-3-III	-	Pump Curves	[redacted]	[redacted]
83	Volume-II, Section-3-III	Cl.1.3 Pg.357	Compressed Air	Please furnish volumetric design margin over design requirement of Compressed air.	SEPCO indicated margin as 10%

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
84	Volume-II, Section-3-III	Cl.3.4.3 Pg.367	Compressed Air line	Please provide automatic sensing type drains all along compressed air line.	SEPCO agreed
85	Volume-II, Section-3-III	Cl. 3.4.4	Nitrogen System	Bidder to provide complete write up on N2 system	SEPCO agreed
86	Volume-II, Section-3-III	Cl.3.3.3 Pg.365	Steam Turbine	Please elaborate control oil system. We presume fire resistant synthetic oil with purificaton system will be provided.	During Detailed Engineering
87	Volume-II, Section-3-III	-	Steam Turbine	[illegible]	[illegible]
88	Volume-II, Section-3-III	-	Steam Turbine	Bidder to explain the reason for selecting 2 x100% CEP instead of 3 x 50% CEP as mentioned in Specification. 3 x 50% CEP is preffered.	2 x 100 % CEP is acceptable to WPCPL
89	Volume-II, Section-3-III	-	Steam Turbine	Bidder to provide turbine bypass system capacity (60%) as per specification	SEPCO agreed
90	Spec. Vol. III, Part A, M2	1.00.00	Steam Turbine	Please note that performace parameters for TMCR condition is only mentioned for steam turbine. Please provide parameters for various loads as asked for in the specification.	SEPCO agreed
91	Spec. Vol. III, Part A, M2	3.01.00	Steam Turbine	Bidder to provide information on extraction points i.e. from which stage extraction are considered.	During Detailed Engineering
92	Volume-II, Section-3-VII	Cl. VII-A Pg.561	Turbine Lube oil system	Kindly confirm capacity of MOT is equal to (Normal working oil level+Total oil volume in oil circuit +10% margin)	SEPCO agreed
93	Volume-II, Section-3-VII	Cl. VII-A Pg.561	Turbine Lube oil system	Kindly consider one overhead oil tank for each unit of 600 MW with MOC of tanks and piping as SS.	SEPCO indicated same is not applicable for their system
94	Volume-II, Section-3-VII	Cl. VII-A Pg.561	Turbine Lube oil system	Please consider one clean oil tank and one dirty oil tank for 3 x 600 MW units alongwith auxiliaries and piping.	SEPCO agreed
95	Volume-II, Section-3-VII	Cl. VII-A Pg.561	Turbine Lube oil system	Please confirm lubricating oil piping shall be of SS material.	SEPCO agreed
96	Volume-II, Section-3-VII	Cl. VII-A Pg.561	Turbine Lube oil system	[illegible] (separate centrifuge 2 x 100% capacity each) and 2 x 100% reusable oil filters for each unit of 600 MW.	SEPCO agreed , however for 2x100% oil filters they shall confirm by 26.09.08 after checking
97	Specs. Section-XVI	-	Condensate Extraction Pump	Bidder to explain the mode of execution of civil works with resepct to CEP pit bottom as mentioned as (-) 11.6 m.	During Detailed Engineering
98	Volume-II, Section-3-III	-	Condenser	[illegible]	Sepco not agreeing for VWO condition
99	Volume-II, Section-3-III	-	Condenser	Please confirm condenser tube material as SS-304.	SEPCO agreed
100	Volume-II, Section-3-III	-	Condenser	Please confirm condenser shall have two sections of cooling chamber one for each LP section.	SEPCO agreed
101	Volume-II, Section-3-III	Cl.3.3.3 Pg.365	Condenser and CW system	Please note that offer mentions about "Once through sea water cooling". We envisaged closed cycle cooling only. Condenser shall be designed as per Specification.	SEPCO Noted

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
102	Volume-II, Section-3-III	Cl. 7.1 Pg.381	CW Pumps	[redacted]	SEPCO not agreeing for VWO condition
103	Volume-II, Section-3-III	-	CW Pumps	[redacted]	SEPCO not agreeing for VWO condition
104	Volume-II, Section-3-III	Cl.3.3.4 Pg.366	ACW system	Please specify capacity and head margins considered for the pumps.	Flow - 10 % and Head-20%
105	Volume-II, Section-3-III	-	ACW System	Bidder to confirm that the system for ACW all turbine and boiler auxiliaries shall be cooled by Plate type heat exchanger using DM Water.	SEPCO Noted and agreed
106	Volume-II, Section-3-III	-	Coal handling System	Please confirm that bulldozers will be as per specification Vol.II, Sec-3. Each bulldozer bucket volume shall be minimum 7.5 m3.	**If same capacity or more is available in China market, same shall be provided by SEPCO, otherwise nearest capacity shall be provided**
107	Specs. Section-IV, E2	-	Coal handling System	Please note that revised coal handling system will be as follows: 1) The Coal Handling Plant shall consist of two Track Hoppers, two crusher houses and two stacker-reclaimers. 2) Each track hopper shall be of 4500 T coal holding capacity and shall have two conveyors, each of capacity 1800 TPH. Each conveyor shall be fed by two paddle feeders. 3) Coal from each track hopper shall be led to a transfer tower, from which coal will be fed into a crusher house. Two crusher houses shall be provided, each having 2 x 100% screens and crushers. 4) Crushed coal shall be stored in two stockpiles of total 15 days capacity (considering BMCR operation with worst coal), through two stacker reclaimers. 5) Crushed coal shall be conveyed to the bunkers of the boilers by two conveying streams, each with 2 x 100% conveyors. 6) The design capacity of each conveyor and of each equipment shall be 1800 TPH. 7) Each conveying stream shall feed one phase of 1800 MW capacity 8) All other design features shall be as already specified.	Refer Coal Handling Part resolution Point No.49 -77 of Annexure A1
108	Volume-II, Section-3-III	Cl.5.2.2	Coal handling System	Bidder to note that Belt speed for all CHP conveyors shall not exceed to 2.0 m/sec as per spec. (between track hopper and crushers for stone picking facility)	SEPCO agreed to provide 2.0 m/sec belt speed for both streams between crusher house and transfer tower before cursher house.
109	Volume-II, Section-3-III	Cl.5.3.3	Coal handling System	Bidder to indicate the type of screens and crushers offered by them along with their data sheets.	SEPCO confirmed ring granulator crusher and roller type screen.

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
110	Volume-II, Section-3-III	Cl.5.3.5	Coal handling System	Bidder to note that details regarding CHP auxiliary equipments is not available in their offer. Please provide the same.	CHP auxiliary equipments will be indicated in Scheme drawing.
111	Volume-II, Section-3-III	Cl. 5.4 Pg.378	Dust Suppression	Please confirm provision of Dry fog (Mist) type dust suppression system whenever coal size handled is equal to or more than 200 mm. For coal size less that 200 mm, dust extraction and collection system with SPM emission of 50 mg/Nm3 will be provided.	SEPCO agreed
112	Volume-II, Section-3-III	-	Ash handling system	Bidder to confirm that the dedicated air compressors for ash conveying will be provided.	SEPCO agreed
113	Specs. Section-VII	Redundancy Requirement	Ash handling system	Bidder to confirm redundancy of all the ash handling equipments will be as per specification and specification drawings. The system capacity shall be based on the specified worst coal and other specified criteria.	SEPCO agreed
114	Volume-II, Section-3-III	Cl. 6.2.1 Pg. 379	Ash handling Piping	Ash handling piping material shall be ASTM A-106 Gr-B or better, abrasion resistant properties with min. 9.5 mm thk.	SEPCO informed piping with 7 mm thickness will be provided for pipes having dia less than 200 NB, for 200 NB and above it shall be 9.5 mm thick
115	Volume-II, Section-3-III	Cl. 6.2.1 Pg. 379	Bottom ash handling system	Bottom ash conveying system shall consist of Water impounded hopper with feed gate, clinker grinder, jet pumps as per specification.	Refer AHP discussion Point. 78 to 100 of Annexure-A1
116	Volume-II, Section-3-III	Cl. 6.2.1 Pg. 379	Ash handling system	[illegible]	[illegible]
117	Volume-II, Section-3-III	Cl. 6.2.4 Pg. 380	Ash silo system	Ash conveying line coming to silo shall be branched in two lines to connect to each silo. This lines for each Silo shall be provided with individual valve. Arrangement shown in the referred drawing is not acceptable as common diverter valve for both Silos. In this case if common diverter valve needs maintenance then evacuation of respective hopper gets stopped and purpose of Standby silo/two silo get defeated.	SEPCO agreed
118	Volume-II, Section-3-III	Cl. 6.2.4 Pg. 380	HCSD system	HCSD system shall be included in scope, as specified. In the slurry of this system, ash to water ratio shall be maintained as 70 :30 by weight.	In HCSD system ash to water ratio shall be maintained as 65:35 by weight. SEPCO agreed
119	Volume-II, Section-3-III	Cl. 12.3 Pg.440	HVAC	[illegible]	[illegible]
120	Volume-II, Section-3-III	Cl. 12.3 Pg.440	HVAC Turbine Hall Ventilation	[illegible]	[illegible]

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
121	Volume-II, Section-3-III	Cl. 7.2 Pg.383	Water Discharge	Please check and correct " Sea Water Discharge Channel" as Sea water is not use in the project.	Noted and agreed by SEPCO
122	Volume-II, Section-3-III	Cl. 7.4.2/3 Pg. 384	Industrial Waste-Water system	Waste water shall include floor wash water from Main plant, CHP, AHP.	SEPCO agreed
123	Volume-II, Section-3-III	Cl 13.2	Pollution Control	Bidder to provide details alongwith data sheets for all the pollution control equipments. Complete system shall be inlcuded in scope, as specified.	SEPCO agreed
124	Volume-II, Section-3-III	Table 13.3	Effluent Data	[redacted]	[redacted]
125	Volume-II, Section-3-III	Cl. 8.5 Pg.386	Inert Gas Flooding System	Please confirm that Inert Gas Flooding System will be included as speifid and the same shall conform to NFPA-2001.	SEPCO agreed
126	Volume-II, Section-3-III	Cl. 8.7 Pg.387	Fire water pumps	Please confirm interconnection between Hydrant and Spray system at discharge header will be provided.	SEPCO agreed
127	Volume-II, Section-3-III	Cl. 8.5 Pg.386	Foam Tender	Bidder to provide Four (4) fire tenders which includes Two (2) water tenders, One(1) multi-purpose tender and One (1) Foam tender as per attached specification.	SEPCO agreed
128	Volume-II, Section-3-III	Cl. 6.0	Maintenance Schedule	Please elaborate maintenance schedule for the equipment covered in the offer.	SEPCO agreed to provide the same along with DBR
129	Volume-II, Section-3-III	-	Availability, Reliability	[redacted]	[redacted]
130	Spec. Section-XVI	-	Drawing Submission	Bidder to submit GA drawing of all Static equipments such as ESP, Bag Filter, Tanks, Pressure Vessels, Boiler etc. indicating clearly Material of construction of different parts and design criteria (apart from the drgs/documents listed in Section-XVI).	SEPCO agreed
131	Spec. Section-XVI	-	Drawing Submission	[redacted]	[redacted]
132	-	-	Drawing approval	Bidder to note that during drawing review and approval stage in case of disputes on comments, the drawing will be commented and resubmitted max. three times including comments on first revision. After this, bidder shall resolve the issues across the table with the Owner at Owner's/Cosuntant's office in India..	SEPCO agreed
133	-	-	General	All the electrical and instrumentation panels/equipments shall be tagged in English language only.	SEPCO agreed

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
134	-	-	General	Bidder to provide monthly manpower deployment schedule during construction and during commissioning period.	SEPCO agreed
135	-	-	General	Bidder to provide complete details on arrangement for commissioning of plant and vendors responsible for the same.	SEPCO agreed
136	-	-	General	Bidder to confirm erection drawing and erection manual will be submitted 15 days before commencement of erection of any equipment/structure.	SEPCO agreed
137	-	-	General	[redacted]	[redacted]
138	-	-	General	[redacted]	[redacted]
139	-	-	General	[redacted]	[redacted] shall be as per bid specification
140	-	-	Project Schedule		

BID CLARIFICATION FOR 3600 MW COAL BASED POWER PROJECT AT NARIYARA, CHHATISGARH					
				TECHNICAL BID FOR 6 x 600 MW SUB CRITICAL UNIT	
Bidder's Name & Address :SEPCO-I					ANNEXURE - B1
Technical					
Discipline - Electrical					
Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
A)	VOL-II-SECTION-5-II : DRAWING & DIAGRAM				
1	Volume-II, Section-5-II	—	GENERAL LAYOUT	Switchyard shall be shifted to the fourth quadrant (South-East quadrant) of the Plot, with adequate space for locating outgoing transmission towers.	Refer Annexure - B6
2	Volume-II, Section-5-II	—	GENERAL LAYOUT	Rails for maintenance and transportation of transformers (GT, ST & UT) shall be provided upto one of the STG maintenance bays.	Refer Annexure - B6
3	Volume-II, Section-5-II	—	GENERAL LAYOUT	The foundation of transformers (mainly generator transformers) is fouling with CW piping. Please clarify, how it will be taken care of.	Refer Annexure - B6
4	Volume-II, Section-5-II	—	GENERAL LAYOUT	Two station transformer shall be installed in Phase-I. In general layout only one station transformer is indicated in Phase-I. Please check and clarify.	Refer Annexure - B6
5	Volume-II, Section-5-II	—	GENERAL LAYOUT	Generator Transformer 4 & 5 are close to each other. Please check and clarify.	Refer Annexure - B6
6	Volume-II, Section-5-II	—	GENERAL LAYOUT	One number spare single phase generator transformer shall be provided for entire six units as per Cl. No. 4.02.02 of VOL-II/SEC-XVIII of Bid Document and the same shall be located in General Layout.	SEPCO agreed
7	Volume-II, Section-5-II	—	GENERAL LAYOUT	Marshalling boxes in the field shall be located at 1 m above the Finished Ground Level.	Refer Annexure - B6
B)	VOL-II-SECTION-5-II : DRAWING & DIAGRAM				
1	Volume-II, Section-5-II	—	MAIN CIRCUIT SLD	Rating of Station Transformer shall be established by the calculation as per design criteria/sizing criteria mentioned in Cl.No.4.02.10 of Vol-II/Sec-XVIII of the Bid Document	SEPCO agreed to provide during basic design following specification.

C. Nandini (WPPL)

27/09/08 DEPL

SEPCO 28.9.08

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
2	Volume-II, Section-5-II	—	MAIN CIRCUIT SLD	Station Switchboard # 5 & # 6 shall be installed in Phase-I & Station Transformer # 3 shall be installed in Phase-II as per Single Line Diagram (K7V12-000-DWG-E-0101).	SEPCO agreed
3	Volume-II, Section-5-II	—	MAIN CIRCUIT SLD	Only three voltage level 11kV, 6.6kV & 415V shall be considered as per Bid Document.	Already discussed
C)	**VOL-II-SECTION-3-II : DATAS & DOCUMENTS TO BE FURNISHED BY BIDDER**				
1	Volume-II, Section-3-II	Sl.No.9(c) - xii Page 339 of 1003	DATAS & DOCUMENTS	Layout plan & section of 400kV switchyard shall be submitted.	Shall be submitted by SEPCO during detail design following specification.
2	Volume-II, Section-3-II	Sl.No.-9(d)-xiv Page - 340 of 1003	DATAS & DOCUMENTS	SLD of 400kV switchyard with detailed bus configuration, metering and protection scheme shall be submitted. Bidder to confirm that the relays for Main-1 & Main-2 protections are housed in separate cabinets with separate redundant DC power supplies. Routing of the control & DC power cables shall be laid separately to the extent possible.	SEPCO agreed to provide during basic design following specification
3	Volume-II, Section-3-II	Sl.No.-9(d) - xvi Page - 340 of 1003	DATAS & DOCUMENTS	Requirement of D.C. & A.C. emergency system shall be submitted along with offer	SEPCO agreed to provide during basic design following specification
4	Volume-II, Section-3-II	Sl.No.-9(d) - xviii Page - 340 of 1003	DATAS & DOCUMENTS	Metering and Protection diagram/drawing of generator, generator transformer, station transformer shall be submitted in offer as per Cl.No.4.18.13 of Vol-II/Sec-XVIII of Bid Document.	SEPCO agreed to provide during basic design following specification
5	Volume-II, Section-3-II	Sl.No.-14 (e)-xiii Page - 344 of 1003	DATAS & DOCUMENTS	Detailed write-up on control philosophy of electrical distribution system shall be submitted in offer as per Cl.No.4.18.13 of Vol-II/Sec-XVIII of Bid Document.	SEPCO agreed to provide during basic design following specification

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
D)	VOL-II-SECTION-3-III - TECHNICAL DESCRIPTION				
1	Volume-II, Section-3-III	Cl.No.3.2.5.4 Page - 364 of 1003	TECHNICAL DESCRIPTION	Each unit shall be provided with one DG .	SEPCO agreed
2	Volume-II, Section-3-III	Cl.No.3.3.5 Page - 366 of 1003	TECHNICAL DESCRIPTION	Motor driven BFP shall be controlled through hydraulic coupling (VOITH, Germany make). Bidder to also indicate the VFD applications for motors.	Refer Annexure - B6
3	Volume-II, Section-3-III	Cl.No.4.1 Page - 368 of 1003	TECHNICAL DESCRIPTION	Please note and '5 x 660 MW' as '5 x 600MW', mentioned many places in the offer of 6 x 600MW sub critical EPC Bid Document. Also, please note that number of equipments shall be corrected in line with 6 x 600MW configuration.	This is a typographical error to be corrected.
4	Volume-II, Section-3-III	Cl.No.4.2 Page - 368 of 1003	TECHNICAL DESCRIPTION	Number of 400kV switchyard bays shall be as per Tender SLD (Dwg.No.K7V12-000-DWG-E-0101)	SEPCO agreed to follow the tender drawing
5	Volume-II, Section-3-III	Cl.No.4.3 Page - 368 of 1003	TECHNICAL DESCRIPTION	Please note and confirm that electrical auxiliary system shall have three voltage level - 11kV, 6.6kV & 415V/240V as per Tender SLD.	Already discussed
6	Volume-II, Section-3-III	Cl.No.4.3 Page - 368 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that BFP shall be fed from 11kV switchboard and all other HT motor rated above 200kW shall be fed from 6.6kV switchboard. Bidder to also note that all LT service transformers shall be fed from 11kV switchboard only.	Already discussed
7	Volume-II, Section-3-III	Cl.No.4.3 Page - 369 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that the minimum rating of emergency DG shall be 1500kVA as per Bid Document. However, actual rating shall be as per approved design calculation to be decided during detailed engineering.	SEPCO agreed.
8	Volume-II, Section-3-III	Cl.No.4.3 Page - 369 of 1003	TECHNICAL DESCRIPTION	Bidder to note and confirm that duration of system fault current of 400kV, 11kV, 6.6kV and 415V/240V system shall be as per Bid Document.	SEPCO confirmed as per tender single line diagram and specification. 6.6 kV is not applicable.
9	Volume-II, Section-3-III	Cl.No.4.4 Page - 369 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that each switchgear room shall be provided with cable cellar room below the switchgear room as per Bid Document. Switchgear room in ground floor and under ground cable trenches are not acceptable as per Bid Document. Bidder to also note that minimum clear height of every cable cellar room shall be kept as 2.5M.	Already discussed

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
10	Volume-II, Section-3-III	Cl.No.4.5.1 Page - 369 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that each 220V DC system shall have 2 x 100% high discharge Lead Acid plante type battery with 2 x 100% float-cum-booster charger The nos. of cells of battery shall be 110 considering nominal cell voltage of 2V/cell. Bidder to alsc note that capacity of battery shall be decided during detailed engineering subject approved calculation as per IEEE - 485 and Bid Document.	WPCPL has clarified to provide following batteries : 1) 220 V, 2x100% for each unit & station with 2 x 100% float and float cum boost charger 2) 220 V, 2x100% for switchyard with 2 x 100% float and float cum boost charger 3) Separate battery for AHP & CHP 4) Separate 48V battery for PLCC. 5) 220 V Separate battery for FO handling & pump house, WTP & CW pump house if required. shall be finalise during detail design 6) Separate battery for DG sets, fire systems and Plant communication system. SEPCO agreed to supply batteries along with its accessories.
				Bidder to also note and confirm that battery shall be sized for one hour duration and the following loads shall be considered in unit battery sizing as minimum requirement. a) DC lube oil pump motor b) DC Jacking oil pump motor c) Seal oil pump motor d) DC scanner air fan motor e) Other emergency auxiliaries of Steam Generator and Turbine Generator.	SEPCO agreed to size battery for one hour for emergency load as applicable to SEPCO proposal. Further SEPCO informed DC jacking oil pump & DC scanner air fan motor if provided then battery shall be sized for that also. And SEPCO has included DC motors for a) & c) only.
				f) Continuous loads of indicating lamps on switchgear and control and relay panels, auxiliary relays. g) Momentary loads for tripping / closing of 11kV, 6.6kV & 415V breakers, starting current of all automatically started DC drives, in rush current of excitation system.	
				h) Continuous emergency lighting loads for following areas :- - Operating floor & switchgear room STG Building - Local Control & Switchgear room (for offsite battery) - Switchyard control & relay building (for switchyard battery only). - Strategic locations viz. near entrance/exit, staircase, landings, etc. - Main Control Room - DG room	

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
11	Volume-II, Section-3-III	Cl.No.4.5.2 Page - 370 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that AVR shall have two auto and one manual channel as per Bid Document.	Already discussed
12	Volume-II, Section-3-III	Cl.No.4.6 Page - 370 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that each offsite PLC and Plant PA communication system shall have dedicated UPS system.	SEPCO agreed to provide maintenance free lead acid battery. SEPCO further clarified that following UPS has been considered and shall be supplied: 1) Unitwise UPS 2) Station loads one UPS 3) UPS for CCW/ACW controls (If remote I/O are provided) 4) UPS for FOPH if required. 5) For off site plant separate UPS shall be provided for each PLC . 6) For 400 KV switchyard system 7) One no. 25 kVA UPS with ACDB will be provided for administrative building.
13	Volume-II, Section-3-III	Cl.No.4.7 Page - 371 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that all electrical equipments and systems shall be provided with protective devices as mentioned in Bid Document. All protective relays shall numerical microprocessor based only.	SEPCO agreed to provide as per specification.
14	Volume-II, Section-3-III	Cl.No.4.7 Page - 371 of 1003	TECHNICAL DESCRIPTION	Bidder to note and confirm that motors rated above 1000kW shall be provided with differential protection.	Already discussed
15	Volume-II, Section-3-III	Cl.No.4.8 Page - 371 of 1003	TECHNICAL DESCRIPTION	Bidder to please note that IEC-61850 protocol may be considered for communication and automation of switchyard.	WPCPL / DCPL agreed that IEC-61850 need not be considered.SEPCO inform that the protocol will be IEC-103.
16	Volume-II, Section-3-III	Cl.No.4.10.1.2 Page - 372 of 1003	TECHNICAL DESCRIPTION	Bidder to note and confirm that DC emergency lighting shall be in all critical areas like control room, switchgear room, STG building operating floor, strategic locations viz. near entrance, exits, staircase, landing etc; DG room.	SEPCO agreed to supply DC emergency lighting in control rooms & DG room. SEPCO agreed to supply chargeable, portable DC emergency lights - 100 Nos. for complete plant. WPCPL / DCPL accepted.
17	Volume-II, Section-3-III	Cl.No.4.10.1.3 Page - 371 of 1003	TECHNICAL DESCRIPTION	Bidder to note and confirm that the voltage of lighting of main building and various workshops shall be 415V/240V and shall be fed through lighting transformers.	Already discussed

C. Narchal (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
18	Volume-II, Section-3-III	Cl.No.4.10.1.3 Page - 373 of 1003	TECHNICAL DESCRIPTION	Bidder to please note and confirm that the insulation lighting wires shall be minimum PVC for places where ambient temperature is prevalent and heat resistant cables for high temperature areas like boiler etc.	SEPCO agreed.
19				Bidder to confirm that even at the min mum tap of Generator Transformer the rise of oil & winding temperature will be within the specified limits for the rated output of Generator.	SEPCO agreed.
E)	**VOL-II-SECTION-3-VII - DATA SHEETS (ELECTRICAL)**				
1	Volume-II, Section-3-VII	Cl.No.1.2.1 & 1.2.2 Page - 743 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that rated output of generator shall be 600MW at TMCR and also be capable of generating additional power corresponding to VWO condition of Turbine. Please check all relevant data for 600MW unit.	SEPCO agreed to change the relevent data sheet & submitt before our ordering on them.
2	Volume-II, Section-3-VII	Cl.No.1.2.9 Page - 744 of 1003	GNERATOR & ACCESSORIES	Bidder to note and confirm that SCR value of generator shall be 0.5 without any negative tolerance.	SEPCO agreed to provide SCR not less than 0.5 without negative tolerance.
3	Volume-II, Section-3-VII	Cl.No.1.3.5 & 1.3.8 Page - 744 & 745 of 1003	GENERATOR & ACCESSORIES	Generator reactive capability & short circuit withstand capability need to be confirmed.	SEPCO agreed to provide these values before placement of our order on them.
4	Volume-II, Section-3-VII	Cl.No.1.9.2-(e) Page - 750 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that impulse voltage strength of generator stator winding shall be 4U ÷ 5, where U = Rated voltage.	SEPCO shall supply as per IEC. WPCPL/DCPL informed that 4u+5 shall be provided.

C. Nanchuk (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
5	Volume-II, Section-3-VII	Cl.No.1.9.3-(f) Page - 750 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that dielectric test voltage of winding shall be 2U + 1, where U = Rated voltage and the same for terminal bushings shall be 1.5 times the one minute test voltage of winding.	SEPCO agreed.
6	Volume-II, Section-3-VII	Cl.No.1.10.2-(a) Page - 751 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that 2 x 100% AC seal oil pump (one normal & one emergency) with 1 x 100% DC emergency seal oil pump shall be provided on both air and hydrogen side.	Refer Annexure - B6
7	Volume-II, Section-3-VII	Cl.No.1.11.6 Page - 753 of 1003	GENERATOR & ACCESSORIES	Hydrogen cylinders and carbon dioxide cylinders shall be included in scope of bidder.	Refer Annexure - B6
8	Volume-II, Section-3-VII	Cl.No.1.13.0 Page - 755 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that AVR shall ABB make microprocessor based digital type only. Accuracy class and other details shall be as per Tender Specification.	SPECO agreed to supply with additional price.
9	Volume-II, Section-3-VII	Cl.No.1.18.0 Page - 760 of 1003	GENERATOR & ACCESSORIES	All the performance curves as mentioned in this shall be submitted with offer.	SEPCO agreed to provide all the performance curves before placement of our order on them.
10	Volume-II, Section-3-VII	Cl.No.1.20.0 Page - 761 of 1003	GENERATOR & ACCESSORIES	Details of Generator Protection and Generator excitation system along with AVR need to be submitted with offer	SPECO agreed Generator Protection and Generator excitation system shall meet the specification requirement. Details shall be furnish in Basic engineering stage.
11	Volume-II, Section-3-VII	Cl.No.1.20.5 Page - 762 of 1003	GENERATOR & ACCESSORIES	All shop tests as indicated in Cl.No.2.09.00 of VOL-II/SEC-XVIII of Tender Specification shall be carried out. Please note and confirm.	SPECO agreed to carry out shop tests.
12	Volume-II, Section-3-VII	Cl.No.1.0.0 Page - 743 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that the generator including its auxiliary and ancillary systems shall be designed for the same or higher MTBF as the turbine. The generator shall have the same life expectancy as the turbine, taking into account the operating cycles expected for the entire turbine-generator set (overhauls).	SPECO confirmed.
13	Volume-II, Section-3-VII	Cl.No.2.1.1-(i) Page - 762 of 1003	GENERATOR ISOLATED PHASE BUSDUCT	Bidder to note and confirm that short circuit current rating of IPBD shall be established by calculation during detail engineering and short time rating shall be 3 sec.	SPECO confirmed.

C. Nandhini (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
14	Volume-II, Section-3-VII	Cl.No.2.1.1-(u) & 2.1.11-(d) Page - 764 & 768 of 1003	GENERATOR ISOLATED PHASE BUSDUCT	Bidder to note and confirm that rated voltage of seal off bushing, insulators and other equipments mounted on IPBD shall be of 24kV class for 20 or 22kV generation voltage.	SPECO confirmed.
15	Volume-II, Section-3-VII	Cl.No.2.1.4-(g) Page - 765 of 1003	GENERATOR ISOLATED PHASE BUSDUCT	Bidder to note and confirm that all CT used for Generator Protection and differential protection of Generator, Generator transformers & UT shall be of Class - PS. CT & PT used for Generator metering shall be of Class - 0.2S and 0.2 respectively.	SEPCO confirmed supply of CT's & PT's of 0.2S & 0.2 respectively. However PS class CT's are not manufactured in China.SEPCO confirmed that for differential protection depending upon relay manufacturer's requirement suitable CT of 5P 30/ 5P 20 as per application checks shall be supplied. WPCPL / DCPL agreed.
16	Volume-II, Section-3-VII	Cl.No.2.1.7 & 2.1.8 Page - 767 of 1003	GENERATOR ISOLATED PHASE BUSDUCT	Continuous and intermittent duty of Neutral Grounding Transformers and Loading Resistor shall be indicated.	SPECO agrred to provide Continuous and intermittent duty of Neutral Grounding Transformers and Loading Resistor during Basic Design.
17	Volume-II, Section-3-VII	Cl.No.2.1.1 Page - 762 of 1003	GENERATOR ISOLATED PHASE BUSDUCT	Bidder to note and confirm that the generator isolated phase busduct shall be pressurized and natural air cooled type.	SPECO confirmed.
18	Volume-II, Section-3-VII	Cl.No.4.0.0-(i) Page - 772 of 1003	LT BUS DUCT (415V)	Bidder to note and confirm that temperature rise over 50 deg.C design ambient of bus conductor and bus enclosure and support structure shall be as per Tender Specification (Cl.No.4.03.02 of VOL-II/SEC-XVIII of Bid Document.	SPECO confirmed.
19	Volume-II, Section-3-VII	Cl.No.5.6.0 Page - 775 of 1003	GENERATOR TRANSFORMER	Bidder to note and confirm that ONAN and ONAF rating of generator transformer shall be as per Cl.No.4.02.02 of VOL-II/SEC-XVIII of Bid Document.	SPECO confirmed.
20	Volume-II, Section-3-VII	Cl.No.5.7.0 Page - 775 of 1003	GENERATOR TRANSFORMER	Bidder to please note and confirm that LV and HV side rating shall be 20 and 420/√3. Please check and reconfirm the vo tage ratings.	SPECO confirmed.
21	Volume-II, Section-3-VII	Cl.No.5.13.0 Page - 775 of 1003	GENERATOR TRANSFORMER	Bidder to note and confirm that temperature rise over reference ambient shall be as per Cl.No.4.02.04 of VOL-II/SEC-XVIII of Bid Document	SPECO confirmed.

C. Nandkumar (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
22	Volume-II, Section-3-VII	Cl.No.5.15.0 Page - 775 of 1003	GENERATOR TRANSFORMER	Insulation level of transformer windings shall be indicated.	SEPCO confirmed as per IEC.Values would be submitted during basic engineering.
23	Volume-II, Section-3-VII	Cl.No.5.16.0 & 5.17.0 Page - 776 of 1003	GENERATOR TRANSFORMER	Transformer impedance on base MVA and Guaranteed losses at principal tap shall be indicated for ONAN/ONAF and OFAF.	SPECO will provide during Basic engineering.
24	Volume-II, Section-3-VII	Cl.No.5.21.0 Page - 777 of 1003	GENERATOR TRANSFORMER	Bidder to note and confirm that maximum flux density at 110% rated voltage shall not be more than 1.9 Tesla.	SPECO confirmed.
25	Volume-II, Section-3-VII	Cl.No.5.22.0 Page - 777 of 1003	GENERATOR TRANSFORMER	Bidder to reconfirm the figure of maximum current density with respect to unit indicated in data sheet.	WPCPL / DCPL indicated that maximum current density shall not be more than 2.5 A/ mm^2. SPECO to revert back before order.
26	Volume-II, Section-3-VII	Cl.No.5.24.0 Page - 777 of 1003	GENERATOR TRANSFORMER	Cooling system of generator transformer shall be indicated.	SEPCO will provide during Basic design.
27	Volume-II, Section-3-VII	Cl.No.5.26.0 Page - 777 of 1003	GENERATOR TRANSFORMER	Bidder to note and confirm that winding material of transformers shall be copper only.	SEPCO confirmed.
28	Volume-II, Section-3-VII	Cl.No.5.29.0 Page - 777 of 1003	GENERATOR TRANSFORMER	Voltage class insulation level of transformer bushings shall be indicated.	SEPCO will furnish correct Data Sheet before placement of our order on them.
29	Volume-II, Section-3-VII	Cl.No.5.29.0 Page - 777 of 1003	GENERATOR TRANSFORMER	Bidder to note and confirm that CT for measuring and protection purposes of transformer shall be installed as built in units in the tank dome of the HV phase and HV star point.	WPCPL / DCPL insisted that GT shall be provided with suitable no. of bushing mounted CT's on all phases & neutral bushing for protection & metering. SEPCO confirmed. Details shall be furnished during Basic engineering.
30	Volume-II, Section-3-VII	Cl.No.5.00	GENERATOR TRANSFORMER	Bidder to note and confirm that bolted connections with intermediary sealing, hinges, pins and the like are not considered to be conductive connections.	WPCPL / DCPL insisted that suitable jumpering / flexible shall be installed for bolted connections with intermediary sealing, hinges, pins etc. SEPCO confirmed.
31	Volume-II, Section-3-VII	—	GENERATOR TRANSFORMER	Bidder to note and confirm that if the transformers are installed, the grounding shall also be effective for high frequency occurrences.	To be discussed later.

C. Nanduri (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
32	Volume-II, Section 3-VII	—	—	Bidder to note and confirm that protective lightning arresters shall be provided in LV side of the transformers (for Unit & Station transformers), if required. This requirement shall be established by calculation and shall be submitted for owner's review.	SEPCO agreed to provide on 11 kV switchgear. WPCPL / DCPL noted.
33				The comment under GENERATOR TRANSFORMER are also applicable for STATION & UNIT TRANSFORMER	SEPCO agreed.
34	Volume-II, Section 3-VII	Cl.No.8.3.0 Page - 786 of 1003	LT TRANSFORMERS	Bidder to note and confirm that oil filled transformers shall be considered for offsite areas as indicated in Tender SLD (Drg. No. K7V12-000-DWG-E-0101).	In view of no 3.3 kV, 6.6kV system offered by SEPCO this point is not applicable. WPCPL / DCPL noted.
35	Volume-II, Section 3-VII	Cl.No.8.6.0 Page - 786 of 1003	LT TRANSFORMERS	Bidder to note and confirm that maximum capacity of LT transformers shall be 2500kVA. Bidder to also note that the size of LT transformers shall be established by supporting calculation considering voltage drop during running of all connected loads and starting of largest motor.	SEPCO agreed During Basic design the details shall be furnished.
36	Volume-II, Section 3-VII	Cl.No.8.15.0 Page - 787 of 1003	LT TRANSFORMERS	Winding insulation level of LT transformers shall be indicated.	SEPCO confirmed as per IEC.Values would be submitted during basic engineering.
37	Volume-II, Section 3-VII	Cl.No.8.21.0 Page - 788 of 1003	LT TRANSFORMERS	Bidder to note and confirm that maximum flux density at 110% shall not be more than 1.9 Tesla.	SEPCO agreed.
38	Volume-II, Section 3-VII	Cl.No.8.22.0 Page - 788 of 1003	LT TRANSFORMERS	Bidder to reconfirm the figure of maximum current density with respect to unit indicated in data sheet	WPCPL / DCPL indicated that maximum current density shall not be more than 2.5 A/ mm^2. SPECO to revert back before order.
39	Volume-II, Section 3-VII	Cl.No.8.24.0 Page - 788 of 1003	LT TRANSFORMERS	Bidder to note and confirm that winding shall be of copper. Insulation class of winding shall be F with temperature rise limited to Class-B	SEPCO confirmed. Temperature rise as per specification.
40	Volume-II, Section 3-VII	Cl.No.8.29.0 Page - 789 of 1003	LT TRANSFORMERS	Bidder to note and confirm that degree of protection of dry type transformer shall be IP 23 and marshalling box shall be IP55.	SEPCO confirmed that the degree of protection of dry type transformer shall be IP 23 and marshalling box shall be IP42.

C. Nandkumar (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
41	Volume-II, Section-3-VII	Cl.No.9.3.6 Page - 791 of 1003	HT SWITCHGEAR	Bidder to note and confirm that busbar of HT Switchgear shall be of aluminium / aluminium alloy. Copper busbars shall be usec for bus bar current rating above 2000A.	SEPCO confirmed & agreed.
42	Volume-II, Section-3-VII	Cl.No.9.4.33 Page - 795 of 1003	HT SWITCHGEAR	Bidder to note and confirm that minimum 8NO + 8NC contact shall be provided for HT circuit breaker.	SEPCO agreed to provide as per requirement.
43	Volume-II, Section-3-VII	Cl.No.9.5.2 Page - 797 of 1003	HT SWITCHGEAR	Bidder to note and confirm that key interlock shall be provided for selector switch.	SEPCO agreed.
44	Volume-II, Section-3-VII	Cl.No.9.6.2 Page - 797 of 1003	HT SWITCHGEAR	Bidder to note and confirm that class of CT used for differential protection shall be PS instead of 5P20.	Already discussed.
45	Volume-II, Section-3-VII	Cl.No.9.6.3 Page - 797 of 1003	HT SWITCHGEAR	Bidder to note and confirm that CT used for metering of incomer feeder shall be 0.2S	SEPCO agreed to provide CT for metering with 0.5 class. WPCPL / DCPL agreed
46	Volume-II, Section-3-VII	Cl.No.9.6.3 Page - 796 of 1003	HT SWITCHGEAR	Bidder to note and confirm that voltage transformer shall have one metering core of Class 0.2	SEPCO agreed to provide VT for metering with 0.5 class. WPCPL / DCPL agreed.
47	Volume-II, Section-3-VII	Cl.No.10.0.0 Page - 804 of 1003	LT SWITCHGEAR	Bidder to note and confirm that all equipments of LT switchgear shall be rated 1.1kV.	SEPCO confirmed.
48	Volume-II, Section-3-VII	Cl.No.10.1.9 Page - 804 of 1003	LT SWITCHGEAR	Bidder to note and confirm that degree of protection of LT switchgear shall be as per Tender Specification.	SEPCO agreed that LT panels in TG building will be IP-42 & LT panels at off site areas like CHP, AHP, ESP, WTP & CW shall be IP-52.
49	Volume-II, Section-3-VII	Cl.No.10.4.11 Page - 807 of 1003	LT SWITCHGEAR	Bidder to note and confirm that rated making current of circuit breaker shall be 105kA instead of 50kA.	SEPCO confirmed.
50	Volume-II, Section-3-VII	Cl.No.10.10.1 Page - 814 of 1003	LT SWITCHGEAR	[illegible] feeder.	[illegible] specification for protection of equipment. OPEN POINT

C Nandkumar (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
51	Volume-II, Section-3-VII	Cl.No.11.2.4 4 & 12.2.4 Page - 818 OF 1003 & 822 OF 1003	HT MOTORS & LT MOTORS	All motor shall energy efficient type as per Cl. No. 4.14.06 of VOL-II/SEC-XVIII of Bid Document.	SEPCO confirmed.
52	Volume-II, Section-3-VII	Cl.No.11.2.7, 11.2.8, 12.2.7 & 12.2.8 Page - 818 of 1003 & 822 OF 1003	HT MOTORS & LT MOTORS	Bidder to note and confirm that all motors shall be rated for voltage and frequency variation as mentioned in Cl.No.4.14.02 of VOL-II/SEC-XVIII of Bid Document.	SEPCO confirmed.
53	Volume-II, Section-3-VII	Cl.No.11.4.4 & 12.4.4 Page - 819 of 1003 & 823 of 1003	HT MOTORS & LT MOTORS	Bidder to note and confirm that temperature rise over 50 deg.C ambient of all motors shall be limited to Class B as per Cl.No.4.14.09 of VOL-II/SEC-XVIII of Bid Document.	SEPCO confirmed.
54	Volume-II, Section-3-VII	Cl.No.11.6.0 & 12.6.0 Page - 820 of 1003 & 824 of 1003	HT MOTORS & LT MOTORS	Bidder to note and confirm that terminal box of all motors shall comply to Cl.No.4.14.11 of VOL-II/SEC-XVIII of Bid Document.	SEPCO confirmed.
55	Volume-II, Section-3-VII	Cl.No.11.7.7 Page - 821 of 1003	HT MOTORS & LT MOTORS	Bidder to note and confirm that CT used for motor differential protection shall be Class PS.	SEPCO confirmed that for differential protection depending upon relay manufacturer's requirement suitable CT of 5P 30/ 5P 20 as per application checks shall be supplied. WPCPL / DCPL agreed.
56	Volume-II, Section-3-VII	Cl.No.17.1.0 Page - 836 of 1003	CONTROL & RELAY PANEL	Bidder to note and confirm that degree of protection of control & relay panel shall be IP32.	SEPCO confirmed.
57	Volume-II, Section-3-VII	Cl.No.23.4.0 Page - 871 of 1003	EMERGENCY DG	Bidder to note and confirm that degree of protection of DG control panel shall be IP 42.	SEPCO confirmed.

C. Nandurkar (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
58	Volume-II, Section-3-VII	Cl.No.25.0.0 Page - 877 of 1003	400kV SWITCHYARD	Bidder to note and confirm that all 400kV switchyard equipments shall be rated for Power frequency withstand voltage of 630 kV rms, Lightning impulse withstand voltage of 1425kVp and switching impulse withstand voltage of 1050kVp.	SEPCO confirmed.
59	Volume-II, Section-3-VII	Cl.No.25.1.0 Page - 877 of 1003	400kV SWITCHYARD	Bidder to note and confirm that creepage distance of insulator/bushing for 400kV system shall be considered as 25mm/kV as per Tender Specification.	SEPCO confirmed.
60	Volume-II, Section-3-VII	Cl.No.25.0.0 Page - 877 of 1003	400kV SWITCHYARD	Bidder to note and confirm that various clearances shall be considered for switchyard design as mentioned in Cl.No.4.11.04 of VOL-II/SEC-XVIII of Bid Document and CBIP Manual of Sub-station & IE Rule.	SEPCO confirmed.
61	Volume-II, Section-3-VII	Cl.No.25.1.0-(4) Page - 878 of 1003	400kV SWITCHYARD	Bidder to note and confirm that separate CT & PT shall be considered for owner's tariff metering as per Cl.No.3.09.05 of VOL-II/SEC-XVIII of Bid Document..	Already discussed.
62	Volume-II, Section-3-VII	Cl.No.25.3.0-(6) Page - 879 of 1003	400kV SWITCHYARD	Bidder to reconfirm the numbers of poles of 400kV circuit breaker and isolators.	SEPCO agreed that these details will be discussed & finalise during detailing.
63	Volume-II, Section-3-VII	Cl.No.25.5.0 Page - 879 of 1003	400kV SWITCHYARD	Bidder to note and confirm that the switchyard breakers shall have arrangement to take care of uniform distribution of voltage during break.	SEPCO confirmed.
64	Volume-II, Section-3-VII	Cl.No.25.3.0 Page - 879 of 1003	400kV SWITCHYARD	Bidder to note and confirm that all 400kV breaker shall be synchronizing duty class only. Necessary IEC compliance to prove that breaker is of synchronizing duty shall be established.	SEPCO confirmed that all 400 kV breakers will be of synchronizing duty class only.
65	Volume-II, Section-3-VII	Cl.No.25.3.0 Page - 879 of 1003	400kV SWITCHYARD	Bidder to note and confirm that number of trip coils of 400kV breakers shall be two.	SEPCO confirmed.

C. Navaneet (WPCPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
F)	GENERAL COMMENTS				
1	—	—	—	SEPCO-1 has not submitted the duly filled up data sheets. The comments mentioned on data sheet below are the minimum. SEPCO to note and ensure that the complete data will be provided after contract and along with basic design.	SEPCO confirmed.
2	—	—	—	All electrical equipments and systems shall comply the relevant IEC/IEEE as indicated in the enclosed List of Standards (Annexure-A).	Will be discussed separately
3	—	—	—	Bidder to note that all the tests as indicated in List of Tests (Annexure-B) enclosed shall be conducted. Detailed QAP of manufacturer shall be submitted for review & approval of owner.	Will be discussed separately
4	—	—	—	Bidder to note and confirm that all electrical and instrument panel tags shall be in English only.	SEPCO confirmed.
5	—	—	[illegible]	[illegible]	SEPCO confirmed to provide as per [illegible] during basic design
6	—	—	—	Bidder to note that 2 x 100% 11kV feeders instead of 4 nos. as specified in Tender Spec, to feed 5.5MW loads of Raw Water Intake P/H and Intermittent P/H shall be considered in 11kV Station Switchboard. Bidder to also note that two nos. suitably rated 11/33kV step up transformers (7.5MVA corresponding to 5.5MW) for Raw Water Intake P/H and Intermittent P/H shall be considered in his scope of supply. Scope of works for this purpose will be the 33kV outdoor bushings of 11/33kV step up transformers. Supply and installation of 11kV cables and 11/33kV step up transformers shall be considered in bidder's scope.	SEPCO agreed to provide 2 nos of 11kv feeders for RWPH and 2 nos of 11kv feeder for colony supply.
7	—	—	—	2 x 100% uncabled out going feeders in 11kV station switchboard to feed colony loads shall be provided as mentioned in Cl.No.4.04.04 of VOL-II/SEC-XVIII of Bid Document. Bidder to note that each feeder considered for this purpose shall be rated for minimum 630 Amp.	

C. Narshul (WPGPL)

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
8	—	—	—	Tropical Protection - All electrical equipments, accessories and wiring shall have fungus protection involving special treatment of insulation of and metal against fungus, insects and corrosion.	SEPCO agreed.
9	—	—	—	Bidder to note that all electrical equipments rating shall be established by calculation as per sizing criteria mentioned in Bid Document and subject to approval of Owner.	SEPCO agreed to submit the calculation for sizing during detailing
10	—	—	—	Bidder to note that all electrical equipments shall be design for ambient of 50 deg.C and shall be suitable for operation at ± 10% voltage and ± 5% frequency variation and combined variation of voltage & frequency of 10% (except for generator voltage & frequency variation).	WPCPL insisted that SEPCO to consider voltage & frequency variation as per specification as it is minimum requirement to get grid connectivity and to run the power plant in parallel with the grid. WPCPL requested SEPCO to meet above requirement with additional cost when they submit revised contract price. WPCPL agreed for additional contract price. SEPCO to revert back.
11			GENERAL	Sizing as proposed in the offer can not be accepted. As an EPC contractor SEPCO shall furnish the sizing of equipment inline with the design criteria of tender specification and establish all sizing meeting approval of the owner in basic design stage.	SEPCO agreed.
				Vendor list for all Electrical equipments shall be provided before ordering	Refer Annexure - B6
				All test as per Annexure - B3 shall be carried out.	SEPCO agreed
				Electrical equipments / systems shall comply with International Standards as per Annexure - B2	SEPCO agreed

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Electrical equipments / systems shall comply the following International Standards

Standards	Descriptions
IEC-60034 (Part-1 to Part-19)	Rotating electrical machines
IEC-60044-1	Current transformers
IEC-60044-2	Voltage transformer
IEC-60044-4	Instrument transformers: Measurement of Partial Discharges
IEC-60051(Part-1 to Part-9)	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60076 (Part-1 to Part -5)	Power transformers
IEC-60076-10	Determination of transformer and Reactor Sound Levels
IEC-61095	Electromechanical Contactor for household and similar purposes
IEC-60099-425	Metal oxide surge arrestors without gaps
IEC-60129	Alternating Current Disconnectors (Isolators) and Earthing switches
IEC-1129	Alternating Current Earthing Switches induced Current switching
IEC-60137	Insulated bushings for alternating voltages above 1000V
IEC-60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V.
IEC-60183	Guide to the selection of high voltage cables
IEC-60189 (Part-1 to Part- 7)	Low frequency cables and wires with PVC insulation and PVC sheath
IEC-60214	On-Load-Tap-Changers
IEC-60233	Tests on hollow insulators for use in electrical equipment
IEC-60255 (Part-1 to Part-23)	Electrical relays
IEC-60265 (Part-1 to Part 2)	High voltage switches
IEC-60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC-60289	Reactors
IEC-60297 (Part-1 to Part- 4)	Dimensions of mechanical structures of the 482.6mm(19 inches) series
IEC-60376	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	Radio interference Test on high voltage insulators
IEC-60507	Artificial pollution tests on high voltage insulator to be used on AC systems
IEC-60694	Common specification for high voltage switchgear & control gear standards
IEC-60815	Guide for selection of insulators in respect of polluted conditions
IEC-60865 (Part-1&	Short Circuit Current – Calculation of effects

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Standards	Descriptions
Part-2)	
IEC-60354	Loading Guide for oil –immersed power transformers
IEC-62271-100	High voltage alternating current circuit breakers
IEC-62271-102	Alternating current disconnectors and earth switches
IEC-60427	Synthetic Testing of High Voltage alternating current circuit breakers
IEC-61264	Pressurized Hollow Column Insulators
IEC-60358	Coupling capacitors and capacitor dividers
IEC-60481	Coupling Devices for power line carrier systems
IEC-60529	Degree of protection provided by enclosures
IEC-60947-4-1	Low voltage switchgear and control gear
IEC-60439 (Part-1&2)	Low voltage switchgear and control gear assemblies
IEC-60353	Line traps for A.C. power systems
IEC-60495	Single sideboard power line carrier terminals
IEC-60683	Planning of (single side-board)power line carrier systems
IEC-60359	Expression of the performance of electrical and electronic measuring equipment
IEC-60387	Symbols for alternating-current electricity meters
IEC-60447	Man Machine Interface (MMI)-actuating principles
IEC-60521	Class 0.5,1,and 2 alternating current watt hour meters
IEC-60547	Modular plug-in unit and standard 19-inch rack mounting unit based on NIM standard(for electronic nuclear instruments)
IEC-60305	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for ac. Systems characteristics of string insulator units of the cap and pin type
IEC-60372 (1984)	Locking devices for ball and socket couplings of string insulator units: dimensions and tests
IEC-60383 (Part-1&2)	Insulators for overhead lines with a nominal voltage above 1000V
IEC-60433	Characteristics of string insulator units of the long rod type
IEC-60471	Dimension of clevis and tongue couplings of string insulator units
IEC-60227(part 1 to 7)	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750
IEC-60228	Conductor of insulated cables
IEC-60230	Impulse tests on cables and their accessories
IEC-60287 (Part-1 to 3)	Calculation of continuous current rating of cables (100% load factor)
IEC-60304	Standard colours for insulation for low- frequency cables and wires
IEC-60331	Fire resisting characteristic of electric cables
IEC-60332 (Part-1 to 3)	Tests on electric cables under fire conditions
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from

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Standards	Descriptions
	1kV up to 30kV
IEC-754 (Part-1 to 2)	Tests on gases evolved during combustion of electric cables
IEC-60071	Insulation Co-ordination
IEC-60060	High voltage test techniques
IEC-60270	Partial discharge measurement
IEC-61233	Guide for inductive load switching
IEC-60298	AC metal enclosed switchgear and control gear up to 52kV
IEC-105	Bus bars (Aluminium)
IEC-61641	Enclosed low voltage switchgear and control gear assemblies. Guide for testing under conditions of arcing due to internal fault
IEC-60292	Starters
IEC-60146	Semiconductor converters and Pulse transformer
IEC-61000-1995	Electromagnetic compatibility (EMC)
IEC-60148	Semiconductor rectifier assemblies and thyristor converters
IEC-60034-34	Guide for testing three phase induction motors
IEC-60079	Classification of hazardous areas
IEC-60896	Lead acid type With Plante positive plate
IEC-60309	Plugs, socket-outlets and couplers for industrial purposes
IEC-60598	Luminaries : General requirement
IEC-60726	Dry type power transformers
IEC-60870	Telecontrol equipment and systems
IEC-60874	Conductors for optical fibres
IEC-60921	Ballasts for tubular florescent lamps – Performance requirements
IEC-60929	AC-supplied electronic ballasts for tubular fluorescent lamps – Performance requirements
IEC-61850	Communication networks and systems in sub stations
IEC-60364	Electrical installations of buildings
IEEE-80 Std. 2000	Guide for safety in Alternating Current Sub station grounding
IEEE-665	Guide for generating station grounding
IEEE-446	Emergency standard power systems
IEEE-485	Recommended practice for sizing large lead acid storage batteries for generating stations and sub-stations
IEEE-519	Harmonic limits in power systems
IEEE-32	Requirements, Terminology and test procedure for Neutral Grounding Devices.
IEEE-48	Test Procedures and Requirement for High Voltage Alternating Current Cable terminations.
IEEE-81	Measuring Earth Resistivity Ground Impedance and Earth Surface Potentials of a Ground System.
ANSI/IEEE-242	Protection and Co-ordination of Industrial and Commercial Power

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Standards	Descriptions
	Systems.
IEEE-422/1986	Guide for the Design and Installation of Cable Systems in Power Generating Stations.
IEEE/ 450-1995	Recommended Practice for maintenance, testing and replacement of Large lead Storage Batteries for Generating Stations and Substations.
IEEE-484	Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Sub-stations.
IEEE/ 605 1998	Guide for Design of Sub-station Rigid Bus Structures.
IEEE/ 979 -1979	Guide for Sub-station Fire Protection.
IEEE/ 62.1/1984	IEEE Standard for Surge Arrestors for AC Power Circuits.
IEEE PAS VOL-97	Generator Neutral Grounding Some Aspects of Application for Distribution Transformer with Secondary Resistor and Resonant Types.

All electrical installation shall comply the following statutory regulations / acts / standard.

Indian Electricity Act 1910
Electricity Supply Act, 1948
Indian Electricity Rules
Indian Electricity Act 2003
Tariff Advisory Committee (TAC)
Central Bureau of Irrigation and Power (CBIP)
Protection of buildings and allied structures against lightning (IS-2309)
Other local statutory requirement

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ANNEXURE-B3

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
1	Generator	Retaining Rings	Chemical Prperties	
			Mechanical Properties	
			Elec / Electromagnetic	
			Liquid Penetration Inspection	
			Ultrasonic Test	
			Visual & Dimensional	
		Hubs	Chemical Properties	
			Mechanical Propeties	
			Heat Treatment	
			Ultrasonic Test	
			Visual & Dimensional	
		Complete rotor	Chemical Prperties	
			Mechanical Properties	
			Elec / Electromagnetic	
			Heat Treatment	
			Micro Structure	
			Magnetic Particle Inspection	
			Ultrasonic Test	
			Residual Stress	
			Visual & Dimensional	
		Bearing Shells	Chemical Properties	
			Mechanical Properties	
			Heat Treatment	
			Ultrasonic Test	
			Visual & Dimensional	
		Machine Assembly and Testing	Mechanical Performance	
			Electrical Performance testing as per IEC-60034 and Tender Specification (Including HV Test on Stator & Rotor after Performance Test)	

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Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
2	HT Transformer	Routine Test	Measurment of winding resistance	
			Measurment of voltage ratio & check of voltage vector relationship	
			Measurment of impedance voltage / short circuit impedance (principal tapping) and load loss.	
			Measurment of no load loss and current	
			Measurment of insulation resistance	
			Dielectric Test	
			Oil leakage Test	
			Vacuum Test	
			Pressure Test	
		Type Test	Temperature rise test	
			Pressure Relief device test	
			Measurment of capacitance and tan delta	
		Special Test	Measurment of zero sequence reactance	
			Measurment of acoustic noise level	
			Measurment of power taken by fans and oil pumps	
			Measurment of harmonic level on no load current	
			One Cooler control cabinet of each type	
			HV withstand test on auxiliary equipment and wiring after complete assembly.	

C. Navekar (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
3	LT Transformer	Routine Test	Measurment of winding resistance	
			Measurment of voltage ratio & check of voltage	
			Measurment of impedance voltage / short circuit	
			Measurment of no load loss and current	
			Measurment of insulation resistance	
			Dielectric Test	
			Oil leakage Test	
			Vacuum Test	
			Pressure Test	
		Additional Test	Temperature Rise Test	
			Measurment of Zero Sequence impedance	
			Measurment of acoustic noise level.	
4	HT Switchgear	Routine Tests	Completeness including internal clearance	
			Dimensional Checks including paint thickness	
			Physical Condition	
			Power frequency test on main and auxiliary circuit	
			Rack - in and out operation	
			Verification of wiring and ferruling	
			Paint shade thickness and adhesion	
			Functional and operational test on compartments, Earthing truck including interlock	
			Contact alingment - By breaker rack in / rack out	
			Interchangibility of breakers	
			Earthing arrangement	
			Bus bar tightness by torque wrench method	
			BOM checking	

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
5	LT Switchgear	Routine Tests	Visual /Dimensional Checks BOM checking Functional Checking IR test Dielectric test	
6	HT Cables	Routine Test	1. Acceptance Testing: a) Conductor Resistance test b) High Voltage test c) Partial Discharge test d) Test on Insulation test i) Thickness ii) T.S and Elongation iii) Volume Resistivity at room temperature and at rated temperature iv) Hot Set test 2. F.R.L.S Test: a) Test on outer sheath i) Thickness ii) T.S and Elongation iii) Smoke Density Test iv) Thermal Stability (PVC) test v) Oxygen Index test vi) Temperature Index test vii) HCL gas generation test viii) Flammability test ix) Swedish Chimney test (Not applicable for cables having overall diameter above 70mm)	

C. Nanchal (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
7	LT Cables	Routine Test	1. Acceptance Testing: a) Conductor Resistance test b) High Voltage test c) Partial Discharge test d) Test on Insulation test i) Thickness ii) T.S and Elongation iii) Volume Resistivity at room temperature and at rated temperature	
			2. F.R.L.S Test: a) Test on outer sheath i) Thickness ii) T.S and Elongation iii) Smoke Density Test iv) Thermal Stability (PVC) test v) Oxygen Index test vi) Temperature Index test vii) HCL gas generation test viii) Swedish Chimney test (Not applicable for cables having overall diameter above 70mm)	

C. Nandi (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
8	HT Motors	Material	Shaft (Blank) : i) Dimensional and Visual check ii) Ultrasonic Test	
		Fan	D.P checks on welds	
		Fabrication	Stator frame, Shaft fabrication i) D.P Checks on welds of stator frame	
		S.C. Ring (Forged)	D.P Checks on welds / joints	
		Machhinig	Stator Frame: Final dimensional Checks Shafts: Final dimensional and visual check for bearing, seating diameter, coupling seating diameter, run out (eccentricity)	
		Bearing Housing Final Machining	Final dimensional Checks	
		Rotor / Stator Core Punching and vent spacers	a) Dimensional & Visual Check b) Burr Closing c) Quality Check of welding of vent spacers	
		Rotor complete including brazing of SC ring	a) UT of brazed joints and visual checks b) Dynamic balancing at rated speed	
		Stator Core assembly	Hot Spot test if filing is done	
		Wound Stator capsule	a) Measurement of resistance of RTDs b) Interturn insulation surge voltage test c) Resistance Measurement after wiring connection d) Ensure putty to be below bore level e) IR, HV DC test after assembly	
		VPI Process	a) Tan Delta, Delta tan delta test on indivudial phase of winding after VPI b) IR, HV AC test after VPI c) Resistance Measurement (After VPI)	

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ANNEXURE-B3

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
	HT Motors	Routine Test	Visual Checks : i) Marking on rating plates ii) Appearance and painting iii) Location and details of T.B and Accessories iv) Check of phase sequence and terminal marks v) Dimensional checks ar per OGA drawing	
			Measurement of winding, Space heater and RTDs resistance	
			Reduced voltage running test in actual direction of rotation	
			No load running and reading of current, voltage, power, bearing temperature during steady state condition	
			Shaft voltage measurement at rated frequency and voltage	
			Measurement of IR on stator winding before HV	
			IR value of space heater, RTDs and BTDs	
			Polarisation Index at 5kV	
			HV test on stator winding	
			Measurement of IR on stator winding after HV	
			IR value of space heater and winding RTDs after HV	
			Over speed Test	

C. Nandurkar (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
	HT Motors	Type Test	All the tests listed under routine test	
			Measurement of noise at no load	
			Momentary over current test duing heat run	
			Full load test	
			Temperature rise test	
			No load running and reading of current, voltage, power, breaing temperature during steady state condition and preparation of no load saturation and loss curve up to approx. 115% or rated voltage	
9	LT Motors	Routine Test	GA & Dimensional Test	
			Winding Resistance Test	
			Locked Rotor Test	
			Open Circuit Test	
			HV Test (In main ckt and space heater)	
			IR Test (In main ckt and space heater before and after HV test)	
			Over Speed Test	
			Vibration Test	
			DOP Test	
			Noise Level Test (If applicable)	

C. Nanhal (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
10	Busduct		Impulse Voltage withstand Test	
			Temperature Rise Test	
			Short circuit mechanical strength and thermal withstand test.	
			Air Leakage and water tightness test	
11	Isolator	Routine Test	Power Frequency Voltage Withstand Dry Test on the Main Circuit.	
			Voltage Withstand test on auxiliary and control circuits	
			Measurment of resistance of the main circuit	
			Mechanical operating Test	
		Type Test	Dielectric Test	
			Radio Interference Voltage Test	
			Temperture Rise Test	
			Shot time and peak withstand current test	
			Test to prove the short circuit making performance of earth fault	
			Operating and mechanical endurance test	
			Operation under severe ice condition	
			Opeertaion at the temperature limits	

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
12	Current transformer (Outdoor)	Routine Test	Polarity Test	
			Power frequency high voltage test	
			Inter turn overvolatge test	
			Resistance Measurment	
			ISF / Composite Eror	
			Knee Poiint Voltage Measurment for PS Class CTs	
			Accuracy Test	
			Capacitance & tan delta measurments	
			Partial Discharge test	
		Type Test	Short Time Current tests	
			Temperature Rise Test	
			Lightning Impulse test	
			Switching Impulse Voltage Test	
			High Voltage power frequency wet withstand voltage tset	

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ANNEXURE-B3

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
13	Circuit Breaker	Routine Test	Mechanical Operation test	
			Operating speed, time and travel test	
			Contact Resistance test	
			Power frequency voltage withstand test for 1min. on main circuit	
			HV test of 2kV for 1min. On auxiliary circuit	
			Visual inspection and dimensional check	
			Spare parts checking	
			Control and auxiliary circuit checking	
			Stored energy check	
			Safety valve operation test	
			Air and Gas pressure switch check	
			Additional type test: a) Out of phase closing test as per IEC- 267 and IEC-56 b) Line charging breaking current test. The breaker shall be able to interrupt the line charging current with a test voltage of 1.4p.u instead of 1.2 p.u as per IEC- 56 c) Seismic withstand test in unpressurised condition d) Corona extinction voltage test	

C Nanchuk (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
14	Lightning Arrester	Routine Test	Measurement of power frequency, voltage at reference current	
			Measurement of reference current	
			Measurement of partial discharge	
			Test on discharge counter	
			Visual and dimensional checks	
15	Voltage Transformer	Type test	Temperature rise test	
			Lightning impulse test for voltage transformer for service in electrially exposed installation	
			Switching impulse voltage test for voltage transformer of 420kV and above	
			High voltage power frequency wet withstand voltage test on outdoor voltage transformers up to and including 245kV	
			Determination of errors or other characteristics according to the requirements of the appropriate designation or accuracy class	

C Nanduri (WPCPL)

Sl. No.	Equipment	Proposed Stage for Inspection	Type of Inspection	Remarks
		Routine Test	Verification of terminal marking and polarity	
			Power frequency dry withstand test on primary winding	
			Power frequency dry withstand test on secondary winding	
			Partial discharge measurement	
			Determination of errors or other characteristics according to the requirements of the appropriate designation or accuracy class	
16	Capacitive Voltage Transformer	Type Test	Temperature rise test	
			Impulse test	
			Ferroresonance test	
			Transient response test	
			Test for Accuracy	
		Routine Test	Power frequency test	
			Capacitor voltage divider	
			Low voltage terminal of the capacitor voltage divider	
			Electromagnetic unit	
			Test for accuracy	

C Nanekar (WPCPL)

ANNEXURE- B4

6 X 600 MW SUBCRITICAL THERMAL POWER PLANT AT CHHATISGARH
TENDER CLARIFICATION, (ELECTRICAL)
PROPOSAL NO.:
NAME OF TENDERER: SEPCO ELECTRIC POWER CONSTRUCTION CORP.
DEVIATION/ SEPCO-1/ELEC/01

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
	ELECTRICAL PART					
	Vol.-II/Section-IV: SCOPE OF WORK AND TERMINAL POINTS					
1	J ELECTRICAL SYSTEM 10	12	AC uninterruptible power supply system complete with battery inverter, etc.	AC uninterruptible power supply system , etc.	Not acceptable. Each UPS shall be provided with dedicated battery for 30 minutes backup.	SEPCO agreed to provide separate battery for UPS.
	Vol.-II/Section-XVIII: DESIGN CRITERIA (ELECTRICAL SYSTEM)					

C Nandkumar (WPCPL)

27/09/08
DCPL

29.9.08)

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
2	1.04.00	1	All electrical installation work shall comply with the provisions of the CEIG, Indian Electricity Act, Indian Electricity Rules, Code of Practices by BIS, recommendation of the Tariff Advisory Committee (TAC) and all other rules and regulations applicable to the work.	All electrical installation work shall comply with the provisions of the IEC , the provisions of the CEIG, Indian Electricity Act, Indian Electricity Rules, Code of Practices by BIS, recommendation of the Tariff Advisory Committee (TAC) and all other rules and regulations applicable to the work.	As per Tender Specification.	SEPCO to note IEC is not applicable for electrical installation. SEPCO Noted & agreed.

C Nandkumar (WPCPL)

DCPL

ANNEXURE- B4

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
3	1.09.00	2	[redacted]	[redacted]	[redacted]	[redacted]
4	2.01.00	4	xviii) Excitation System	Static	Agreed	Noted

C Nandal (WPCPL)

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SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
5	2.04.00	5	i) One (1) set of brush less or static excitation system with main & pilot exciter or field suppression/flashing equipment, excitation transformer, thyristoerized rectifier, interconnecting special cables etc. complete with all equipment & accessories.	i) One (1) set of static excitation system with field suppression/flashing equipment, excitation transformer, thyristoerized rectifier, interconnecting special cables etc. complete with all equipment & accessories.	Agreed	Noted
6	2.06.02		a) The stator core shall be fabricated out of best quality grain oriented silicon steel so that losses are minimum.	The stator core shall be fabricated out of best quality grain non-oriented silicon steel so that losses are minimum.	Preferable to be grain oriented. However, non grain oriented may be considered acceptable with supporting document of manufacturer regarding their practices.	SEPCO to revert back before submission of price.
7	2.06.13	13	d) H2 gas is cooled by DM water heat exchangers located in the generator housing.	H2 gas is cooled by ACW water heat exchangers located in the generator housing.	H2 gas shall be cooled by DM water heat exchangers which in turn cooled by ACW heat exchangers.	Refer Annexure – B6

WPCPL

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
8	2.06.14	14	There shall be individual starting panels for each pump and one common signaling panel.	There shall be not individual starting panels for each pump and the signal shall be sent to DCS.	Not acceptable. Local push button stations with start and stop for each pump shall be provided for individual pump motors. A common signaling panel may be considered for monitoring at local and interfacing with DCS.	SEPCO agreed to provide Local push button with start and stop for each pump shall be provided for individual pump motors.
9	2.07.01	15	a) The dual channel excitation system shall be static or brush less type with all features including V/f limiter and protection.	a) The dual channel excitation system shall be static type with all features including V/f limiter and protection.	Agreed	Noted
10	2.07.04		Thyristor bridges design has (N - 2) redundancy. If two bridge is out of operation, the other can satisfy with the requirement of all operation conditions including 1.1 times rated excitation current and field forcing.	Thyristor bridges design has (N - 1) redundancy. If one bridge is out of operation, the other can satisfy with the requirement of all operation conditions including 1.1 times rated excitation current and field forcing.	Not acceptable. Thyristor bridge design shall have (N-2) redundancy.	SEPCO confirmed N-2 redundancy if two bridge are out of operation, the other can satisfy with the requirement of all operation conditions including 1.1 times rated excitation current except field forcing. WPCPL agreed.

C. Nandkumar (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
11	2.07.04	17	b) This comprises of essentially a two-pole field breaker and non-linear field discharge resistor.	This comprises of essentially a one-pole field breaker and non-linear field discharge resistor.	Not acceptable. Two pole field breaker with non-linear discharge resistor shall be provided.	WPCPL / DCPL insisted for 2 pole field breaker, SEPCO replied single pole field breaker shall be provided.
12	2.07.05	18	Brushless Excitation System	N/A	Agreed	Noted.

C. Nawkal (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
13	2.08.02	21	d) PLC base voltage regulator. i) Arrangement shall be made for both automatic and manual control of the voltage regulator from plant DCS. j) Follow-Up Circuits In order to avoid a sudden change from `Auto' to `Manual' operation, a motorized rheostat shall be provided to follow-up changes in `Auto' mode. An alarm and visual indication shall be provided by means of a relay to indicate changeover from `Auto' to `Manual'. Automatic changeover shall be possible from `Auto' to `Manual' in case of loss of main feed back by any of voltage transformer fuses blowing up. A center zero balance meter shall be provided for comparison of output from the error amplifier with that from the hand control potentiometer.	d),i) -----N/A j) Follow-Up Circuits In order to avoid a sudden change from `Auto' to `Manual' operation, a automatic changeover device (include in AVR) will be provided to follow-up changes in `Auto' mode. An alarm and visual indication will be provided by means of a relay to indicate changeover from `Auto' to `Manual'. Automatic changeover will be possible from `Auto' to `Manual' in case of loss of main feed back by any of voltage transformer fuses blowing up. The comparison of output from the error amplifier with that from the hand controller will be indicated on local display screen.	To be discussed	d) SEPCO confirmed Digital AVR will be provided. WPCPL / DCPL agreed. i) Voltage raise / lower possible from DCS. WPCPL / DCPL agreed. j) SEPCO clarification is acceptable to WPCPL / DCPL. SEPCO further clarified there will be 2 auto & 1 manual channel in the AVR.

C. Nandini (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
14	3.01.01	31	Voltage for AC auxiliaries	11 kV & 415/240 V	Electrical auxiliary system shall have three voltage level – 11kV, 6.6kV & 415V/240V as per Tender SLD (Drg. No. K7V12-000-DWG-E-010 1). Bidder may also consider 3.3kV system instead of 6.6kV system and quote as an optional offer.	SEPCO informed for the plants of this size, it is their standard practice to have 11kV & 415 V. SEPCO confirmed motors upto 200kW shall be 415 V & all motors above 200kW shall be with 11kV.

C Nandkumar (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
15	3.02.02	31	The bidder shall be required to carry out the detailed computer studies considering single machine with infinite bus so as to confirm the suitability of the Turbine Generator and its excitation system in the grid for maintaining the power system stability under dynamic and transient conditions and tune the PSS parameters at site for the machines. The data and worst possible conditions pertaining to Purchaser's system shall be discussed and finalized between Purchaser and the Bidder, in accordance with the system modeling techniques and depth of modeling. The Bidder shall furnish the details of simulation technique and method, which he proposes to use for this purpose.	The bidder shall be required to carry out the detailed computer studies considering single machine with infinite bus so as to confirm the suitability of the Turbine Generator and its excitation system in the grid for maintaining the power system stability under dynamic and transient conditions and tune the PSS parameters at site for the machines. The data and worst possible conditions pertaining to Purchaser's system shall be discussed and finalized between Purchaser and the Bidder, in accordance with the system modeling techniques and depth of modeling.	Details of simulation technique and method shall be provided.	SEPCO will furnish the study details during detailed engg.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
16	3.03.02	32	Boiler Feed Pump (BFP) motor shall be fed from 11kV switchboard and all other motors rated above 200kW shall be fed from 6.6kV switchboard.	Boiler Feed Pump (BFP) motor shall be fed from 11kV switchboard , all other motors rated and above 200kW shall be fed from 11kV switchboard.	Electrical auxiliary system shall have three voltage level – 11kV, 6.6kV & 415V/240V as per Tender SLD (Drg.No. K7V12-000-DWG-E- 0101). Bidder may also consider 3.3kV system instead of 6.6kV system and quote as an optional offer. Bidder to note and confirm that BFP shall be fed from 11kV switchboard and all other HT motor rated above and including 200kW shall be fed from 6.6kV switchboard. In case of 3.3kV system motors rated from 200kW upto 1500kW shall be fed from 3.3kV and motor rated above 1500kW shall be fed from 11kV. Bidder to also note that all LT service transformers shall be fed from 11kV switchboard only in both the cases mentioned above.	Refer point no. 14 above.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
35	4.06.01	47	The batteries for the DC system shall be stationary storage type, consisting of high performance lead acid plante cells along with accessories with the cells assembled in polypropylene/hard rubber container. Freestanding type Heavily galvanized with acid resistant painted steel stand will be used for plante type lead acid battery. The batteries shall be installed in single/double tier and single/double row arrangement.	The batteries for the DC system will be stationary storage type, consisting of high performance lead acid plante cells along with accessories with the cells assembled in polypropylene/hard rubber container. Maintenance free type lead acid battery will be supplied. The batteries will be installed in single/double tier and single/double row arrangement.	Not acceptable. All DC system shall have Lead Acid Plante type battery only. Maintenance free type Lead Acid Battery may be considered for UPS System. Heavily galvanized with acid resistance painted steel stand as per spec. required.	SEPCO agreed to provide Lead Acid Plante type battery for unit, station and switchyard DC battery only.

C Nandini (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
34	4.14.04	72	Motors up to 200 kW shall be 415 V rated and above 200 KW shall be of 6.6 kV rating and only BFP motor shall be 11 kV rated. Motors of rating up to 110 kW shall be contactor operated. Higher ratings shall be ACB operated. All motors above 30 kW shall have space heater for avoiding condensation during idle hours.	Motors up to 200 kW shall be 415 V rated and above 200 KW shall be of 11 kV rating and only BFP motor shall be 11 kV rated. Motors of rating up to 110 kW shall be contactor operated. Higher ratings shall be ACB operated. All motors above 30 kW shall have space heater for avoiding condensation during idle hours.	Refer Sl.No.16 commented above	WPCPL / DCPL agreed.

C Nandkumar (WPCPL)

H.C. DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
33	4.12.04	64	FRLS outer sheathed	ZRC outer sheathed	Not acceptable. It shall be Fire Retardant & Low Smoke (FRLS) type only.	SEPCO agreed to provide FRLS type cables. WPCPL / DCPL insisted that all MV, LV power & control cables shall be armoured. However SEPCO agreed to provide armoured power cables for 11 kV system and other cables in the following areas like Fuel oil handling, hydrogen generation plant, chemical handling areas, and in power house for phosphate hydrazine ammonia dosing areas and all buried cables shall be armored. All cable within the building (both the end of the cable within the same building) terminated shall be unarmoured. All the cable laid from the building to outside for field equipments shall be armoured cable. WPCPL / DCPL agreed. Fire Survival type LV power and control cables shall be provided for the services listed under Cl. No. 4.12.08 of tender specification. SEPCO agreed to provide the same as per specification

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
31	4.10.03	57	The main lighting distribution board (MLDB) shall be supplied from PCC through 2x100% rated 415/433 V lighting transformer. For AC emergency lighting, 2x100% rated lighting transformer and emergency lighting distribution board (ELDB) shall be considered.	The main lighting distribution board (MLDB) shall be supplied from lighting switchboard. Lighting transformer shall be provide for the lighting system. For AC emergency lighting, 1x100% rated lighting transformer and emergency lighting distribution board (ELDB) shall be considered.	Refer Sl.No. 27 above.	Refer to point No. 27 of electrical part above.
32	4.11.03	58	420 kV equipments shall be of ABB/SIEMENS/AREAVA make only.	Deleted	Not acceptable. Tender Specification prevails.	• WPCPL requested SEPCO to supply ABB / SIEMENS/ AREVA make for circuit breaker, Current transformer, voltage transformer, control & relays. SEPCO agreed to supply & shall include additional price in the revised contract offer to be submitted. WPCPL / DCPL agreed • PLCC shall be of ABB make – Type ETL 41/42.

C Nanchal (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
30		52	Each push button shall have 2 NO + 2 NC contacts, rated for 5A A.C. and 2A DC at operating voltage. Push button shall be shrouded type except for emergency stop button which shall be mushroom type for easy identification. Emergency stop button shall be pressed to lock & release by key type. As per statutory requirement, locable push button should be provided for all the local control stations including emergency stop buttons. Emergency tripping device (with glass break) shall be provided near the transformers.	Each push button shall have 2 NO + 2 NC contacts, rated for 5A A.C. and 2A DC at operating voltage. Push button shall be shrouded type except for emergency stop button which shall be mushroom type for easy identification. Emergency stop button shall be pressed to lock & release by key type. As per statutory requirement, locable push button should be provided for all the local control stations including emergency stop buttons.	Not acceptable. Emergency tripping device shall be provided near transformer for emergency tripping and isolation.	SEPCO agreed for GT, UT & ST to provide Emergency tripping device (with glass break).

C Nandhi (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
27	4.05.02	49	Each 415 V Switchgear, PCC and MCC shall have sectionalized bus with two incomers and one bus section.	Each 415 V Switchgear, PCC shall have sectionalized bus with two incomers and one bus section.	2 x 100% incomer with one bus coupler shall be provided upto 415V MCC and MLDB and ELDB. 2 x 100% feeder without bus section may be provided for other DBs.	SEPCO clarified that it is technically possible & it can be provided with additional price. WPCPL requested SEPCO to consider as per specification.
28	4.05.07	50	All SWGRs, PCCs, MCCs, DBs shall have 2 x100% incomers at two extreme end of line up.	All SWGRs, PCCs, shall have 2 x 100% incomers at two extreme end of line up.	Refer Sl. No. 27 above.	SEPCO clarified that it is technically possible & it can be provided with additional price. WPCPL requested SEPCO to consider as per specification.
29	4.06.02	52	Push button shall be oil tight, heavy duty, push to actuate type with coloured button and inscription plate marked with its function.	The push button shall be satisfy design requirement.	Please indicated specific deviation intended. However, Tender Specification shall prevail.	SEPCO agreed as per specification.

C Navaneet (WPCPL)

DCPL

ANNEXURE- B4

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
25	4.03.07	44	[redacted]	[redacted]	[redacted]	[redacted]
26	4.04.07	45	[redacted]	[redacted]	Not acceptable. Tender Specification prevails.	Not acceptable. Tender Specification prevails. OPEN POINT

C. Nandhini (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
24	Vol-II, S-XVIII Clause No. 4.02.12	Page - 44 of 118	the transformers along with all accessories and fittings shall be subjected to routine tests as per [illegible]	Partial discharge measurement shall be done on oil filled transformers as per relevant standard.	Not acceptable, Tender Specification prevails.	SEPCO agreed that the transformers along with all accessories and fittings shall be subjected to routine tests as per relevant IEC. In addition, oil leakage test on each oil filled transformer shall be carried out as routine test. Also, one no. transformer out of each size shall be subjected to vacuum test with pressure [illegible]. Each rating of transformer shall be subjected to temperature rise test as type test. Partial discharge measurement shall be done on oil filled transformers as per relevant standard and shall not be applicable for dry type transformers. WPCPL requested SEPCO to carry out the same [illegible]

C. Nandwal (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
22	4.02.05	41	GT and ST shall be provided with OLTC with ± 10% range or taps in steps of 1.25%.	GT and UT shall be OCTC. ST shall be OLTC.	Not acceptable. Tender Specification prevails.	SEPCO agreed to provide OLTC for GT & ST as per specification.
23	4.02.07	41	The GT, ST, UT and auxiliary H.T transformer shall be capable of being operated continuously on any tap at the rated MVA with voltage variation of ± 10%.	SINCE the voltage variation of 400kV system is within ± 5% the HV side tap changer of GT shall be capable of being operated continuously on any tap at rated MVA with voltage variation of ± 5%.	Not acceptable. Tender Specification prevails.	Already discussed in clarifications points.

C Nandan (WPCPL)

Dcm

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
17	3.03.03	32	Station auxiliary load like Ash Handling Plant, Coal Handling Plant, Water Treatment etc shall be fed from 11 kV station switchboards and 6.6 kV station switchboards.	Station auxiliary load like Ash Handling Plant, Coal Handling Plant, Water Treatment etc shall be fed from 11 kV station switchboards	Refer Sl.No.16 above	Refer point no. 14 above.
18	3.04.00	34	ii) Each UPS shall have separate dedicated battery.	From the DC feeder panel ,provide the separate power for UPS , the ups will have not battery.	Refer Sl.No.1 above	Refer point no. 1 of electrical part above.
20	4.02.03	40	[redacted] banks shall be provided for the [redacted]	[redacted] Isolator banks shall be provided	Not acceptable. Tender Specification prevails.	Not acceptable. Tender Specification prevails. **Open Point**
21	4.02.04		Temperature rise over ambient temperature of 50oC shall be as under: For GT a) Top oil by thermometer - 40 deg.C b) Winding by resistance - 50 deg.C	a) Top oil by thermometer - 45 deg.C b) Winding by resistance - 55 deg.C	Not acceptable. Tender Specification prevails.	SEPCO agreed as per Tender Specification.

C Navchand (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
36	4.07.03	48	The main lighting distribution board (MLDB) shall be supplied from PCC through 2x100% rated 415/433 V lighting transformer. For AC emergency lighting, 2x100% rated lighting transformer and emergency lighting distribution board (ELDB) shall be considered.	The main lighting distribution board (MLDB) shall be supplied from lighting switchboard. Lighting transformer shall be provide for the lighting system. For AC emergency lighting, 1x100% rated lighting transformer and emergency lighting distribution board (ELDB) shall be considered.	Refer Sl.No.31 commented above.	SEPCO agreed to provide with additional price.
37	4.08.02	50	c) Class-C trip mode for abnormal operating conditions and system disturbances.	N/A	Unit shall be capable to operate in house load operation and hence Class-C trip shall be considered. However, this point needs to be discussed during clarification meeting.	Refer Annexure – B6

C. Navaneel (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
38		50	CLASS-C TRIP In this mode of tripping the generator is isolated from the power system by tripping the circuit breaker connecting the state grid. The set runs with HP/ LP by pass system and generator continues to feed unit auxiliaries through Unit Transformer. All necessary relays, auxiliary relays, etc for the same shall be considered.	N/A	Refer Sl.No.37 commented above	Refer Annexure – B6
39		50	The successful bidder shall establish and submit the logic diagram of class A, B & C trips for review and approval of owner. For house load operation the grid condition or abnormalities in addition to machine requirements shall be considered.	The successful bidder shall establish and submit the logic diagram of class A, B for review and approval of owner.	Refer Sl.No.37 commented above and also note that Class-C trip also be included.	Refer Annexure – B6

C Nandkumar (WPCPL)

DCPL

ANNEXURE- B4

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
40	4.09.00	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

CNanchal (WPCPL)

DCPL

Page 23 of 30

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
41	4.10.02	54	FRLS outer sheathed	ZRC outer sheathed	Refer Sl.No.33 commented above.	Refer point No. 33 above.
42	4.10.09	58	b. Heat-shrinkable sleeve type for LT & HT cables of Raychem make	Heat-shrinkable sleeve type for LT & HT cables	Agreed. However, it shall satisfy the requirement of relevant IEC codes.	Agreed.
43	4.10.10	59	All cables shall be provided with unique numbers at both ends and at bends and floor/wall crossing for identification	All cables shall be provided with unique numbers at both ends for identification	Not acceptable. Tender Specification prevails.	SEPCO disagreed. WPCPL / DCPL insisted for the same & inform it is a good engineering practice and NO EXTRA COST
44	4.12.03	61	Motors up to 200 kW shall be 415 V rated and above 200 KW up to 1500 kW shall be of 3.3 kV rating. Motors above 1500kW shall be of 11 kV. Motors of rating up to 110 kW shall be contactor operated. Higher ratings shall be ACB operated.	Motors up to 200 kW will be 415 V ,rated and above 200 KW will be of 11 kV . Motors of rating up to 110 kW will be MCCB operated. Higher ratings will be ACB operated.	Refer Sl.No.16 commented above. In addition to this please note and confirm that motors of rating 110kW shall be SFU with contactor operated. MCCB is not acceptable for motor circuits.	Refer point No. 16. On query from WPCPL / DCPL, SEPCO confirmed that MCCB for motor control can be controlled from DCS. Incase if it is not possible to control from DCS, SEPCO shall provide SFU with contactor operated. WPCPL / DCPL agreed.

C. Nanchal (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
45	6.05.01		a) Cable vaults shall be below switchgear and control rooms as well as local control room. In case of cable vaults, minimum 3.5 M clear height shall be maintained from finished ground floor level.	Cable vaults shall be below switchgear and control rooms. In case of cable vaults, minimum 1.9 M clear height shall be maintained from finished ground floor level to bottom of the main beam.	Bidder to please note and confirm that each switchgear and control rooms shall be provided with cable vault and minimum 2.5M clear height shall be maintained from finished floor level to bottom of equipment floor level main beams on switchgear floor.	Refer Civil resolutions.
	Turbine manufacture					
2	WPCPL-TPP-VOL-II_SEC-6 – D.TURBINE 2. Critical Parameters		g) Frequency variation - 47.5 Hz to 51.5 Hz	g) Frequency variation - 48.5 Hz to 50.5 Hz	Frequency variation shall be 47.5 Hz to 51.5 Hz. The deviation is not acceptable.	SEPCO agreed.
	Steam turbine generator manufacture					

C Nanda (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
1	2.01.00 Ratings and Salient Parameters of Generator.		Excitation System		Excitation system may be static or brushless type.	SEPCO offered Static excitation system
2	2.05.00 Operating Conditions c) Extended Voltage & Frequency Variation		Generator shall be capable of delivering continuously the rated power at rated Power Factor when the voltage variation is within ±5% and the frequency variation is within +3% and –5% with temperature rises to increase by up to 10°K approximately.	See TECHNICAL PARTICULARS 1.3.3	Not acceptable. Tender Specification prevails.	SEPCO agreed to follow Tender specification.
4	2.06.02 Stator Core 2.09.00 TESTING AND INSPECTION		a) The stator core shall be fabricated out of best quality grain oriented silicon steel so that losses are minimum.	The stator core shall be fabricated out of best quality grain non-oriented silicon steel so that losses are minimum.	Preferable to be grain oriented. However, non grain oriented may be considered acceptable with supporting document of manufacturer regarding their practices.	Already discussed.

C Nankul (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
5	2.07.04. 3.	19	Thyristor bridges design has (N - 2) redundancy. If two bridge is out of operation, the other can satisfy with the requirement of all operation conditions including 1.1 times rated excitation current and field forcing.	For Testing of general assembly, only provide the type test reports of same type generator for refering. Thyristor bridges design has (N - 1) redundancy. If one bridge is out of operation, the other can satisfy with the requirement of all operation conditions including 1.1 times rated excitation current and field forcing.	Not acceptable. Thyristor bridge design shall have (N-2) redundancy as per Tender Specification.	Already discussed.
	Design institute					
1	WPCPL-TPP-ELEC-SEC-18, 4.11.01			Set two more single-phase Potential Transformer between two bus sectionalizers on each bus	Not required. However, this may be discussed further during clarification meeting.	WPCPL/ DCPL will come back during detailed engineering.

C. Nandkumar (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
2	WPCPL-TPP-ELEC-SEC-18 3.03.00		The unit auxiliary loads associated directly with running of a unit like, BF Pump, ID Fan, FD Fan, CW Pump etc shall be fed from the 11 kV & 6.6 kV unit switchboards. Boiler Feed Pump (BFP) motor shall be fed from 11kV switchboard and all other motors rated above 200kW shall be fed from 6.6kV switchboard.	The unit auxiliary loads associated directly with running of a unit like, BF Pump, ID Fan, FD Fan, CW Pump etc shall be fed from the 11 kV unit switchboards.	Electrical auxiliary system shall have three voltage level – 11kV, 6.6kV & 415V/240V as per Tender SLD (Drg.No.K7V12-000-DWG-E-0101). Bidder to provide and confirm that BFP drives shall be fed from 11kV switchboard and all other HT motors rated above and including 200 kW shall be fed from 6.6kV switchboard. Bidder to also note that all LT service transformers shall be fed from 11kV switchboard only in both the cases mentioned above.	Already discussed.

C. Nandakumar (WPCPL)

DCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
3	VOLUME II SECTION XVIII 3.07.01		Accordingly, Local Push button stations shall be provided near all motors for starting & stopping.	Only emergency push button will be provided near each motor.	Not acceptable. Tender Specification prevails.	Already discussed.
4	VOLUME II SECTION XVIII 3.09.02		Separate sets of CTs and PTs shall be provided for the back-up metering system.	No CTs and PTs for the back-up metering system	Not acceptable. Separate CT & PT for Tariff metering system shall be provided.	SEPCO will provide separate CT & EMVT for main & check tariff metering.
5	VOLUME II SECTION XVIII 3.09.03		Motor Control Centers Voltage measured on each bus. Current measured on each feeder.	Current measured on feeder of Motor rated above 55kW.	Not acceptable. Current shall be measured on feeder of motor rated above 30kW and all important motors rated below 30kW.	AS per specification SEPCO agreed to provide Ammeter above 30 kW.
6	VOLUME II SECTION XVIII 4.04.13		Differential protection (87M) for motor rated above 1000kW	Differential protection (87M) for 11kV motor rated above 2000kW.	Not acceptable. Differential protection shall be provided for all motors rated above 1000 kW.	SEPCO will offer with additional price.

C. Nawab (WPCPL)

DCP2

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
7	VOLUME II SECTION XVIII 4.11.02		All outgoing line feeders bus side breakers, isolators shall be controlled from both switchyard control room & central control room where as generator transformer and station transformer feeder shall be controlled from central control room and also all central breakers with isolators shall be controlled from both the control room.	Switchyard control room will be supplied, but nobody will be on duty normally in switchyard contro room, 400kV circuit breakers and isolators will be controlled by DCS and/or NCS (network control system) in central control room.	Control Philosophy shall be as per Tender Specification.	SEPCO will offer SCADA for switchyard control which will be located in switchyard control room for monitoring & control. SEPCO agreed to provide 1 terminal of SCADA in central control room for monitoring & control. SEPCO also agreed to provide the monitoring of switchyard parameters at DCS in central control room.
	General Comment					
					2008.9.22 disagree	**WPCPL / DCPL has given specification to SEPCO & SEPCO has gone through the specification & listed their deviations under deviation schedule.** **All the deviations have been discussed above. There is no other deviation observed by SEPCO from specification.**

C Nandhini (WPCPL)

DCPL

ANNEXURE- B5

SCOPE OF WORK AND TERMINAL POINTS

SECTION-IV
SCOPE OF WORK AND TERMINAL POINTS

The offer shall comprise the design, material selection, manufacturing, testing at works, supply, installation, performance testing at site, commissioning and other related items of work for all plant and equipment, inclusive of all civil, structural and architectural works necessary for a complete working power station, including but not limited to the following (one set per unit, except for systems common for all the units).

The bidder may note that a complete EPC offer including all BTG (Boiler, Turbine & Generator) activities and BOP (Balance Of Plant) activities including all civil and structural works is preferred. If any Bidder prefers to offer only BTG or only BOP equipments, accessories and services, the scope shall include the relevant civil and structural work and other services also. The offer shall clearly identify all the following items in terms of scope of work and services:

SL. NO.	ITEMS	WHEATHER REQUIRED		
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	SEPC REPL (EPC Sub critic super critic
	ELECTRICAL SYSTEM			
1.	Main Generators with Excitation system, Automatic Voltage Regulation, Surge Protection and Neutral Grounding Equipment and necessary controls.	Yes	BTG	Yes
2.	Generator Transformers with required tap-changer and all other fittings & accessories and Lightning Arrestors.	Yes	BTG	Ye
3.	Station and Unit Transformers with required tap-changers and all other fittings & accessories, neutral grounding resistors and Lightning Arrestors.	Yes	BTG	Ye
4.	HT & LT Auxiliary Distribution Transformers complete with all fittings and accessories.	Yes	BTG/BOP for their respective areas.	Yes
5.	Generator Bus duct of isolated phase design, consisting main, tap-off sections and delta ducts complete with associated equipment.	Yes	BTG	Yes
6.	HV Busducts.	Yes	BTG/BOP for their respective areas.	Yes

SL. NO.	ITEMS	WHEATHER REQUIRED		
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	SEPCO REPLY (EPC – Sub critical super critical
7.	LV Busducts.	Yes	BTG/BOP for their respective areas.	Yes
8.	MV and LV Switchgears/Power Control Centres, Emergency Switchboard, Motor Control Centres, Distribution Boards, Starters for AC/DC drives, Fuse Boards etc.	Yes	BTG/BOP for their respective areas.	Yes
9.	Battery, Battery Charger and DC Supply Distribution system complete with interconnection facility.	Yes	BTG/BOP for their respective areas.	Yes
10.	AC uninterruptible power supply system complete with battery inverter, etc.	Yes	BTG/BOP for their respective areas.	Yes
11.	[redacted]	[redacted]	[redacted]	[redacted]
12.	[redacted]	[redacted]	[redacted]	[redacted]
13.	Control, protection and metering systems including control/relay panels & synchronization panel for generator & transformers.	Yes	BTG	Yes
14.	All Local panels, local P.B. stations, Junction boxes & Local Control stations.	Yes	BTG/BOP for their respective areas.	Yes
15.	400 kV switchyard complete with all equipment, safety devices, protective relaying, controls, metering etc.	Yes	BOP	Yes
16.	[redacted]	[redacted]	[redacted]	[redacted]

C Nautiyal (apppl)

SL. NO.	ITEMS	WHEATHER REQUIRED		
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	SEPC REPLY (EPC - Sub critical super critic
				[redacted]
17.	Cables and cable raceway system with necessary fire barriers, fire proof sealing and coating systems	Yes	BTG/BOP for their respective areas. Interface cabling shall be in scope of BOP	Ye
18.	Grounding and Lightning protection systems	Yes	BTG/BOP for their respective areas. Interconnection shall be under scope of BOP	Yes
19.	Electrical laboratory equipment	Yes	BOP	Yes
20.	DG sets for emergency power supply	Yes	BOP	Ye

C Nautal (apply)

SL. NO.	ITEMS	WHEATHER REQUIRED		
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	SEPCO REPLY (EPC – Sub critical super critical
21.	Neutral Grounding Resistors	Yes	BTG/BOP for their respective areas.	Yes
22.	AC Motors, DC Motors & Motors Actuators	Yes	BTG/BOP for their respective areas.	Yes
23.	Electrical system for auxiliary plants & other peripherals such as CHP, AHP, CWP etc.	Yes	BOP	Yes
24.	24V DC for C&I loads	Yes	BTG	Refer C I
25.	48V DC system for switchyard PLCC system and Plant communication system	Yes	BOP	Yes
26.	33 kV Construction power supply system within plant boundary at one point. Refer drawing No. K7V12 – 000 – DWG – E – SK01, Rev 1	Yes	BTG/BOP for their respective areas.	Yes
27.	SCADA for switchyard control and interface with main DCS	Yes	BOP	Yes
21.	Route survey for transport of large and heavy equipment up to site	Yes	BTG/BOP	

NOTE :

The above list of work is not exhaustive. Any additional works, whether or not specifically described in this bid document, incidental to complete the power plant in all respects shall be deemed to be in the scope of work of the EPC Contractor.

C Nautiyal (WPCL)

	TERMINAL POINTS (FOR COMPLETE EPC PACKAGE)	
1.	Main road entry at plant boundary	
2.	Rail - MGR rail-track with railway siding will be provided by the Owner.	
3.	Raw water supply – at one point at the plant boundary.	
4.	Drinking water supply point to the colony at the plant boundary.	
5.	Coal - outlet from BOBR wagons.	
6.	Fuel Oil - at fuel oil wagon/road tanker outlet flange (Rail by Owner).	
7.	Ash - at ash dump yard. (Ash dump yard is also in Bidder's scope)	
8.	Storm water drainage system - at plant boundary.	
9.	Telecommunication in control room.	Yes
10.	Outgoing gantries in 400 kV switchyard complete with line- connections insulators.	Yes, except line insulators.
11.	Construction Water at one point on plant boundary	
12.	Land - in as acquired condition for plant area would be made available to the EPC contractor.	
13.	11 kV terminals for power supply to colony.	4 Nos. 11 kV uncabled transformer feeders.
14.	Construction Power at one point within plant boundary	Yes

6 X 600 MW SUBCRITICAL THERMAL POWER PLANT AT CHHATISGARH
TENDER CLARIFICATION, (ELECTRICAL)
PROPOSAL NO.:
NAME OF TENDERER: SEPCO ELECTRIC POWER CONSTRUCTION CORP.
DEVIATION/ SEPCO-1/ELEC/01

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
	ELECTRICAL PART					
7	2.06.13	13	d) H2 gas is cooled by DM water heat exchangers located in the generator housing.	H2 gas is cooled by ACW water heat exchangers located in the generator housing.	H2 gas shall be cooled by DM water heat exchangers which in turn cooled by ACW heat exchangers.	SEPCO agreed to provide ACW cooled.
14	3.01.01	31	Voltage for AC auxiliaries	11 kV & 415 V	VFD's as considered shall be clarified	Coal feeders and HCSD drive shall be VFD control. SEPCO agreed.
37	4.08.02	50	c) Class-C trip mode for abnormal operating conditions and system disturbances.	N/A	Unit shall be capable to operate in house load operation and hence Class-C trip shall be considered. However, this point needs to be discussed during clarification meeting.	WPCPL, SEPCO & manufacturer will seat together to discuss the issue after the award of contract to SEPCO.

C Navaneeth (PP&PY)

M.S. Babhulekar

SEPCO

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	WPCPL/DCPL comments	Resolution
38		50	CLASS-C TRIP In this mode of tripping the generator is isolated from the power system by tripping the circuit breaker connecting the state grid. The set runs with HP/ LP by pass system and generator continues to feed unit auxiliaries through Unit Transformer. All necessary relays, auxiliary relays, etc for the same shall be considered.	N/A	Refer Sl.No.37 commented above	WPCPL, SEPCO & manufacturer will seat together to discuss the issue after the award of contract to SEPCO.
39		50	The successful bidder shall establish and submit the logic diagram of class A, B & C trips for review and approval of owner. For house load operation the grid condition or abnormalities in addition to machine requirements shall be considered.	The successful bidder shall establish and submit the logic diagram of class A, B for review and approval of owner.	Refer Sl.No.37 commented above and also note that Class-C trip also be included.	WPCPL, SEPCO & manufacturer will seat together to discuss the issue after the award of contract to SEPCO.

C Nadeem (WPCPL)

M.S. Pathrudkar DCPL

20.8.28

BID CLARIFICATION FOR 3600 MW COAL BASED POWER PROJECT AT NARIYARA, CHHATISGARH

TECHNICAL BID FOR 6 x 600 MW SUB CRITICAL UNIT

Bidder's Name & Address :SEPCO-I

Annexure - B6 part -2

Technical

Discipline - Electrical

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
A)	**VOL-II-SECTION-5-II : DRAWING & DIAGRAM**				
1	Volume-II, Section-5-II	—	GENERAL LAYOUT	Switchyard shall be shifted to the fourth quadrant (South-East quadrant) of the Plot, with adequate space for locating outgoing transmission towers.	Refer general layout resolutions.
2	Volume-II, Section-5-II	—	GENERAL LAYOUT	Rails for maintenance and transportation of transformers (GT, ST & UT) shall be provided upto one of the STG maintenance bays.	Refer general layout resolutions.
3	Volume-II, Section-5-II	—	GENERAL LAYOUT	The foundation of transformers (mainly generator transformers) is fouling with CW piping. Please clarify, how it will be taken care of.	Refer civil resolutions.
4	Volume-II, Section-5-II	—	GENERAL LAYOUT	Two station transformer shall be installed in Phase-I. In general layout only one station transformer is indicated in Phase-I. Please check and clarify.	SEPCO shall revise drawings.
5	Volume-II, Section-5-II	—	GENERAL LAYOUT	Generator Transformer 4 & 5 are close to each other. Please check and clarify.	SEPCO shall revise drawings.
7	Volume-II, Section-5-II	—	GENERAL LAYOUT	Marshalling boxes in the field shall be located at 1 m above the Finished Ground Level.	SEPCO agreed.
D)	**VOL-II-SECTION-3-III - TECHNICAL DESCRIPTION**				
2	Volume-II, Section-3-III	Cl.No.3.3.5 Page - 366 of 1003	TECHNICAL DESCRIPTION	Motor driven BFP shall be controlled through hydraulic coupling (VOITH, Germany make). Bidder to also indicate the VFD applications for motors.	Refer Mechanical
E)	**VOL-II-SECTION-3-VII - DATA SHEETS (ELECTRICAL)**				
6	Volume-II, Section-3-VII	Cl.No.1.10.2-(a) Page - 751 of 1003	GENERATOR & ACCESSORIES	Bidder to note and confirm that 2 x 100% AC seal oil pump (one normal & one emergency) with 1 x 100% DC emergency seal oil pump shall be provided on both air and hydrogen side.	SEPCO agreed.
7	Volume-II, Section-3-VII	Cl.No.1.11.6 Page - 753 of 1003	GENERATOR & ACCESSORIES	Hydrogen cylinders and carbon dioxide cylinders shall be included in scope of bidder.	Refer Mechanical.
			GENERAL	Vendor list for all Electrical equipments like Generators, Transformers, Switchgear etc. shall be provided before ordering	Refer General

BID CLARIFICATION FOR 3600 MW COAL BASED POWER PROJECT AT NARIYARA, CHHATISGARH

TECHNICAL BID FOR 5 x 660 MW SUPER CRITICAL UNIT

Bidder's Name & Address :SEPCO-I

Annexure - B7

Technical

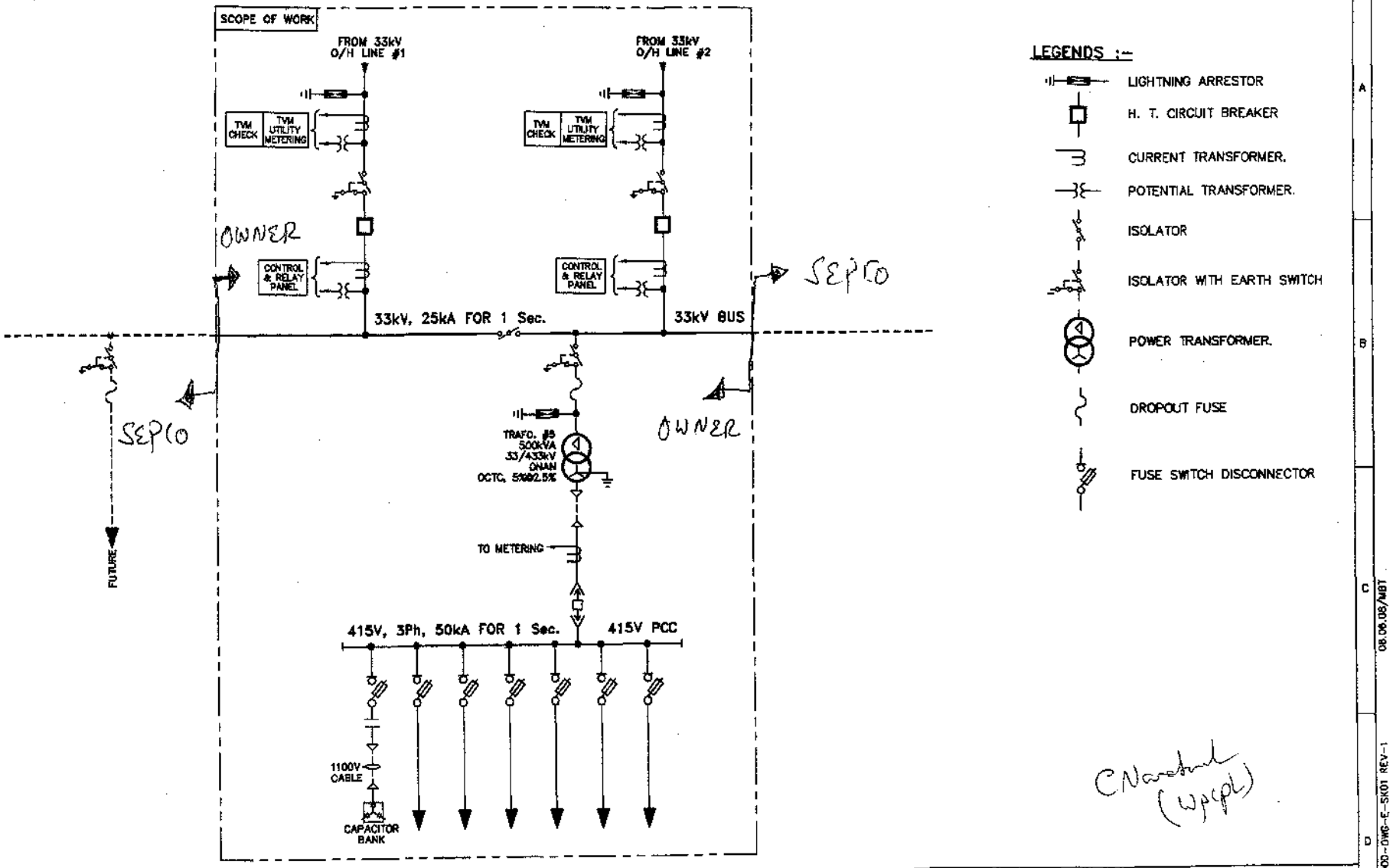
Discipline - Electrical

Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
A)	5 X 660 MW SUPER CRITICAL OFFER				
1			GENERAL	Comments, clarifications, deviations & resolutions thereon of 6 x 600 MW shall be valid for 5 x 660 MW offer of SEPCO to the extent applicable.	SEPCO agreed.
2	Volume-II, Section-5-II	—	MAIN CIRCUIT SLD	Three numbers station transformers shall be provided. Two station transformer shall be installed in Phase-I & one shall be installed in Phase-II. Please correct the SLD accordingly. Also marke phase - I & phase II scope correctly. No of Switchyard bays has to be corrected in view of same.	SEPCO agreed.
3	Volume-II, Section-5-II	—	MAIN CIRCUIT SLD	Rating of Generator Transformer shall be 275MVA instead of 250MVA and also busduct shall be accordingly sized.	SEPCO agreed.
4			GENERAL	Sizing as proposed in the offer can not be accepted. As an EPC contractor SEPCO shall furnish the sizing of equipment inline with the design criteria of tender specification and establish all sizing meeting approval of the owner in basic design stage.	SEPCO agreed.

C Nanchurt (WPCPL)

27/09/08 DCPL

SEPCO



REVIEWED											
					MBT	GENERALLY REVISED	3 rd ISSUE	1	06.06.08	SLD FOR CONSTRUCTION POWER SUPPLY ARRANGEMENT	DEVELOPMENT CONSULTANTS PVT.LTD CONSULTING ENGINEERS KOLKATA • MUMBAI • CHENNAI • NEW DELHI
					MBT	GENERALLY REVISED	2 nd ISSUE	0	02.06.08	3600 MW COAL BASED POWER PROJECT WARDHA POWER COMPANY PVT. LTD.	JOB NO. K7V12 SCALE N.T.S.
		H.C.	A.K.D.	S.S.D.	MBT	-	-	-	29.02.08		DWG. NO. K7V12-000-DWG-E-SK01 REV. 1
		H.C.	A.K.D.	A.I.	N.A.R.	-	-	-	-		
		APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE		

A3 (SHT. SIZE 420 x 297)

CAD FILE : K7V12-000-DWG-E-SK01 REV-1

08.06.08/MBT

27/09/08 DCPL

CNandurkar (WPCPL)

SEPCO

ANNEXURE-C

6 X 600 MW SUBCRITICAL POWER PLANT AT CHHATTISGARH

TENDER CLARIFICATION, (C&I)

NAME OF TENDERER: SEPCO ELECTRIC POWER CONSTRUCTION CORP.

DEVIATIONS/SEPCO/C & I

C&I PART

Sl.No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
2	3.08.00	6/50	An Instrument test/calibration room and an instrument maintenance room shall be provided.	N/A	An instrument test / calibration room is required to house the C&I Lab Equipment specified in Sec. XIXB12 of tender. Also instrument maintenance room is required for performing maintenance of C&I equipment. Hence please confirm provision of both these rooms, as per the requirement in tender and as already agreed by you in cl. 9.3.8, vol II, sec 3-III technical description, page 392 of 1003 of your offer.	SEPCO confirmed.
3	3.08.00	5/50	All these rooms shall be provided with central A/C, false ceiling and cable cellar for	All these rooms will be provided with central A/C, false ceiling and cable-trays for cable laying.	Noted that cable trays have been envisaged for cable laying. Also provision of cable vaults has been already confirmed by you in Sr. No. 45 in Page 468 above. Cable	SEPCO confirmed according to tender specifications. Cable vault/cable cellar will be provided.

			cable laying		vault / cellar is required for Control Equipment Rooms (CERs), Engineering rooms(ER) and Central Control Room (CCR) for cable laying as per tender specifications. Please confirm provision.	
5	3.08.00	6/50	Vastu requirement that operator should face east or north only, shall be followed in the central control room and local control rooms.	It will be determined during detail engineering.	Noted.	SEPCO Confirmed that vastu requirement will be followed during detailed engineering.

6	3.12.00	7/50	Condensate Polishing Unit, H2 Generation Plant, Condenser on line tube cleaning system (COLTCS), Online steam leak detection system, Mill reject handling system etc., shall be PLC based and interfaced to DCS through OPC server for monitoring. The HP & LP dosing system shall be PLC based and interfaced to DCS through OPC server for monitoring. This system shall be supplied with an ES cum OS station."	"Condensate Polishing Unit, H2 Generation Plant, Condenser on line tube cleaning system (COLTCS), Online steam leak detection system, Mill reject handling system etc., shall be PLC based . The HP & LP dosing system have no ES , OS station.	The condensate polishing unit, H2 generation plant, condenser online tube cleaning system, online steam leak detection system have already been agreed in cl. 9.3.12, page 393 of 1003 of your offer. What is the type of interface envisaged between these control systems and DCS? Please clarify. Deviation not clear as interfacing of PLC based HP&LP dosing system to DCS through OPC server has already been agreed by you in cl.9.3.12 of pg 393 of 1003 of your offer. Please clarify how the HP & LP dosing control systems are interfaced to DCS.	Ammonia, Hydrazine and phosphate dosing systems can be automatically controlled both locally and remotely. Local control is from local panel and remote control by Condensate water treatment control PLC from overall water treatment OS. Confirmed for HP/LP dosing control. HP & LP dosing will be performed through OS at condensate water treatment plant control PLC. Also there will be local control panel.
7	3.12.00	7/50	The HP&LP dosing system shall be PLC based and interfaced to DCS through OPC	N/A	Deviation not clear as interfacing of PLC based HP&LP dosing system to DCS through OPC server has already been agreed by you in cl.9.3.12 of pg 393 of	Confirmed for HP/LP dosing control. HP & LP dosing will be performed through OS at condensate water treatment

			server for monitoring. This system shall be supplied with an ES cum OS station.		1003 of your offer. Please clarify how the HP & LP dosing control systems are interfaced to DCS.	plant control PLC. Also there will be local control panel.
8	5.09.00	11/50	All field mounted instruments shall have waterproof enclosures conforming to IP-65.	Only instruments in outdoors area have waterproof enclosures conforming to IP-56.		Confirmed IP-65 for outdoor areas. SEPCO has informed that there will be price implications for IP-65. However, the same shall be taken into consideration while submitting the final commercial offer.
9	5.12.00	11/50	All Instrumentation and control cable trays shall be perforated type with cover.	Instrumentation and control cable trays on the top layer will be covered.	Control & signal cables being smaller size cables than power cables, tend to sag when laid in ladder type cable trays. Hence we recommend use of perforated type cable trays for control & signal cables. Please confirm that all instrumentation & control trays will be perforated type with cover as already agreed by you in cl. 9.5.12, page 397 of 1003 of your offer.	Top cable tray shall be covered. Instrumentation cable tray shall be perforated type. Control cable tray shall be ladder type.

10	5.16.00 5.18.00	12/50	Hardwired back-up panel shall be provided to mount Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator.	Drum level TV is applicable for subcritical boiler only. Window Annunciator will not be supplied.	Deviation not clear. Provision of hard wired back-up panel housing Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator has been already agreed by you in the offer in the Data Sheet Cl. 9.5.16, vol II, sec 3-III, technical requirements, page 398 of 1003 and cl. 9.9.2, page 426 of 1003.	SEPCO Confirmed.
11	5.23.00	13/50	The designation and legends for all instruments, valves etc., interconnection drawings and data sheets shall be as per ISA format.	The designation and legends for all instruments, valves etc., interconnection drawings and data sheets shall be as per ISA format or coordinative Chinese Standard.	The Instrumentation systems and automation Society (ISA, formerly Instrument society of America) format is acceptable.	SEPCO confirmed that ISA standard will be followed.
12	6.01.00	13/50	Drum level TV	Drum level TV is applicable for subcritical boiler only.	Noted.	Noted.
13	6.05.00	15/50	Feed water control	There is no drum for supercritical boiler. So this is applicable for subcritical boiler only.	Feedwater control is applicable for sub-critical and super-critical boiler.	Feedwater control is applicable for super-critical and sub-critical boiler. However, there will be difference in implementation.

3	10.00.00	6/15	PRESSURE GAUGE 07. Accuracy: ±1.0% of span	±2.5%	Deviation not clear. Please mention the accuracy envisaged.	SEPCO agreed for accuracy of ±1.5% of span for pressure gauges.
4	12.00.00	7/15	DIFFERENTIAL PRESSURE GAUGE 06. Accuracy ±1.0% of span	±2.5%	Deviation not clear. Please mention the accuracy envisaged.	SEPCO agreed for accuracy of ±1.5% of span for differential pressure gauges.
5	VOL-II SEC-XIXB8 1.00.00	1/4	Microprocessor based standalone online vibration/machinery monitoring and analysis system shall be used for condition monitoring of TG and HT drives/motors.	analysis system only for TG. HT drives/motors shall be detailed.	Noted.	SEPCO confirmed.

1	VOL-II-SEC-XIXC 1.01.00	1/19	a) Instrument process tubing and instrument air tubing to be designed in accordance with the instrument installation drawings (Refer Typical Hook-up diagrams K7V12-000-DWG-I-002). c) Instrument mounting height shall 4' - 6" above equipment base or platform. d) Instrument tubing installation are designed in accordance with ANSI B31.1 " Power Piping".	These drawings are indicative only. We will offer correlative drawings in detail design. Instrument tubing installations are designed as per CHINESE Standard.		Hook-up drawings will be approved during detailed engineering.
2	1.02.00	1/19	For pressure ≥ 40 bar, impulse pipe 1/2" NB SS316 with weld connection shall be used. For pressure < 40 bar impulse tube 1/2" OD SS316 with double compression SS-316 fittings shall be used.	Stainless steel impulse pipe will be provided that meeting Chinese satandard.		SEPCO confirmed. Schedule of the pipe will be compatible with process requirement. Material of impulse pipe will be 1Cr18Ni9Ti.
4	1.06.00	3/19	Special, screened, shielded or co-axial cables shall be used as required and as such, these special cables shall be supplied by the Contractor.	Special, screened or co-axial cables shall be used as required and as such, these special cables shall be supplied by the Contractor.	Noted.	SEPCO confirmed
5	1.09.08	4/19	All cables should have trace ability from field to JB and JB to DCS/Panel with identification ferrules.	No identification ferrules.	Ferrules are required for identification of cables and during troubleshooting purpose.	SEPCO confirmed
	2.05.03	5/19	All instruments shall be tagged with engraved aluminium tag plates and shall be secured to the instrument with	All instruments shall be tagged with engraved plastic tag plates.	For instrument tagging, engraved aluminium tag plates shall be used.	SEPCO proposed the use of hard PVC plates for instrument tagging. However,

			metallic wire fasteners.			the same shall be subject to owner's approval during erection.
	2.05.09	5/19	After erection, the instruments shall be covered with transparent polythelene sheets to protect from unauthorized handling.	Not necessary.	WPCPL/DCPL agreed	Noted.
	2.05.10	5/19	The cover shall be provided by the contractor immediately after the instrument-mounting job is over. For each type of the instrument design of the cover shall be developed by the Contractor and the sample shall be approved by Purchaser's engineer before contractor starts bulk fabrication of the same. These cover shall be made of 3 mm thick MS sheet and painted with two coats of metal primer and two coats of final paint.	Owner can provide drawings of the cover first.	Canopy is used to cover the instruments located in outdoor area to protect them from rain, dust etc.	SEPCO agreed to provide canopy for instruments mounted in outdoor area.
	2.06.03	5/19	C & I Sub-contractor's erection terminal point shall normally be the root valves or first/second take-off valve on the main equipment vessel or pipeline. Maximum impulse tube/ pipe length allowed is 6 Mtrs.	What's meaning of C & I Sub-contractor? Maximum impulse tube/ pipe length allowed is 15 Mtrs.	WPCPL/DCPL agrees impulse tube/pipe length as 15 meters.	Noted. SEPCO confirmed.
	2.06.03 2.07.01 2.08.02 3.02.01 3.04.01.01 3.07.02	5/19	C & I Sub-contractor's	What's meaning of C & I Sub-contractor?	C & I sub-contractor means erection contractor	Noted.

	2.07.11	7/19	Between erection and cabling work all cable entry points shall be kept plugged with PVC caps to be procured by the Contractor.	PVC caps or others	PVC caps needed as per tender specifications.	SEPCO agreed on PVC caps.
	2.07.14	7/19	All cables shall be ferruled at both the junction box and element head end.	Please elaborate more about ferruled.	Ferrules are required for identification of cables and during troubleshooting purpose.	SEPCO confirmed.
	2.08.03	7/19	mounting and connecting of settling chambers/damper pots/Syphon/seal pots etc.	Please elaborate more about pots/Syphon/seal pots	WPCPL/DCPL explained use of siphon, seal plots, damper pots.	SEPCO confirmed as per tender specifications.
	2.09.02	8/19	In case of External cage type, level switches, installation of the cage, including welding (if required) of extensionnipples are in the Contractor's scope. Float and switching mechanism shall be installed only after welding and installing the cage in position.	Float and switching mechanism shall be installed only after welding and installing the cage in position. Why?		Float and switches mechanism is integral with the level switch itself.
	3.01.05	9/19	All the glands shall be sealed with sealing compound so as to make them thoroughly dust and moisture entry proof. Supply of sealing compound is included in contractor's scope of supply.	Please elaborate more about compound.	Sealing compound means material used for sealing. It is needed in order to ensure that it remains dust & moisture free.	Sealing compound will be decided during detailed engineering.
	3.01.08	9/19	Identification tags for the cables made of aluminium strips with punched cable numbers shall be provided inside and outside the junction boxes panels close to the gladding point.	Identification plastic tags for the cables with printed cable numbers will be provided inside the junction boxes panels close to the gladding point.	WPCPL/DCPL agreed	Noted.

	3.01.11	9/19	After erection, junction boxes shall be covered with Red polyethylene sheets, to be supplied by the Contractor.	Not necessary.	WPCPL/DCPL agreed	Noted.
	3.03.02	10/19	The design of stanchions, supporting frames and stands shall be developed by the Contractor and the sample shall be approved by Purchaser's engineer before contractor starts bulk fabrication.	Owner can provide the design drawings of stanchions, supporting frames and stands first.		During detailed engineering.
	3.03.08	11/19	Contractor shall fabricate 3 mm M.S./Aluminium canopies for shielding of instrument from direct hit by rain.	What's the meaning of M.S.?	M.S. means mild steel	SEPCO agreed to provide M.S./Aluminium canopies for shielding of instruments. mounted in outdoor area.
	3.04.01.05	11/19	Cables shall be laid in covered cable trays/conduits in all areas.	Cable trays on the top layer will be covered.	Noted.	Cable tray will be covered on top layer only.

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8	3.04.02.02	12/19	The distance between instrumentation cables and those of other system shall be as follows : From 11 kV/6.6 kV/3.3 kV tray system - 914 mm From 415V tray system - 610 mm From control cable tray system - 305 mm	From 11 kV/6.6 kV/3.3 kV tray system - 750 mm From 415V tray system - 500 mm From control cable tray system - 250 mm	Cable segregation shall be as per IEEE-std 422 as mentioned in the tender specifications. Please confirm.	From 11 kV/6.6 kV/3.3 kV tray system - 900 mm From 415V tray system - 600 mm From control cable tray system - 300 mm Is agreed by SEPCO. The separation distance in vertically stacked cable tray is between bottom to bottom of tray.
	3.04.03.03	14/19	Cable glands and other openings in the junction boxes shall be properly sealed by means of sealing compound supplied by the contractor at his own cost to make them thoroughly dust vermin and moisture proof.	Please elaborate more about sealing compound.	Refer reply to deviation on clause no. 3.01.05 above.	Sealing compound will be decided during detailed engineering.
	3.04.03.08	14/19	All cable shields shall be individually terminated and jumpered together at the terminal blocks.	As the case may be.	Required as per tender specifications.	Individual cable shield shall be terminated at local JB. Overall shield of cable shall be terminated at cabinet.

	3.04.03.12	14/19	Contractor after laying the cable shall solder cable cores and screen ends to connector pins/plug-in crimped ends of the cable to the connector plug socket/crimp-in special connectors for coupling the cable to the plug socket/wire wrap the ends to connector pins, as the case may be, Contractor shall ensure properness of end connection before embarking upon the termination.	Normal not necessary. Especial case may be.		Noted.
	3.04.03.13	15/19	No splices shall be made in conductors for instrument and control circuits except where required at connections to devices equipped with factory- installed pigtails. Such splices shall be made only in approved splicing boxes of fitting with removable cover. The splices shall be made with sufficient slack left in the wires to permit withdrawal of the splice from the splicing box for ease of future disconnection of the splices. All exposed conductor or connector surfaces shall be covered with a minimum of three half-lapped layers of all weather vinyl plastic electrical tape. Taping shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the other insulation or connections requiring insulation.	Please elaborate more.	Requirement in tender specification shall be followed.	SEPCO agreed that there will be no splices made in conductors for instrument and control circuits.
	3.04.03.15	15/19	Contractor shall furnish two completely new sets of cable termination kits like	Please elaborate more.		SEPCO confirmed.

			Crimping tools, maxi-termi/ wire-wrap tools etc., which are required for maintenance of the system as per the type of termination used.			
	3.04.03.18	15/19	All instrumentation cable trays shall be galvanized aluminium perforated type.	Normally all instrumentation cable trays will be galvanized steel type.		Top cable tray shall be covered. Instrumentation cable tray shall be perforated type. Control and other cable tray shall be ladder type.
	3.04.04.05	16/19	The terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.	Not necessary.	Specifications shall be followed.	SEPCO confirmed.
	3.05.04	17/19	Welding of trays shall not be allowed.	If trays are welded, they should be painted by antirust paint.	Noted.	Noted.
	3.06.02	17/19	Screen of all screened cables between instruments to local junction box shall be terminated by individual terminal blocks.	Screen of all screened cables between instruments to local junction box shall be terminated by common terminal blocks.	Not accepted.	Confirmed as per specifications for instrument cables.
	3.06.04	18/19	All junction boxes, stands, stanchions, local panels, cubicles etc. as installed by the Contractor must be connected to the nearest riser of electrical earth mat by SWG 10 MS wire.	By flat steel.		SEPCO agreed for SWG 10 MS wire. SEPCO agreed for provision of copper flat (as per manufacturer standard) in the cabinet.

	3.07.02	18/19	Normally, C & I Sub-contractor's terminal point for erection of primary impulse piping shall be the first or the second take-offs are permitted within 6 mtr.length of impulse tubing.	What's meaning of C & I Sub-contractor? Maximum impulse tube/ pipe length allowed is 15 Mtrs.	WPCPL/DCPL Noted that impulse tube/pipe length is 15 mtrs.	Noted.
	3.07.05	18/19	All instrument impulse pipe fittings and accessories which shall include but not limited to brackets, supports, clamps, angle irons/flats shall also to be painted as per the Purchaser's approved color code.	Please detail Purchaser's approved color code.	Tender specifications shall be followed.	During detailed engineering
	3.07.10	18/19	Impulse tubing from first isolation valve upto the pressure/DP instrument shall be as per the hookup diagrams. Single lengths of SS tubes shall be 6 meters. Fittings like male/female connectors, unions, tee, plug etc. shall be SS 316. All connectors shall be NPT standard and threaded as per ANSI B2.1. The pressure rating of all fittings shall be 3000 lbs and size shall be ½".	These drawings are indicative only. We will offer correlative drawings in detail design. Instrument tubing installations are designed as per CHINESE Standard.	WPCPL/DCPL will review the vendor drawings during detailed engineering	SEPCO noted.
	3.07.11	19/19	The pipes and fittings for instrument air sub headers shall be galvanized carbon steel.	Why?		SEPCO agreed for galvanized carbon steel.
	3.07.11	19/19	The air distribution to individual consumer shall be done by means of SSTP 321 pipe.	Please elaborate more about SSTP 321.		SEPCO agreed to provide the pipe material as 1Cr18Ni9Ti for the air distribution to individual customer.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
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A	**Section 3-VII C-Datasheets for control and instrumentation**					
1	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 16.00.00, page no. 906 of 1003	PRDS control	Please note that the provision of PRDS control has already been agreed in your offer (ref. cl. No. 9.6.1, vol-II, sec-3-III page 398 of 1003). Hence please update the datasheets accordingly.	Already update.please see revised datasheets.	SEPCO confirmed the provision of PRDS control.
2	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 18.00.00(b), page no. 906 of 1003	Type and number of camera	Please mention the locations envisaged for these two cameras.	One camera will be located at the left side of the boiler, another camera will be located at right side of the boiler. The vertical position is about at middle up part of the boiler.	Noted.
3	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 24.00.00-(a), page no. 906 of 1003	Mill control system	'Not applicable' has been mentioned for mill control system. However, please note that as per cl. No. 3.2.3, vol-II, sec 3-III, page 363 of 1003 of your offer, mills are envisaged. Hence please confirm provision of mill control system and mention the implementation platform envisaged. kindly update the datasheets also.	Already update.please see revised datasheets.	Noted.
4	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 30.00.00-(b), page no. 907 of 1003	CEMS.	'Later has been mentioned regarding the type of detectors for CEMS. However kindly confirm the provision of CEMS as per tender specification sec XIXB7.	Yes, we confirm the provision of CEMS as per tender specification sec XIXB7.	SEPCO agreed for sampling type measurement as per their standard practice.
5	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 32.00.00(d), page no. 907 of 1003	A/C room for SWAS analysers	'NO' has been mentioned in this clause. However, in your offer the provision of 'A/C room for SWAS analysers' has already been agreed in technical description, sec 3-III, page 392 of 1003. Hence kindly confirm provision of A/C room for SWAS analysers as per requirement in tender specification sec-XIXA, cl. No. 3.08.00 and update the datasheets accordingly.	Yes, we confirm provision of A/C room for SWAS analysers as per requirement in tender specification sec-XIXA, cl. No. 3.08.00 and already update the datasheets.please see revised datasheets.	Noted.
6	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 33.00.00-(i), (ii), page no. 907 of 1003	make/model no. of sensor/monitor and vibration analyser for HT motors	'Later' has been mentioned regarding the make and model of sensor/monitor and vibration analysers for machine monitoring for HT motors. However as specified in sec-XIXA, cl. No. 6.30.00, and as mentioned in your offer in cl. 9.6.29, vol II, sec 3-III, page 421, 422 of 1003, bidder shall keep in mind that the vibration data of these HT motors is also required to be compatible for vibration analysis using System 1 package of Bently Nevada. Please confirm.	Already update.please see revised datasheets.	SEPCO confirmed Bently Nevada BNC3500.
7	Vol II, section 3-III, Technical description	cl. No. 9.6.29, page 421 of 1003	Machinery monitoring system	We understand that Generator is also considered in the machine monitoring system. Please confirm.	Yes, Generator is also considered in the machine monitoring system.	Noted.
8	Section 3-VII C-Datasheets for control and instrumentation	cl. No. 34.00.00-(a), (b), page no. 907 of 1003	Fire Alarm system List of areas covered and type of detectors	'Later' has been mentioned regarding the list of areas covered, type of detectors for fire alarm system. However kindly confirm the provision of fire alarm system as per tender specification, I1- sec XIXB9.	Yes,we confirm the provision of fire a.arm system as per tender specification, I1- sec XIXB9.	Noted.

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9	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 36.00.00, page no. 907 of 1003	CCTV system for surveillance	Please confirm that the CCTV system for surveillance offered is as per tender specification sec-XIXB11.	Yes we confirm that the CCTV system for surveillance offered is as per tender specification sec-XIXB11.	Noted.
10	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 37.00.00-(e), page no. 908 of 1003	A/C for remote I/O	'NA' is mentioned in this clause. However, remote I/Os have been shown in the offer drawings F625KB-K-01, 02. Hence, wherever remote I/Os are envisaged, kindly confirm ensure provision of A/C enclosure.	Yes we confirm provision of A/C room Enclosure for remote I/Os as per requirement in tender specification sec-XIXA, cl. No. 3.08.00 and already update the datasheets please see revised datasheets.	Noted.
11	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 38.00.00-(c), page no. 908 of 1003	Turbine stress calculation station	Noted that turbine stress control(TSC) system is in DEH. However there is no mention regarding provision of Turbine stress calculation station in this clause. Please provide turbine stress calculation station as per requirement shown in tender drawing K7V12-000-DWG-I-001.	The tuebine vender will provided the DEH operator saition with turbine stress calcu-ation function	Noted.
12	Section 3-VII C-Datasheets for control and Instrumentation and section 3-III, technical description	cl. No. 41.00.00(c) page no.-909 of 1003 ; cl. No. 9.5.16 and 9.5.17, page 398 of 1003	Hardwired annunciator	We understand that hardwired annunciator is not envisaged in your offer.(cl. No. 41.00.00-(c) of datasheets; cl. No. 9.5.16 and 9.5.17 of vol-II sec 3-III, page 398 of 1003). However please provide hardwired annunciator with 64 windows on the back-up panel as per requirement in tender specification, sec XIXA, cl. no. 5.16.00 and 5.18.00 and update the datasheets accordingly.	If feader insist this point, we will provide the hardwired annunciator with 64 windows on the back-up panel, but the back-up panel will be congested for large video screen is also on the back-up panel.	Noted for number of annunciator windows. Layout of back up panel will be finalised during detailed engineering.
13	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 54.00.00, page no. 910 of 1003	Condenser online tube cleaning system control	'NO' has been mentioned in this clause. However the provision of PLC based 'condenser online tube cleaning system' has been already mentioned in your offer in technical description, C& I part, sec. 3-III, page 393 of 1003, cl. no. 9.3.12. Hence please confirm Provision of 'condenser online tube cleaning system controls' as per requirement in tender specification sec-XIXA, cl. No. 3.12.00 and update the datasheets accordingly.	We confirm provision of 'condenser online tube cleaning system controls' as per requirement in tender specification sec-XIXA, cl. No. 3.12.00 and update the datasheets.	Noted. Condenser online tube cleaning system shall be hardwired to DCS
14	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(I)-(b), page no. 910 of 1003	Conductor size of signal cables	'conductor size' of signal cables is mentioned as 0.75, 0.8 and 1.0 mm2. However please confirm the provision of signal cables with conductor size of '1.5 mm2' as specified in the tender specification sec-XIXB4, cl. No. 2.01.00 and update the datasheets accordingly.	We confirm the provision of signal cables with conductor size of '1.5 mm^2' as specified in the tender specification sec-XIXB4, cl. No. 2.01.00 and update the datasheets.	conductor size 1 sq. mm multi-stranded for signal cables and 1.5 sq. mm multi-stranded for control cables.
15	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(I)-(d), page no. 910 of 1003	Armoured signal cables	'NO' has been mentioned in this clause. However armoured signal cables as specified in the tender specification sec-XIXB4, cl. No. 2.01.00 are required to be provided. Please confirm and update the datasheets accordingly.	Only cable laying underground need armoured. In this project, cable will be laying on cable tray or cable duct, so armoured cable is not needed.	Noted. From instrument to junction box, cable shall run through flexible metal conduit. For high temperature area (eg. Turbine) teflon (PTFE) cables shall be used.

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16	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(II)-(b), page no. 910 of 1003	Conductor size of control cables	conductor size' of control cables is mentioned as 0.75, 0.8, 1.0 and 1.5 mm2. However please confirm the provision of control cables with conductor size of '1.5 mm2' as specified in the tender specification sec-XIXB4, cl. No. 6.01.00 and update the datasheets accordingly.	We confirm the provision of control cables with conductor size of '1.5 mm2' as specified in the tender specification sec-X XB4, cl. No. 6.01.00 and update the datasheets.	conductor size 1 sq. mm multi-stranded for signal cables and 1.5 sq. mm multi-stranded for control cables.
17	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(II)-(d), page no. 910 of 1003	Armoured control cables	'NO' has been mentioned in this clause. However, armoured control cables as specified in the tender specification sec-XIXB4, cl. No. 6.01.00 are required to be provided. Please confirm and update the datasheets accordingly.	Same with item 17	Noted.
18	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.02, page no. 910 of 1003	Functional segregation of DCS controllers/processing units.	No. of controllers/processing units has been mentioned as 24 + 3. Please provide the break up of the functional segregation of the controllers/processing units envisaged. Please confirm that the functional segregation philosophy mentioned in cl. No. 4.01.00, sec XIXB1 of tender specification shall be adopted. Please mention this functional segregation philosophy in the DCS configuration also, for better clarity.	DPU 1-- boiler SCS DPU 2-- ignition oil control DPU 3/4/5-- mill control DPU 6/7/8-- turbine SCS DPU 9 – FSSS DPU 10/11/12/13--MCS DPU 14-- Coordinated Master Control DPU 15/16/17-- ECS DPU 18-- SOE DPU 19-- DEH DPU 20-- ETS DPU 21-- tuebine driven feedwater pump DPU 22-- bypass control DPU 23/24-- DAS Common DPU1-- common electric Common DPU2-- air compresser Common DPU3-- common DAS We confirm that the functional segregation philosophy mentioned in cl. No. 4.01.00, sec XIXB1 of tender specification.	SEPCO has confirmed grouping of controllers. However, grouping of controllers will be finalised during detailed engineering.
19	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.06(b), page no. 911 of 1003	Dedicated station for MIS	'NO' has been mentioned in this clause. However dedicated MIS station as per tender drawing and tender specification XIXB1, cl. No. 6.06.03 required to be provided. Please confirm and update the datasheets accordingly.	We confirm the provision of dedicated MIS station and update the datasheets.	Noted.
20	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.08, page no. 911 of 1003	I/O module redundancy	'NO' has been mentioned in this clause. However I/O redundancy as per tender requirement in Annexure-3, Sec XIXA required to be provided. Please confirm and update the datasheets accordingly.	We confirm I/O module can be recundancy if needed and update the datasheets.	Redundant I/O module will be provided whereever needed.
21	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.12, page no. 911 of 1003	Data transfer speed	Data transfer speed is mentioned as '1Mb' in this clause which is not acceptable. Please confirm the data transfer speed of '10/100 MBps' as specified in the tender specification sec-XIXB1, cl. no. 6.04.04 and update the datasheets accordingly.	We confirm the data transfer speed of '10/100 MBps' as specified in the tender specification sec-XIXB1, cl. no. 6.04.04 and update the datasheets.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
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22	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.21-(b), page no. 911 of 1003	Type of isolation	'Later' has been mentioned in this clause. However please note that as per tender specification sec-XIXB1, cl. No. 6.01.00. all Analog & Digital Inputs and Outputs shall necessarily be galvanically or optically isolated as the case may be. Please confirm.	We confirm.	Noted. SEPCO confirm provision that Analog Inputs and outputs shall be galvanically isolated and digital inputs shall be optically isolated. For Digital outputs interposing relay shall be provided.
23	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.34-(e), page no. 912 of 1003	Functions implemented outside controller	Please clarify how the pressure and temperature compensation will be achieved outside the controller?	Pressure and temperature compensation function will be realized in controller and update the datasheets.	Noted.
24	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.35-(e), (f), page no. 912 of 1003	RAM size, Hard disk capacity	'Later' has been mentioned regarding hard disk capacity and RAM size. However kindly confirm the provision as per requirement in tender specification, sec-XIXB1, cl. No. 6.06.03 and update the datasheets accordingly.	We confirm the provision as per requirement in tender specification, sec-XIXB1, cl. No. 6.06.03 and update the datasheets accordingly.	Noted.
25	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.44-(e), (f), page no. 913 of 1003	LVS quantity	'Later' has been mentioned regarding quantity of LVS. However please mention the quantity in the datasheets inline with the LVS shown in your offer drawing no. F625KB-K-01, 02.	LVS quantity is two each unit.	SEPCO agreed for 72 inch LVS size
28			Data and documents	Data and documents shall be submitted as listed in the tender technical specification, sec XIXA, cl. 12.00.00. Please confirm.	The other data and documents will be provided later.	Noted.
30	Volume II, section 3-III, technical description	cl. No. 9.6.28, page no. 421 of 1003	Ambient air quality monitoring system	In addition to the stated clause, please confirm the following: a) To demonstrate compliance with ambient air quality standards and as required by the state pollution control board, four nos. (4) continuous ambient air quality monitoring systems shall be installed in and around the project area at approved locations. monitoring station locations shall be determined by air quality impact modelling results and in consultation with state pollution control board. b) The monitoring stations shall include SPM, RPM, SO2, NO2 and CO for sampling. c) For monitoring of ambient air quality, high volume sampler with attachment for gaseous sampling and particulate matter sampler shall be provided. d) One completely automatic weather station for metrological data collection and recording shall be supplied. The station shall comprise wind-vane, anemometer, thermometer, hygrometer, rain fall recorder, sunshine recorder, evaporimeter etc. e) The entire station shall be PC based automatic recording type with provision for instantaneous display of different parameters and the same shall be EPA approved. f) A Mobile ambient air monitoring van equipped with sampling and measuring instruments shall also be provided.	The provision of Ambient air quality monitoring system will be meet these requirement.	Noted.

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8	Drawing no. F625KB-K-01, 02 DCS configuration diagram					
1			ESP and AHP control room	From the layout drawing in your offer, it is understood that the local control room for ESP & AHP is common. However, this is not clear in F625KB-K-01, 02 DCS configuration diagram as the control room is named as "bottom ash & fly ash field control room'. Please update the name in the DCS configuration diagram for better clarity.	The control room name have been modified to "ESP & AHP control room".	Noted.
2			HCSD PLC system	HCSD PLC system is not shown in the drawing. Please show thw same and update the drawing.	HCSD PLC system is not finded in tender documents,please give detail description.	SEPCO agreed PLC for HCSD system if HCSD system is included by mechanical.
3			ESP control and interface to DCS	As per your offer (cl no. 9.3.12 of pg 392 of 1003) and tender specs, ESP should have its own control system based on PLC with hardwired signals to DCS for monitoring. However,in the drawing, 'ESP I/O' is shown connected via MB to DCS I/O cabinet. Why is it shown so? Please clarify.	ESP have hardwired signals with DCS. The drawing have benn updated.	Noted. However, ESP PLC shall be connected to DCS interfaced through BOP net for monitoring.
4			Separate ES cum OS for ESP	Separate ES cum OS for ESP has already been agreed in the volume II, section 3-III-- Technical description, page no. 392 of 1003 of your offer, but has not been shown in the drawing Hence kindly confirm the provision of ES cum OS station for ESP as per your offer (and requirement in tender specification, sec XIXA, cl.no. 3.12.00) and update the drawing accordingly. Will this ES cum OS station be located in the ESP-AHP local control room?	We confirm the provision of ES cum OS station for ESP. This drawing can not show every technical detail. The ES cum OS station of ESP will be located in the ESP-AHP local control room.	Noted.
5			OS; OS/ES in AHP local control room	Ash handling system with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no. 427 of 1003. But in the drawing, only one no. OS is shown in AHP local control room and an EWS common to all offsite plants is shown. This is not acceptable. Kindly confirm the provision of operator cum engineering station also in the AHP local control room , as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f). Please update the drawing accordingly.	The quantity of OS and ES for AHP will meet tender requirement.	Noted.
6			OS; OS/ES in CHP local control room	Coal handling system with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no. 427 of 1003. But in the drawing, only one no. OS is shown. in CHP local control room and an EWS common to all offsite plants is shown. This is not acceptable. Kindly confirm the provision of operator cum engineering station also in the CHP local control room , as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f). Please update the drawing accordingly.	The quantity of OS and ES for coal handing system will meet tender requirement.	Noted.

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7			OS & ES in water treatment plant local control room	DM plant with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no 426 of 1003. But in the drawing, only one no. OS is shown in WTP local control room and an EWS common to all offsite plants is shown. This is not acceptable. Kindly confirm the provision of operator cum engineering station also in the WTP local control room , as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f). Please update the drawing accordingly.	The quantity of OS and ES for DM system will meet tender requirement.	Noted.
8			OS; OS/ES in Compressed air system local control room	Compressed air system with PLC based system with OS and OS/ES is mentionec in the offer submitted by you, technical description, vol II, sec 3-III, page no. 427 of 1003. But in the drawing,OS & OS/ES for compressed air system is not shown. Hence kindly confirm the provision of these stations, as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f) and update the drawing accordingly.	The quantity of OS and ES for compressed air systemwill meet tender requirement.	Noted.
9			Condensate water treatment control	In the drawing, 'Condensate water treatment' system PLC is shown interfaced to overall water treatment system network. However, it is not clear to us as to what are the system controls envisaged to be done by this PLC.Please clarify	The condensate water treatment system include condensate polishing, resin regeneration etc	Noted.
10			Water treatment control	Water treatment control & others are shown with PLC & remote I/O interfaced to PLC in 'overall water treatment field control room'. However it is not clear what system controls are envisaged from this PLC. Please clarify. Also what are these remote I/Os envisaged for?	Remote I/O cabinet will be used in pretrearsent area far from control room. The water treatment system include pretreatment,RO,electro ultrafiltration,EDI,etc	Noted.
11			Controls implemented in DM plant PLC	Controls like 'Raw water pump intake', 'pre-treatment plant including the chlorination system', 'Auxiliary water system(potable, service, CW make up water, DM make up etc)','CCW side treatment', 'effluent treatment plant','RO plant' shall be implemented in DM plant PLC is mentioned in the offer submitted by you in technical description, vol II, sec 3-III, page no. 426 & 427 of 1003. But the same are not reflected in the drawing. Hence kindly confirm provision of all these controls and update the drawing accordingly.	Please see technical description ANNEXURE-1 "Control implementation philosophy for BOP systems". These system are monitored and controlled on local control panel without connnect to DCS net.	The mentioned systems are monitored and controlled from local control room and connected to DCS through BOP net.
12			ACW system control; cooling tower system control	There is no mention of ACW system control; cooling tower system control etc in the drawing? As per tender requirement and your offer (cl.9.11, pg 426 and 427 of 1003), DCS based control is envisaged for these systems. Please confirm and mention in the drawing for better clarity.	ACW is shown as "CIRCULATING WATER PUMP HOUSE" in this drawing.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
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13			sampling and dosing system	A sampling and dosing system I/O cabinet is shown in the overall water treatment control room. But is it not shown connected to any PLC/network.Please clarify.	It is shown clearly in this drawing that this cabinet connect to CONDENSATE WATER TREATMENT CONTROL PLC	Noted.
14			HP & LP dosing systems for subcritical plant	Please list out the HP & LP dosing systems envisaged for subcritical plant.	Please see chemical part.	Please refer resolution of point no. 6 of C & I deviations.
15			HP & LP dosing system controls	The HP & LP dosing system shall be PLC based and interfaced to DCS through OPC server for monitoring. This system shall be supplied with an ES cum OS station' is mentioned in vol II, sec 3-III, technical description, page 392 of 1003. But these aspects are not reflected in the drawing. Please confirm and update the drawing accordingly	Later	Please refer resolution of point no. 6 & 7 of C & I deviations.
16			CPU, COLTCS and Steam leak detection system controls	Condensate Polishing Unit(CPU), condenser on line tube cleaning system(COLTCS) and Online steam leak detection system will be PLC based' is mentioned in the vol II, sec 3-III, technical description, page 392 of 1003. But the same is not reflected in the drawing. Please clarify and mention the same in drawing.	Condensate Polishing Unit(CPU) is "CONDENSATE WATER TREATMENT" shown in this drawing. COLTCS and Online steam leak detection system are independent PLC system and have hardwaired with DCS.	Noted.
17			Details of 'Interface'	In drawing, for connecting BOP system, SCADA system and for interconnecting other units, a block named 'INTERFACE' is shown. A) Please provide the details regarding the same. It is not clear to us as to what is the type of 'interface' envisaged by you. B) Is the type of link shown for connecting offsite PLCs to DCS TCP/IP?	Later	During detailed engineering
19			OS for rest of BOP	Only one OS has been provided in the CCR for the rest of BOP. However, as per tender requirement (ref tender drawing), two nos. OS are required to be provided. Please confirm and accordingly update the drawing.	two or three BOP os will be provided.	Noted
20			TSC station	Please provide the TSC station inline with tender drawing.	TSC station is included in DEH operator station.	Noted. No separate TSC station. Function of TSC station is included in DEH operator station.
21			MIS station	One MIS station consisting of server with firewall to access all process data, alarm message, history report, trend display etc. via the plant network and open connectivity for viewing at remote locations without virus infection to control network is required to be provided as per tender specifications(cl.4.02.00, sec-XIXB1). Please confirm provision and accordingly show the station in the drawing.	Yes, We confirm	Noted.
22			TSI monitoring and analysis	Please confirm that TSI monitoring and anaysis is done at Machine monitoring station inline with tender drawing.	Yes, We confirm	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
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23			Type of printers in CCR	In the CCR, One Dot Matrix Printer & One Laser B/W printer for BTG alarms & logs respectively; One Dot Matrix Printer & One Laser B/W printer for common systems; One Dot Matrix Printer & One Laser B/W printer for offsite systems; One dedicated dot matrix printer for SOE; dedicated B/W laser printer for SCADA ES; dedicated colour laser printer for every ES; dedicated B/W laser printer for machine monitoring station are required to be provided (refer tender specs cl no. 4.02.00,sec-XIXB1) . Please confirm and accordingly mention the type of printers in the drawing .	Yes, We confirm.	Noted.
24			Type of printers in local control rooms	A4 size colour laser network printer required to be provided in each local control room (refer cl.2.07.00, sec-XIXB2).Please confirm and accordingly mention the type of printers in the drawing .	Yes, We confirm.	Noted.
25			CD writer for ES	As per tender requirement (cl.no. 4.02.00,sec-XIXB1) every ES is required to be provided with a CD writer. Please confirm and mention in the drawing.	Yes,We confirm.	Noted.
26			Backup panel	Provision of hardwired backup panel has been shown in the drawing. However, please confirm that this hardwired backup panel will house Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator as already agreed by you in the offer cl.no.9.5.16, pg 397 of 1003.	Yes.We confirm	Noted. However, drum level TV, EWLI will not be part of super-critical boiler.
27			Clarity regarding equipment envisaged in Central control room	In the drawing, there is a overall block drawn around all the local control rooms and marked as 'central control room'. The purpose is not clear to us. Please clarify. Also 'workshop' is mentioned in Bottom Ash & Fly Ash filed control. This is also not clear to us. Please clarify	It is means BOP-net wil be located in CCR. It is means PLC cabinet will be located in local control room in workshop.	Noted.
28			Control rooms for CHP and AHP	In the drawing, only one control room is shown for CHP and one for AHP. However, this issue to be discussed.	One control room for CHP for all 8 units. One control room for ash handling per phase	Noted.
29			DCS feature	DCS shall have facility of capturing the process information with specified interval in a spreadsheet for defined time period. Operator shall have facility to asign the tags. Bidder to confirm		DCS will capture the process information from history station.
30			Bunker level and fly ash silo level measurement	From the offer C & data sheet, cl. No. 52.00.00, we understand that ultrasonic type of coal bunker level monitoring system is envisaged. Non-contact type ultrasonic or Radar type measurement for coal bunker and fly ash silos shall be provided. To be discussed.	SEPCO confirmed.	Radar type measurement shall be used.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
1	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 37.00.00-(a), page no. 908 of 1003	Location of central control room(CCR)	'Central control room will be at EL. 13.700m floor' is mentioned in the cl. no. 11.4.1.5, vol II, sec 3-III, technical description, page 436 of 1003. However in the layout drawing F625KB-Z-01, the central control buildings(sr. no.40) has been shown as extensions of the power house building. So the location envisaged for CCR is not clear. Hence please confirm the provision of 'control tower as an extension of the power house building' as per requirement in tender specification sec-XIXA, cl. 3.08.00 and update the datasheets accordingly. Also note that a irrespective of the number of phases in which the project is executed, a single common central control room shall be planned for all the units.	We confirm the provision of 'control tower as an extension of the power house building' as per requirement in tender specification sec-XIXA, cl 3.08.00 Already update the datasheets, please see revised datasheets T	SEPCO will consider single central control room later. Open point.
2	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 37.00.00(d), page no. 908 of 1003	A/C for local control rooms	'NO' has been mentioned in this clause. However the provision of split A/C for each local control room is already mentioned in your offer in section 3-III-technical description, page 392 of 1003. Hence please confirm the provision of A/C for local control rooms as per requirement in tender specification sec-XIXA, page 6 of 50, cl. No. 3.08.00 and update the datasheets accordingly.	Yes, we confirm provision of A/C room for local control room as per requirement in tender specification sec-XIXA, cl No 3.08.00 and already update the datasheets please see revised datasheets.	Noted.
3			Training simulator	Please furnish the configuration diagram of the training simulator offered. What are the softwares envisaged to be supplied along with the training simulator?	Later	SEPCO confirmed but with optional price.
4			Triple redundancy	MFT, Steam turbine protections shall have triple redundant I/Os and processors. Bidder to confirm		SEPCO confirmed.
5			Vacuum Breaker	Bidder shall provide DC operated Vacuum Breaker for the Steam Turbine.		WPCPL insisted for DC motor operated vacuum break valve with handwheel(for manual operation) SEPCO will discuss with turbine manufacturer and will revert.
6			Field Transmitters instead of process switches	Bidder shall provide smart transmitters instead of process switches.		SEPCO clarified that process switches will be used at some places. WPCPL/DCPL agreed provided the switches are of reputed make (SOR, UE)

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7			Online degassed cation conductivity measurement	Please provide online degassed cation conductivity measurement for improvement in steam quality.		SEPCO will discuss and revert WPCPL/DCPL will give a typical datasheet for the same.
8			feedwater control	SEPCO to confirm the BFP speed control by scoop and control of DP across feed control pneumatic valve for low load control.		SEPCO will submit the control philosophy.
9				Refer deviations by SEPCO in files 'Deviation of I & C by SEPCO' and 'Additional deviations by SEPCO' and revised technical particulars submitted by SEPCO. There is no other deviation. So SEPCO is fully complying with tender specifications other than agreed deviations. SEPCO to confirm.		SEPCO confirmed and there is not any other additional requirement by WPCPL/DCPL.
10	Section 4-V laboratory equipments list	Equipment list of I & C laboratory, page 969 of 1003	Missing laboratory instruments	Please note that the following equipment specified in sec XIXB12 are missing in your offer: Hand held Pyrometer, Standard tool box, Digital Storage Oscilloscope, Soldering/desoldering station with all accessories, Cable tester (Time domain reflectometer), Fibre optic cable continuity tester, Fibre optic splicer, Fibre optic connectorisation tool. Please confirm the provision of these instruments.	Detail laboratory instruments list will be discuss later.	SEPCO agreed to supply all items other than Fibre optic cable continuity tester, Fibre optic splicer and Fibre optic connectorisation tool.
11				Vendors for all C & I items shall be as per agreed vendor list.		See attached vendor list.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
1	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 58.00.00(a), page no. 914 of 1003	Redundant UPS for DCS	'NO' has been mentioned in this clause. However 'Redundant UPS for DCS' is required. Please confirm provision as per tender specification XIXA, cl. No. 7.01.00	For "Redundant UPS" we understand two UPS power supply from UPS,not two UPS equipment.	One redundant UPS means two sets of rectifier-inverter-static switch with one battery. From UPS two feeders shall be provided for power supply to DCS.
2	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 58.00.00(b), page no. 914 of 1003	Redundant UPS for offsite system	'NO' has been mentioned in this clause. However 'Redundant UPS for each offsite system' is required. Please confirm provision as per tender specification XIXB1, cl. No. 5.01.00	For "Redundant UPS" we understand two UPS power supply from UPS,not two UPS equipment	One redundant UPS means two sets of rectifier-inverter-static switch with one battery. From UPS two feeders shall be provided for power supply to PLC to each offsite system.
3			Drive control philosophy	In the offer submitted by you, 'drive control philosophy' envisaged is not mentioned. Please confirm the drive control philosophy as per tender specification. Annexure-2, Sec XIXA, shall be adopted in this project.	We confirm the drive control philosophy as per tender specification. Annexure-2, Sec XIXA.	Noted.
4		cl. No. 4.11.1, page 373 of 1003	PA system	Kindly consider EPBX of at least 20 in and 250 out lines. PA system should be provided at all equipment floor levels of major equipment buildings along with in other auxiliary plants like AHP,CHP, WTP etc.	Please see electric part.	SEPCO agreed.
5			Coal handling system PLCs	Two coal handling PLCs are shown in coal handling control room. However it is not clear what system controls/functional segregation are envisaged for each of the PLCs. Please clarify. Also the 'stacker reclaimer PLC', 'Mill reject handling system PLC'.	Please see electric part	During detailed engineering.
6			Electrical control system	Numerical relays and Load managers of MCCs (may be Daisy chained) will be connected to OPC server for interfacing to DCS' is mentioned in the offer submitted by you, vol II, sec 3-III, technical description, page 421 of 1003. But the same is not reflected in drawing.	It is incude in electrical part.	Confirmed. Details will be worked out during detailed engineering.
7			SCADA system	In the drawing, there is a block named SCADA system and two DCS cabinets, one EWS and one printer are shown in the block. The location of these equipment is not clear to us. Please clarify. Are these equipment related to switchyard SCADA? Please clarify.	Later	Refer electrical MOM

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8		Deviation 7 in page 476 of 1003	NCS	NCS is mentioned as network control system in your offer. From the drawing it is not clear to us as to what this NCS is. Please clarify.	Please see electric part.	NCS is SCADA
9			Auxiliary console	Provision of Auxiliary console has been shown in the drawing. However, please confirm that this auxilairy console will house PA system station and direct hardwired push buttons and respective status indication lamps to ensure emergency trip of boiler, turbine, as already agreed by you in the offer cl.no.9.5.17, pg 397 of 1003.Please mention in the drawing notes for better clarity.	Yes, We confirm.	Noted.

LIST OF VENDORS – CONTROL & INSTRUMENTATION

Sr. No.	Item	Sub-vendor
1.	DCS	ABB, WESTINGHOUSE, FOXBORO,
2.	PLC	ALLEN BRADLEY, SIEMENS, SCHNEIDER, MODICON
3.	Pressure/DP transmitter	ROSEMOUNT, HONEYWELL, ABB, YOKOGAWA
4.	Level transmitter	E & H, SOR, MOBREY, MAGNETROL
5.	Temperature/pressure gauge	WIKA, GLUCK, BOURDAN, ASHCROFT/CHINESE MAKE
6.	Temperature element	DEGUSSA, OMEGA/CHINESE MAKE
7.	DP/Flow/Level switch	MAGNETROL, E & H, SOR, UE
8.	Temperature/Pressure switch	SOR, UE
9.	Control valve	A) FISHER, MASONEILAN, COPES-VULCAN, HOPKINSON B) CHINESE MAKE (ONLY FOR NON CRITICAL APPLICATION)
10.	Solenoid valve	ASCO, HERION , SMC
11.	Mass flowmeter	ROSEMOUNT, E & H, KROHNE, YOKOGAWA
12.	Magnetic/Vortex flowmeter	ROSEMOUNT, E & H, KROHNE, YOKOGAWA
13.	Tank gauging	E &H, SAAB, ENRAF/CHINESE MAKE
14.	Analyzer	AMETEK, ROSEMOUNT, POLYMETRON, E & H, KROHNE
15.	Electric actuator	ROTORK
		AUMA
		LIMITORQUE
		HARTMANN & BRAUN
16.	EWLI	HYDRASTEP, KEYSTONE, YARWAY
17.	CEMS	AMTEK H&B, SICK,ABB,DURAG
18.	TSI -Vibration monitoring & Analysis	BENTLEY , EVADA, BNC-3500 & SYSTEM-1
19.	EPABX / PA system	ELECTRIC PART
20.	Ambient Environment Monitoring System	CHEMTROL, EMERSON, FORBES MARSHALL

CHINESE MAKE VENDORS SHALL BE APPROVED BY OWNER

2	VOL–II SECTION-XIXA 7.01.00	37/50	ELECTRIC POWER SUPPLY Separate UPS shall be provided for administrative office UPS for communication system shall be separate from plant UPS 24VDC power supply shall be used for contact interrogation	24V/48VDC power supply shall be used for contact interrogation		Refer electrical MOM. 24V/48VDC power supply shall be used for contact interrogation.

6 X 600 MW SUBCRITICAL POWER PLANT AT CHHATTISGARH

TENDER CLARIFICATION, (C&I)

NAME OF TENDERER: SEPCO ELECTRIC POWER CONSTRUCTION CORP.

ADDITIONAL DEVIATIONS/SEPCO/C & I

Sl. No.	Clause Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
1	VOL–II SECTION-XIX A 6.19.00	26/50	Turbine supervisory instruments shall monitor the behavior of the turbine under various operating conditions and provide adequate information on the operational aspects of the turbine. h) Bearing metal and drain oil temperature. i) Turbine metal temperature.	Bearing metal and drain oil temperature and Turbine metal temperature will be monitored to DEH.		Bearing metal and drain oil temperature and Turbine metal temperature will be monitored to DEH.
2	VOL–II SECTION-XIXA 8.00.00	38/50	METERING BASES OF CHART UNITS	International meteting units	Noted	SI(international standard) units confirmed.

6 X 600 MW SUBCRITICAL POWER PLANT AT CHHATTISGARH

TENDER CLARIFICATION, (C&I)

NAME OF TENDERER: SEPCO ELECTRIC POWER CONSTRUCTION CORP.

DEVIATIONS/SEPCO/C & I

1	VOL-II SEC-XIXA 3.07.00	4/50	Centralized control for all the units of the plant has been envisaged from one Central Control Room.	Centralized control for every three units of the plant has been envisaged from one Central Control Room.		SEPCO will consider single central control room later. Open point.
4	3.08.00	6/50	The air conditioning in each local control room shall be adequate such that even on failure of one split AC, the room shall be fully air conditioned.	Only one air conditioning in each local control room.	Split A/C's of adequate capacity based on Heat load calculation of respective rooms shall be provided along with one additional spare in all local control rooms.	SEPCO confirmed.

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14	VOL-II SEC-XIXA ANNEXURE -4	50/50	Redundancy criteria for transmitters Triple Redundant transmitters shall be provided for the following controls / measurements, as a minimum: Drum level Feed water flow Main steam flow Main steam pressure Furnace pressure Primary Air flow Secondary air flow Reheater Desuperheater temperature Reheater Outlet temperature Superheater Desuperheater temperature Superheater Outlet temperature	No Main steam flow. Main steam flow is measured indirectly through pressure difference at first turbine blade of HP. And Only one transmitter will be provided for Primary Air flow and Secondary air flow.	Please note that as per requirement in Cl. 6.05.00, Sec XIXA of tender specifications and as already agreed by you in Cl. 9.6.5, Vol-II, Sec. 3-III, Pg. 401 of 1003 of your offer, steam flow shall be measured using nozzles. Please confirm. Triple redundant transmitters shall be provided for primary air flow and secondary air flow measurements, as mentioned in the tender specifications, as they are critical parameters. Please confirm.	SEPCO confirmed one number flow nozzle for main steam flow. Three transmitters shall be provided for all as mentioned in tender specifications except Reheater Desuperheater temperature, Reheater Outlet temperature, Superheater Desuperheater temperature, Superheater Outlet temperature for which two ~~transmitters~~ temperature shall be provided.

3	1.02.00	2/19	g) A single blow down valve or double blow down valves (if the process root valves are doubled) shall be installed to the sensing lines of all pressure transmitters that are tapped off liquid or steam process systems. h) An additional isolation valve shall be used at the instrument for isolation on those instruments without valve manifolds.	40 kg/sq.cm and above process pressure, double Root Valves, single Isolations & Blow Down Valve will be provided. Below 40 kg/sq.cm single Root Valve, Isolations & Blow Down Valve will be provided.	Two root valves and two drain valves required to be provided for process pressure above 40 kg/cm2 and one root valve and one drain valve for process pressure upto 40 kg/cm2. Please confirm.	SEPCO confirmed two number root valves and one number secondary isolation valve for transmitters/switches/gauges for process pressure above 40 kg/sq. cm. Regarding two number drain valves, SEPCO will revert back.
	3.04.02.04	12/19	3 Cable tray numbering and marking: To be provided at every 10m and at each end of cable way & branch connection			SEPCO agreed for cable tray numbering and marking at every 40 meter of cable.

	3.04.04.01		The terminal blocks in Control Equipment Room logic/ termination/ marshalling cubicles shall be suitable for post mounted maxi- termi/ cage clamp connection at the field input end. The terminal blocks for DCS input/output connections from/to SWGR/ MCC, Actuators with Integral Starter (for coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT & VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the Contractor and the technical details of the same including width etc. shall be subject to Owner's approval.	According to the manufacturer requirements.	Requirement in tender specifications shall be followed.	SEPCO agreed for fork type terminal block.

	3.07.08	18/19	All impulse pipes shall be subjected to hydraulic test at 1.5 times the maximum working pressure and leakage test at site after erection.	All high pressure impulse pipes shall be subjected to hydraulic test at 1.5 times the maximum working pressure and leakage test at site after erection.		SEPCO agreed for all impulse pipes.
1	C&I DRAWINGS		HOOKUP Drawing	These drawings are indicative only. We will offer correlative drawings in detail design. Instrument tubing installations are designed as per CHINESE Standard. 40 kg/sq.cm and above process pressure, double Root Valves, single Isolations & Blow Down Valve will be provided. Below 40 kg/sq.cm single Root Valve, Isolations & Blow Down Valve will be provided.		SEPCO confirmed two number root valves and one number secondary isolation valve for transmitters/switches/gauges for process pressure above 40 kg/sq. cm. Regarding two number drain valves, SEPCO will revert back.

5	VOL–II SECTION-XIXA	50/50	ANNEXTURE-4 Dual Redundant transmitters shall be provided for the following controls/measurements, as a minimum: CBD lever, Heater drain flow, HP bypass flow, BFP recirculation flow, Gland steam condenser outlet flow, Primary SCAPH outlet temperature	Heater drain flow, HP bypass flow, BFP recirculation flow, no elements; Gland steam condenser outlet flow, delete. Primary SCAPH outlet temperature		SEPCO confirmed as per tender specifications except following. For heater drain no flow element and transmitter will be connected. However, necessary arrangement shall be provided for PG test. There will be no HP bypass flow measurement as main steam flow nozzle is provided. There will be one flow measurement for Gland steam condenser outlet flow or condensate flow. (as both are same)
6	VOL–II SECTION-XIXA 6.25.08	32/50	b) For system like Governing Control, Steam Bypass Control etc. hydraulically controlled final control element shall be used to match the dynamic response of the plant.	What does "Governing Control, Steam Bypass Control etc" include?		For use of hydraulic/pneumatic control valve refer Mechanical MOM.
4	VOL–II SECTION-XIXA 10.02.00	40/50	Performance calculation & optimization system	NO optimization system		SEPCO confirmed provision of optimization system.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
9	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 36.00.00, page no. 907 of 1003	CCTV system for surveillance	Please confirm that the CCTV system for surveillance offered is as per tender specification sec-XIXB11.	Yes, we confirm that the CCTV system for surveillance offered is as per tender specification sec-XIXB11.	Noted.
10	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 37.00.00-(e), page no. 908 of 1003	A/C for remote I/O	NA' is mentioned in this clause. However, remote I/Os have been shown in the offer drawings F625KB-K-01, 02. Hence, wherever remote I/Os are envisaged, kindly confirm ensure provision of A/C enclosure.	Yes, we confirm provision of A/C room/ Enclosure for remote I/Os as per requirement in tender specification sec-XIXA, cl. No. 3.08.00 and already update the datasheets.please see revised datasheets.	Noted.
11	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 38.00.00-(c), page no. 908 of 1003	Turbine stress calculation station	Noted that turbine stress control(TSC) system is in DEH. However there is no mention regarding provision of Turbine stress calculation station in this clause. Please provide turbine stress calculation station as per requirement shown in tender drawing K7V12-000-DWG-I-001.	The tuebine vender will provided the DEH operator sattion with turbine stress calculation function.	Noted.
12	Section 3-VII C-Datasheets for control and Instrumentation and section 3-III, technical description	cl. No. 41.00.00(c) page no.-909 of 1003 ; cl. No. 9.5.16 and 9.5.17, page 398 of 1003	Hardwired annunciator	We understand that hardwired annunciator is not envisaged in your offer.(cl. No. 41.00.00-(c) of datasheets; cl. No. 9.5.16 and 9.5.17 of vol-II sec 3-III, page 398 of 1003). However please provide hardwired annunciator with 64 windows on the back-up panel as per requirement in tender specification, sec XIXA, cl. no. 5.16.00 and 5.18.00 and update the datasheets accordingly.	If tender insist this point, we will provide the hardwired annunciator with 64 windows on the back-up panel, but the back-up panel will be congested for large video screen is also on the back-up panel	Noted for number of annunciator windows. Layout of back up panel will be finalised during detailed engineering.
13	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 54.00.00, page no. 910 of 1003	Condenser online tube cleaning system control	'NO' has been mentioned in this clause. However the provision of PLC based 'condenser online tube cleaning system' has been already mentioned in your offer in technical description, C& I part, sec. 3-III, page 393 of 1003, cl. no. 9.3.12. Hence please confirm Provision of 'condenser online tube cleaning system controls' as per requirement in tender specification sec-XIXA, cl. No. 3.12.00 and update the datasheets accordingly.	We confirm provision of 'condenser online tube cleaning system controls' as per requirement in tender specification sec-XIXA, cl. No. 3.12.00 and update the datasheets.	Noted. Condenser online tube cleaning system shall be hardwired to DCS
14	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(i)-(b), page no. 910 of 1003	Conductor size of signal cables	'conductor size' of signal cables is mentioned as 0.75, 0.8 and 1.0 mm2. However please confirm the provision of signal cables with conductor size of '1.5 mm2' as specified in the tender specification sec-XIXB4, cl. No. 2.01.00 and update the datasheets accordingly.	We confirm the provision of signal cables with conductor size of '1.5 mm2' as specified in the tender specification sec-XIXB4, cl. No. 2.01.00 and update the datasheets.	conductor size 1 sq. mm multi-stranded for signal cables and 1.5 sq. mm multi-stranded for control cables.
15	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(i)-(d), page no. 910 of 1003	Armoured signal cables	'NO' has been mentioned in this clause. However armoured signal cables as specified in the tender specification sec-XIXB4, cl. No. 2.01.00 are required to be provided. Please confirm and update the datasheets accordingly.	Only cable laying underground need armoured. In this project, cable will be laying on cable tray or cable duct, so armououred cable is not needed.	Noted. From instrument to junction box, cable shall run through flexible metal conduit. For high temperature area (eg. Turbine) teflon (PTFE) cables shall be used.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
16	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(II)-(b), page no. 910 of 1003	Conductor size of control cables	conductor size of control cables is mentioned as 0.75, 0.8 1.0 and 1.5 mm2. However please confirm the provision of control cables with conductor size of '1.5 mm2' as specified in the tender specification sec-XIXB4, cl. No. 6.01.00 and update the datasheets accordingly.	We confirm the provision of control cables with conductor size of '1.5 mm2' as specified in the tender specification sec-XIXB4, cl. No. 6.01.00 and update the datasheets.	conductor size 1 sq. mm multi-stranded for signal cables and 1.5 sq. mm multi-stranded for control cables.
17	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 55.00.00(II)-(d), page no. 910 of 1003	Armoured control cables	'NO' has been mentioned in this clause. However, armoured control cables as specified in the tender specification sec-XIXB4, cl. No. 6.01.00 are required to be provided. Please confirm and update the datasheets accordingly.	Same with item 17	Noted.
18	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.02, page no. 910 of 1003	Functional segregation of DCS controllers/processing units	No. of controllers/processing units has been mentioned as 24 + 3. Please provide the break up of the functional segregation of the controllers/processing units envisaged. Please confirm that the functional segregation philosophy mentioned in cl. No. 4.01.00, sec XIXB1 of tender specification shall be adopted. Please mention this functional segregation philosophy in the DCS configuration also, for better clarity.	DPU 1-- boiler SCS DPU 2-- ignition oil control DPU 3/4/5-- mill control DPU 6/7/8-- turbine SCS DPU 9 -- FSSS DPU 10/11/12/13--MCS DPU 14-- Coordinated Master Control DPU 15/16/17-- ECS DPU 18-- SCE DPU 19-- DEH DPU 20-- ETS DPU 21-- turbine driven feedwater pump DPU 22-- bypass control DPU 23/24-- DAS Common DPJ1-- common electric Common DPJ2-- air compresser Common DPJ3-- common DAS We confirm that the functional segregation philosophy mentioned in cl. No. 4.01.00 sec XIXB1 of tender specification.	SEPCO has confirmed grouping of controllers. However, grouping of controllers will be finalised during detailed engineering.
19	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.06(b), page no. 911 of 1003	Dedicated station for MIS	'NO' has been mentioned in this clause. However dedicated MIS station as per tender drawing and tender specification XIXB1, cl. No. 6.06.03 required to be provided. Please confirm and update the datasheets accordingly.	We confirm the provision of dedicated MIS station and update the datasheets.	Noted.
20	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.08, page no. 911 of 1003	I/O module redundancy	'NO' has been mentioned in this clause. However I/O redundancy as per tender requirement in Annexure-3, Sec XIXA required to be provided. Please confirm and update the datasheets accordingly.	We confirm I/O module can be redundancy if needed and update the datasheets.	Redundant I/O module will be provided whereever needed.
21	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.12, page no. 911 of 1003	Data transfer speed	Data transfer speed is mentioned as '1Mb' in this clause which is not acceptable. Please confirm the data transfer speed of '10/100 MBps' as specified in the tender specification sec-XIXB1, cl. no. 6.04.04 and update the datasheets accordingly.	We confirm the data transfer speed of '10/100 MBps' as specified in the tender specification sec-XIXB1, cl. no. 6.04.04 and update the datasheets.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
22	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.21-(b), page no. 911 of 1003	Type of isolation	'Later' has been mentioned in this clause. However please note that as per tender specification sec-XIXB1, cl. No. 6.01.00, all Analog & Digital Inputs and Outputs shall necessarily be galvanically or optically isolated as the case may be. Please confirm.	We confirm.	Noted. SEPCO confirm provision that Analog Inputs and outputs shall be galvanically isolated and digital inputs shall be optically isolated. For Digital outputs interposing relay shall be provided.
23	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.34-(e), page no. 912 of 1003	Functions implemented outside controller	Please clarify how the pressure and temperature compensation will be achieved outside the controller?	Pressure and temperature compensation function will be realized in controller and update the datasheets.	Noted.
24	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.35-(e), (f), page no. 912 of 1003	RAM size, Hard disk capacity	'Later' has been mentioned regarding hard disk capacity and RAM size. However kindly confirm the provision as per requirement in tender specification, sec-XIXB1, cl. No. 6.06.03 and update the datasheets accordingly.	We confirm the provision as per requirement in tender specification, sec-XIXB1, cl. No. 6.06.03 and update the datasheets accordingly.	Noted.
25	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 57.00.44-(e), (f), page no. 913 of 1003	LVS quantity	'Later' has been mentioned regarding quantity of LVS. However please mention the quantity in the datasheets inline with the LVS shown in your offer drawing no. F625KB-K-01, 02.	LVS quantity is two each unit.	SEPCO agreed for 72 inch LVS size
28			Data and documents	Data and documents shall be submitted as listed in the tender technical specification, sec XIXA, cl. 12.00.00. Please confirm.	The other data and documents will be provided later	Noted.
30	Volume II, section 3-III, technical description	cl. No. 9.6.28, page no. 421 of 1003	Ambient air quality monitoring system	In addition to the stated clause, please confirm the following: a) To demonstrate compliance with ambient air quality standards and as required by the state pollution control board, four nos. (4) continuous ambient air quality monitoring systems shall be installed in and around the project area at approved locations. monitoring station locations shall be determined by air quality impact modelling results and in consultation with state pollution control board. b) The monitoring stations shall include SPM, RPM, SO2, NO2 and CO for sampling. c) For monitoring of ambient air quality, high volume sampler with attachment for gaseous sampling and particulate matter sampler shall be provided. d) One completely automatic weather station for metrological data collection and recording shall be supplied. The station shall comprise wind-vane, anemometer, thermometer, hygrometer, rain fall recorder, sunshine recorder, evaporimeter etc. e) The entire station shall be PC based automatic recording type with provision for instantaneous display of different parameters and the same shall be EPA approved. f) A Mobile ambient air monitoring van equipped with sampling and measuring instruments shall also be provided.	The provision of Ambient air quality monitoring system will be meet these requirement.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
B	Drawing no. F625KB-K-01, 02 DCS configuration diagram					
1			ESP and AHP control room	From the layout drawing in your offer, it is understood that the local control room for ESP & AHP is common. However, this is not clear in F625KB-K-01, 02 DCS configuration diagram as the control room is named as "bottom ash & fly ash field control room". Please update the name in the DCS configuration diagram for better clarity.	The control room name have been modified to "ESP & AHP control room".	Noted.
2			HCSD PLC system	HCSD PLC system is not shown in the drawing. Please show thw same and update the drawing.	HCSD PLC system is not finded in tender documents,please give detail description.	SEPCO agreed PLC for HCSD system if HCSD system is included by mechanical.
3			ESP control and interface to DCS	As per your offer (cl.no. 9.3.12 of pg 392 of 1003) and tender specs, ESP should have its own control system based on PLC with hardwired signals to DCS for monitoring. However,in the drawing, 'ESP I/O' is shown connected via MB to DCS I/O cabinet. Why is it shown so? Please clarify.	ESP have hardwired signals with DCS. The drawing have beenn updated.	Noted. However, ESP PLC shall be connected to DCS interfaced through BOP net for monitoring.
4			Separate ES cum OS for ESP	Separate ES cum OS for ESP has already been agreed in the volume II, section 3-III-- Technical description, page no. 392 of 1003 of your offer, but has not been shown in the drawing Hence kindly confirm the provision of ES cum OS station for ESP as per your offer (and requirement in tender specification, sec XIXA, cl.no. 3.12.00) and update the drawing accordingly. Will this ES cum OS station be located in the ESP-AHP local control room?	We confirm the provision of ES cum OS station for ESP. This drawing can not show every technical detail. The ES cum OS station of ESP will be located in the ESP-AHP local control room	Noted.
5			OS; OS/ES in AHP local control room	Ash handling system with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no. 427 of 1003. But in the drawing, only one no. OS is shown in AHP local control room and an EWS common to all offsite plants is shown. This is not acceptable. Kindly confirm the provision of operator cum engineering station also in the AHP local control room , as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f). Please update the drawing accordingly.	The quantity of OS and ES for AHP will meet tender requirement.	Noted.
6			OS; OS/ES in CHP local control room	Coal handling system with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no. 427 of 1003. But in the drawing, only one no. OS is shown in CHP local control room and an EWS common to all offsite plants is shown. This is not acceptable. Kindly confirm the provision of operator cum engineering station also in the CHP local control room , as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f). Please update the drawing accordingly.	The quantity of OS and ES for coal handing system will meet tender requirement.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
7			OS & ES in water treatment plant local control room	DM plant with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no. 426 of 1003. But in the drawing, only one no. OS is shown in WTP local control room and an EWS common to all offsite plants is shown. This is not acceptable. Kindly confirm the provision of operator cum engineering station also in the WTP local control room , as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f). Please update the drawing accordingly.	The cuantity of OS and ES for DM system will meet tender requirement.	Noted.
8			OS; OS/ES in Compressed air system local control room	Compressed air system with PLC based system with OS and OS/ES is mentioned in the offer submitted by you, technical description, vol II, sec 3-III, page no. 427 of 1003. But in the drawing,OS & OS/ES for compressed air system is not shown. Hence kindly confirm the provision of these stations, as per requirement in tender specification, annexure 1of sec XIXA, and as already agreed by you in data sheet cl. 38.00.00(f) and update the drawing accordingly.	The cuantity of OS and ES for compressed air systemwill meet tender requirement.	Noted.
9			Condensate water treatment control	In the drawing, 'Condensate water treatment' system PLC is shown interfaced to overall water treatment system network. However, it is not clear to us as to what are the system controls envisaged to be done by this PLC.Please clarify	The condensate water treatment system include condensate polishing, resin regeneration,etc	Noted.
10			Water treatment control	Water treatment control & others are shown with PLC & remote I/O interfaced to PLC in 'overall water treatment field control room'. However it is not clear what system controls are envisaged from this PLC. Please clarify. Also what are these remote I/Os envisaged for?	Remote I/O cabinet will be used in pretreatment area far from control room The water treatment system incude pretreatment,RO,electro ultrafiltration,EDI,etc	Noted.
11			Controls implemented in DM plant PLC	Controls like 'Raw water pump intake', 'pre-treatment plant including the chlorination system', 'Auxiliary water system(potable, service, CW make up water, DM make up etc)','CCW side treatment', 'effluent treatment plant','RO plant' shall be implemented in DM plant PLC is mentioned in the offer submitted by you in technical description, vol II, sec 3-III, page no. 426 & 427 of 1003. But the same are not reflected in the drawing. Hence kindly confirm provision of all these controls and update the drawing accordingly.	Please see technical description ANNEXURE-1 "Control implementation philosophy for BCP systems". These system are monitored and controlled on local control panel without connect to DCS net.	The mentioned systems are monitored and controlled from local control room and connected to DCS through BOP net.
12			ACW system control; cooling tower system control	There is no mention of ACW system control; cooling tower system control etc in the drawing? As per tender requirement and your offer (cl.9.11, pg 426 and 427 of 1003), DCS based control is envisaged for these systems. Please confirm and mention in the drawing for better clarity.	ACW is shown as "CIRCULATING WATER PUMP HOUSE" in this drawing.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
13			sampling and dosing system	A sampling and dosing system I/O cabinet is shown in the overall water treatment control room. But is it not shown connected to any PLC/network.Please clarify.	It is shown clearly in this drawing that this cabinet connect to CONDENSATE WATER TREATMENT CONTROL PLC.	Noted.
14			HP & LP dosing systems for subcritical plant	Please list out the HP & LP dosing systems envisaged for subcritical plant.	Please see chemical part.	Please refer resolution of point no. 6 of C & I deviations.
15			HP & LP dosing system controls	The HP & LP dosing system shall be PLC based and interfaced to DCS through OPC server for monitoring. This system shall be supplied with an ES cum OS station' is mentioned in vol II, sec 3-III, technical description, page 392 of 1003. But these aspects are not reflected in the drawing. Please confirm and update the drawing accordingly.	Later	Please refer resolution of point no. 6 & 7 of C & I deviations.
16			CPU, COLTCS and Steam leak detection system controls	Condensate Polishing Unit(CPU), condenser on line tube cleaning system(COLTCS) and Online steam leak detection system will be PLC based' is mentioned in the vol II, sec-3-III, technical description, page 392 of 1003. But the same is not reflected in the drawing. Please clarify and mention the same in drawing.	Condensate Polishing Unit(CPU) is "CONDENSATE WATER TREATMENT" shown in this drawing. COLTCS and Online steam leak detection system are independent PLC system and have hardwaired with DCS.	Noted.
17			Details of 'Interface'	In drawing, for connecting BOP system, SCADA system and for interconnecting other units, a block named 'INTERFACE' is shown. A) Please provide the details regarding the same. It is not clear to us as to what is the type of 'interface' envisaged by you. B) Is the type of link shown for connecting offsite PLCs to DCS TCP/IP?	Later	During detailed engineering .
19			OS for rest of BOP	Only one OS has been provided in the CCR for the rest of BOP. However, as per tender requirement (ref tender drawing), two nos. OS are required to be provided. Please confirm and accordingly update the drawing.	two or three BOP os will be provided.	Noted
20			TSC station	Please provide the TSC station inline with tender drawing.	TSC station is included in DEH operator station.	Noted. No separate TSC station. Function of TSC station is included in DEH operator station.
21			MIS station	One MIS station consisting of server with firewall to access all process data, alarm message, history report, trend display etc. via the plant network and open connectivity for viewing at remote locations without virus infection to control network is required to be provided as per tender specifications(cl.4.02.00, sec-XIXB1). Please confirm provision and accordingly show the station in the drawing.	Yes. We confirm.	Noted.
22			TSI monitoring and analysis	Please confirm that TSI monitoring and anaysis is done at Machine monitoring station inline with tender drawing.	Yes. We confirm.	Noted.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
23			Type of printers in CCR	In the CCR, One Dot Matrix Printer & One Laser B/W printer for BTG alarms & logs respectively; One Dot Matrix Printer & One Laser B/W printer for common systems; One Dot Matrix Printer & One Laser B/W printer for offsite systems; One dedicated dot matrix printer for SOE; dedicated B/W laser printer for SCADA ES; dedicated colour laser printer for every ES; dedicated B/W laser printer for machine monitoring station are required to be provided (refer tender specs cl.no. 4.02.00,sec-XIXB1) . Please confirm and accordingly mention the type of printers in the drawing .	Yes, We confirm.	Noted.
24			Type of printers in local control rooms	A4 size colour laser network printer required to be provided in each local control room (refer cl.2.07.00, sec-XIXB2).Please confirm and accordingly mention the type of printers in the drawing .	Yes, We confirm.	Noted.
25			CD writer for ES	As per tender requirement (cl.no. 4.02.00,sec-XIXB1) every ES is required to be provided with a CD writer. Please confirm and mention in the drawing.	Yes,We confirm.	Noted.
26			Backup panel	Provision of hardwired backup panel has been shown in the drawing. However, please confirm that this hardwired backup panel will house Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator as already agreed by you in the offer cl.no.9.5.16, pg 397 of 1003.	Yes.We confirm	Noted. However, drum level TV, EWLI will not be part of super-critical boiler.
27			Clarity regarding equipment envisaged in Central control room	In the drawing, there is a overall block drawn around all the local control rooms and marked as 'central control room'. The purpose is not clear to us. Please clarify. Also 'workshop' is mentioned in Bottom Ash & Fly Ash filed control. This is also not clear to us. Please clarify	It is means BOP-net will be located in CCR. It is means PLC cabinet will be located in local control room in workshop.	Noted.
28			Control rooms for CHP and AHP	In the drawing, only one control room is shown for CHP and one for AHP. However, this issue to be discussed.	One control room for CHP for all 6 units. One control room for ash handling per phase.	Noted.
29			DCS feature	DCS shall have facility of capturing the process information with specified interval in a spreadsheet for defined time period. Operator shall have facility to assign the tags. Bidder to confirm		DCS will capture the process information from history station.
30			Bunker level and fly ash silo level measurement	From the offer C & I data sheet, cl. No. 52.00.00, we understand that ultrasonic type of coal bunker level monitoring system is envisaged. Non-contact type ultrasonic or Radar type measurement for coal bunker and fly ash silos shall be provided. To be discussed.	SEPCO confirmed.	Radar type measurement shall be used.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
1	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 37.00.00-(a), page no. 908 of 1003	Location of central control room(CCR)	'Central control room will be at EL. 13.700m floor' is mentioned in the cl. no. 11.4.1.5, vol II, sec 3-III, technical description, page 436 of 1003. However in the layout drawing F625KB-Z-01, the central control buildings(sr. no.40) has been shown as extensions of the power house building. So the location envisaged for CCR is not clear. Hence please confirm the provision of 'control tower as an extension of the power house building' as per requirement in tender specification sec-XIXA, cl. 3.08.00 and update the datasheets accordingly. Also note that a irrespective of the number of phases in which the project is executed, a single common central control room shall be planned for all the units.	We confirm the provision of 'control tower as an extension of the power house building' as per requirement in tender specification sec-XIXA, cl. 3.08.00 Already update the datasheets.please see revised datasheets T	SEPCO will consider single central control room later. Open point.
2	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 37.00.00(d), page no. 908 of 1003	A/C for local control rooms	'NO' has been mentioned in this clause. However the provision of split A/C for each local control room is already mentioned in your offer in section 3-III-technical description, page 392 of 1003. Hence please confirm the provision of A/C for local control rooms as per requirement in tender specification sec-XIXA, page 6 of 50, cl. No. 3.08.00 and update the datasheets accordingly.	Yes, we confirm provision of A/C room for local control room as per requirement in tender specification sec-XIXA, cl. No. 3.08.00 and already update the datasheets.please see revised datasheets	Noted.
3			Training simulator	Please furnish the configuration diagram of the training simulator offered. What are the softwares envisaged to be supplied along with the training simulator?	Later	SEPCO confirmed but with optional price.
4			Triple redundancy	MFT, Steam turbine protections shall have triple redundant I/Os and processors. Bidder to confirm		SEPCO confirmed.
5			Vacuum Breaker	Bidder shall provide DC operated Vacuum Breaker for the Steam Turbine.		WPCPL insisted for DC motor operated vacuum break valve with handwheel(for manual operation) SEPCO will discuss with turbine manufacturer and will revert.
6			Field Transmitters instead of process switches	Bidder shall provide smart transmitters instead of process switches.		SEPCO clarified that process switches will be used at some places. WPCPL/DCPL agreed provided the switches are of reputed make (SOR, UE)

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7			Online degassed cation conductivity measurement	Please provide online degassed cation conductivity measurement for improvement in steam quality.		SEPCO will discuss and revert WPCPL/DCPL will give a typical datasheet for the same.
8			feedwater control	SEPCO to confirm the BFP speed control by scoop and control of DP across feed control pneumatic valve for low load control.		SEPCO will submitt the control philosophy.
9				Refer deviations by SEPCO in files 'Deviation of I & C by SEPCO' and 'Additional deviations by SEPCO' and revised technical particulars submitted by SEPCO. There is no other deviation. So SEPCO is fully complying with tender specifications other than agreed deviations. SEPCO to confirm.		SEPCO confirmed and there is not any other additional requirement by WPCPL/DCPL.
10	Section 4-V laboratory equipments list	Equipment list of I & C laboratory, page 969 of 1003	Missing laboratory instruments	Please note that the following equipment specified in sec XIXB12 are missing in your offer: Hand held Pyrometer, Standard tool box, Digital Storage Oscilloscope, Soldering/desoldering station with all accessories, Cable tester (Time domain reflectometer), Fibre optic cable continuity tester, Fibre optic splicer, Fibre optic connectorisation tool. Please confirm the provision of these instruments.	Detail laboratory instruments list will be discuss later.	SEPCO agreed to supply all items other than Fibre optic cable continuity tester, Fibre optic splicer and Fibre optic connectorisation tool.
11				Vendors for all C & I items shall be as per agreed vendor list.		See attached vendor list.

SR. NO.	Bid Reference		Brief subject	COMMENTS/CLARIFICATION REQUIRED	SEPCO's Reply	Remarks/Resolutions
	Volume/Section/ Part/ Chapter no	Clause no / Page no				
1	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 58.00.00(a), page no. 914 of 1003	Redundant UPS for DCS	'NO' has been mentioned in this clause. However 'Redundant UPS for DCS' is required. Please confirm provision as per tender specification XIXA, cl. No. 7.01.00	For "Redundant UPS" we understand two UPS power supply from UPS,not two UPS equipment.	One redundant UPS means two sets of rectifier-inverter-static switch with one battery. From UPS two feeders shall be provided for power supply to DCS.
2	Section 3-VII C-Datasheets for control and Instrumentation	cl. No. 58.00.00(b), page no. 914 of 1003	Redundant UPS for offsite system	'NO' has been mentioned in this clause. However 'Redundant UPS for each offsite system' is required. Please confirm provision as per tender specification XIXB1, cl. No. 5.01.00	For "Redundant UPS" we understand two UPS power supply from UPS,not two UPS equipment.	One redundant UPS means two sets of rectifier-inverter-static switch with one battery. From UPS two feeders shall be provided for power supply to PLC to each offsite system.
3			Drive control philosophy	In the offer submitted by you, 'drive control philosophy' envisaged is not mentioned. Please confirm the drive control philosophy as per tender specification. Annexure-2, Sec XIXA, shall be adopted in this project.	We confirm the drive control philosophy as per tender specification. Annexure-2, Sec XIXA	Noted.
4		cl. No. 4.11.1, page 373 of 1003	PA system	Kindly consider EPBX of at least 20 in and 250 out lines. PA system should be provided at all equipment floor levels of major equipment buildings along with in other auxillary plants like AHP,CHP, WTP etc.	Please see electric part.	SEPCO agreed.
5			Coal handling system PLCs	Two coal handling PLCs are shown in coal handling control room. However it is not clear what system controls/functional segregation are envisaged for each of the PLCs. Please clarify. Also the 'stacker reclaimer PLC', 'Mill reject handling system PLC',	Please see electric part	During detailed engineering.
6			Electrical control system	Numerical relays and Load managers of MCCs (may be Daisy chained) will be connected to OPC server for interfacing to DCS'. Is mentioned in the offer submitted by you, vol II, sec 3-III, technical description, page 421 of 1003. But the same is not reflecected in drawing.	It is incude in electrical part.	Confirmed. Deta.ls will be worked out during detailed engineering.
7			SCADA system	In the drawing, there is a block named SCADA system and two DCS cabinets, one EWS and one printer are shown in the block. The location of these equipment is not clear to us. Please clarify. Are these equipment related to switchyard SCADA? Please clarify.	Later	Refer electrical MOM

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22			Description of foundation system adopted for buildings, structures and equipment	shall be submitted along with the bid	SEPCO agreed to provide the foundation system to meet Indian standards and as per the results of geotechnical investigation.
23			Description of major building and structures	shall be submitted along with the bid	for sizes of buiildings, as per point no.14 and specifications of the building as per the bid document. SEPCO agreed
24			Information on RC chimney and its method of construction	shall be submitted along with the bid	SEPCO informed WPCPL that they shall use Slipform for construction of Chimney
25			Description of Virbation isolation system for TG and other machine foundations	shall be submitted along with the bid	SEPCO informed WPCPL that they shall use foundation isolation procedure but shall not provide viscous dampers
26	II/S-4 F 10	8 of 23	Ash pipelines beyond up to and including Ash Dump Yard	it shall be in bidder's scope	Shall be addressed under [illegible]
27	II/S-4 I 14	10 of 23	Passenger lift for administrative building (one) suitable for ten persons, and stack elevators (in the chimney).	it shall be in bidder's scope	SEPCO agreed for [illegible]
28	II/S-4 I 15	10 of 23	Plant maintenance workshop equipped with necessary equipment & facilities for best upkeeping of the entire plant. Bulldozer and other Vehicle maintenance shop	it shall be in bidder's scope	Shall be addressed under [illegible]

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			a) (i) Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards. (ii) equivalent Chinese standards for RCC and structural steel detailing (iii) equivalent Chinese standards for construction materials b) National Building Code of India. c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India. d) IS-1200 : Method of measurement of Building and Civil Engineering Works. e) IS-1256 : Code of Practice for Building Bylaws.	Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards and this caluse is **non negotiable**	SEPCO desires to design the structures as per Chinese standards. However, it shall comply with Indian standards and other interntaional standards which shall be checked by DCPL / WPCPL and SEPCO shall incroporate the same. SEPCO agreed.
19			Wind Load	WPCPL requested SEPCO to inform the basis of wind load consideration	SEPCO Confirmed that they will use wind pressure of 0.5 kPa for structural design.
20			Seismic Load	WPCPL requested SEPCO to inform the basis of Seismic load consideration	SEPCO Confirmed that they will adopt 7 Degree seismic intensity as per Chinese code for structural design.
21			RCC -grade of concrete	WPCPL informed SEPCO to comply with the grade of concrete as per Indian standard as detailed in the technical specification supplied to bidders along with the bid document.	SEPCO confirmed.

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14	2.2.2	Power plant plan	Sizes of buildings	WPCPL / DCPL Reply : Sizes of the buildings shall be as per F625KB-Z-01. WPCPL-TPP-VOL-II-SEC-17 and the location of all the structures shall be as per Plot plan supplied along with the bid document.	Non plant buildings shall be as per the attached Building Data Sheet and plant buildings shall be as per functional requirements.
15			Site Grading	WPCPL / DCPL Reply: The grading shall be done as per Vastu Document supplied along with Bid document and grading shall be done accordingly. The storm water drainage system of the plant shall be provided considering the surrounding levels and effective drainage system	SEPCO requested for exclusion of this from their scope. WPCPL reiterated that the plant grading as per Vastu and Layout requirements shall be part of Bidder's scope. SEPCO agreed.
16	2.2.5		Road and Drains	WPCPL / DCPL Reply: The access road which is connected to NH200 will be 14.0 meters in addition to 1.0m wide shoulders on either side and the main road shall be 7.0 meters in addition to 1.5m wide shoulders on either side shall be designed to carry the crane of capacity of 500 Metric Tons. Pre-cast RCC covers shall be provided over RCC storm water drain of adequate capacity shall be provided on either side.	Main access roads shall comply with the best specification out of Loading class AA and 70 R of IRC specification and a copy of the same has been handed over to SEPCO and the road layout has been handed over to SEPCO. SEPCO agreed for the same.
17	2.2.6		Boundary Wall	The details of Boundary wall shall be as per clause no. 4.05.09 of our specification supplied vide document reference : WPCPL-TPP-VOL-II_SEC17A SEC-17A: 21 OF 30	**SEPCO excludes the Boundary wall from their scope.**
18			**CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS**		

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8	VOL - III, PART - D, DS - CIVIL	7.1	Method to be adopted for Shell construction is Glide moulding Board.	Bidder should confirm whether it is same as slipforming ? If not, how it differs ?	Slipform has been agreed by SEPCO
9	VOL - III, PART - D, DS - CIVIL	7.12 & 7.13	Minimum number of Aviation Lights and its specifications are not mentioned.	The same should be as per ICAO regulations	SEPCO agreed
10	VOL - III, PART - D, DS - CIVIL	8.0	Along wind load and across wind load on Chimney will be calculated as per GB50051 - 2002.	If these loads are being calculated as per Chinese code, the bidder should ensure that it is equivalent to or more stringent than IS 4998 (PART - 1) : 1992. Chimney shall also be analyzed as per ACI - 307. Wind tunnel test should be performed to check the stability of the structure. Finally , the Chimney shall be designed for worst response under the wind load resulting from all these methods.	SEPCO agreed
11	VOL - II, SECTION 5	DRG. No. F625KB-J-01	Plane Drawing of Main Building Layout - It shows 2 Nos. chimneys with 3 Nos. Flue per chimney.	Please clarify whether the no. of flue duct openings per chimney is 2 or 3.	SEPCO confirmed that it is 3 openings for one no. chimney
12	VOL - II, SECTION 3 - III	2.2.3	Finished grade level above sea level for the power house area to be developed is 275m, that for raw water reservoir and raw water pretreatment plant to be developed is 274m, that for the coal pile area to be developed is 269m.	Bidder should confirm that these finished grade levels are in line with the vastu requirements for the plant.	SEPCO agreed
13	VOL - II, SECTION 3 - VIIA, M13	1.17.7	Height of Stock pile = 13.5m	As per VOL - II, SECTION - IX , clause 13 of bid document, the height of coal stock pile should be 10m. Bidder should clarify this variation.	[illegible] addressed under [illegible]

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ANNEXURE-D

WARDHA POWER CO. PVT. LTD.
6×600 MW SUBCRITICAL COAL BASED POWER PROJECT
NARIYARA, JANJGIR-CHAMPA, CHHATISGARH

26.9.2008

Sl.no	Volume / Section	Para / clause no	Particulars in offer	WPCPL Query	Resolution
1	VOL - III, PART - D, DS - CIVIL	4.0	Seismic analysis will be conducted as per GB5001 - 2001. Response Spectrum and seismic acceleration spectra will be utilized.	If seismic analysis shall be done as per GB5001 - 2001, the bidder should ensure that it is equivalent to or more stringent than IS 1893 (PART - 1) : 2002.	As per point no.20
2	VOL - III, PART - D, DS - CIVIL	5.0 (b)	For Seismic analysis, Importance factor = 1.0	Please clarify the basis for Importance factor = 1.0 for seismic analysis as the value of same is 1.5 as per IS 1893 (PART - 1) : 2002.	As per point no.20
3	VOL - III, PART - D, DS - CIVIL	2.0	Nature of fuel, Maximum quantity of flue gas through the Chimney, Flue gas temperature at entry of Chimney are not mentioned under Flue gas data.	These data should be specified.	Shall be addressed under [illegible]
4	VOL - III, PART - D, DS - CIVIL	5.0 (a)	Drag Coefficient, C_d to be considered for Wind load analysis is not mentioned.	Model study / wind tunnel test shall be conducted by the bidder to establish the coefficient of wind drag.	SEPCO agreed
5	VOL - III, PART - D, DS - CIVIL	3.1	Maximum and minimum outside ambient temperatures are not mentioned.	The same should be specified.	Shall be addressed under [illegible]
6	VOL - III, PART - D, DS - CIVIL	6.2	Permissible tip deflection of Chimney is not mentioned.	As per bid document, the same should be restricted to H/500, where H is the height of shell above pile cap.	SEPCO agreed
7	VOL - III, PART - D, DS - CIVIL	6.4 & 6.5	Minimum grade of concrete in Chimney Shell and base raft / pile cap is C30.	As per bid document, VOL - II, SECTION 17C, Clause no. 4 (b), the minimum grade of concrete for Chimney shall be M 30	SEPCO agreed

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			provided. The clamps required for fixing of cable shall be supplied by the Contractor. The Cable *shall be clamped to the* trays with GI/Aluminium clamps at not more than 0.5 metre intervals for horizontal runs and vertical runs. 9 Optical fibre cables Inside conduit shall be laid on cable trays wherever available and feasible. buried in separate trench approx.1metre depth, to be laid in 2" gi/rodent proof HDPE conduits covered with sand, brick and soil along the pipe line route; While crossing roads - to be laid in GI/ rodent proof HDPE conduits with sand filling at bottom and sand, soil filling at top with cement concrete; While crossing canals/ river- to be laid in GI/ rodent proof HDPE conduits within hume pipe.			

S B R Prasad

	3.04.02.04	12/19	All the cable runs shall be properly identified by engraved aluminium number tag plates, in owner's approved *format, fastened* to the cable with steel wires, which shall be provided at both field ends junction box ends and at Control room equipment ends and at every 25m length of the cable.	All the cable runs shall be properly identified by engraved plastic number tag plates, in normal format, fastened to the cable with cotton wires, which will be provided at both ends of the cable.	Reply to no. 2 is noted. Reply to no. 5, 6 is Noted. Reply to no. 8, 9 is Noted.	SEPCO will provide the cable tags on both the ends of cables (start point and end terminal).
		12/19	2 Identification tags for cables. Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 25 m in cable trench/tray. 5 Buried cable protection: With concrete slabs; Route markers at every 20 Meters along the route & at every bend. 6 Road Crossings: Cables to pass through buried high density PE pipes encased inPCC. 7 Segregation (physical isolation to prevent fire jumping): *b Interplant* cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. 8 Cable clamping All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray. For cables in trefoil formation, trefoil clamps shall be	2 not necessary. 3 not necessary. 5 As the case may be. 6 Cables to pass through buried GI steel pipes. 7 Please elaborate more. 8 All cables laid on trays shall be neatly dressed up & suitably tied to the tray by steel wires. 9 As the case may be.		

	3.06.05	18/19	For terminating grounding wires only ring-tongue typelugs shall be used and the wires; shall be ferruled at both ends.	Please elaborate more.		SEPCO confirmed.
2	6.01.00	10/50	All inputs shall be taken through interposing relays for isolation and contact multiplication.	Please elaborate more.	Inputs are required to be taken through interposing relays for isolation and contact multiplicati on. Deviation not clear. To be discussed.	Noted. SEPCO confirm provision that analog inputs and outputs shall be galvanically isolated and digital inputs shall be optically isolated. For digital outputs interposing relay shall be provided.

8	VOL–II SECTION-XIXB15.01.00		a) Process I/O racks shall contain 20% installed spare I/O modules. Other system components to support the spare I/O such as I/O power supply, I/O cables. Communication processors, terminal blocks etc shall also be installed with 20% spare capacity. All spare I/O modules must be pre-wired up to terminal blocks. b) Process I/O racks shall have an additional 20% spare rack space only without installed modules. However all other system components must be available in the system to accommodate this future requirements. e) The system design shall include the capability for atleast 20% future expansion in respect to process I/O's, which shall be achieved by addition of equipment, without modifying or replacing existing equipment's, communication cables, system operating software etc.	a) Process I/O racks shall contain 15% installed spare I/O modules. Other system components to support the spare I/O such as I/O power supply, I/O cables. Communication processors, terminal blocks etc shall also be installed with 15% spare capacity. All spare I/O modules must be pre-wired up to terminal blocks. b) Process I/O racks shall have an additional 15% spare rack space only without installed modules. However all other system components must be available in the system to accommodate this future requirements. e) The system design shall include the capability for atleast 15% future expansion in respect to process I/O's, which shall be achieved by addition of equipment, without modifying or replacing existing equipment's, communication cables, system operating software etc.		SEPCO agreed for 15% spare.

	3.04.04.03	16/19	At least 20% spare unused terminals shall be provided everywhere *including local* junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.	At least 10% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. Printed labels shall be provided on the terminal blocks.	Specifications shall be followed.	SEPCO agreed for 15% spare.
7	VOL-II SECTION-XIXB14.02.00	7/50	HMI reqirement d) Separate operating station shall be provided for diagnostic/maintenance e) Separate operating station shall be provided for performance monitoring/calculation. f) Separate operating station shall be provided for turbine stress calculation. g) One HART management workstation.	NOT NECESSARY		SEPCO confirmed. However, no hand-held calibrators for smart transmitters shall be provided.

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
F.	**ASH HANDLING PLANT**			
1.	Complete with bottom ash, coarse ash and fly ash conveying systems to intermediate storage or to silos directly and transportation system up to the ash dump area by High Concentration Slurry Disposal (HCSD) system.	Yes	BOP	Yes
2.	Bottom Ash Hoppers with jet pumps, piping and other accessories with drives and accessories.	Yes	BOP	Yes
3.	Clinker grinders, Pumps, compressors, blowers, heaters, piping etc. as required for bottom ash handling.	Yes	BOP	Yes
4.	Lean phase slurry disposal for the bottom ash.	Yes	BOP	Yes
5.	Fly ash extraction system with all equipments and accessories.	Yes	BOP	Yes
6.	Fly ash silos, intermediate surge hoppers, dust extraction/suppression systems, unloader etc., and ash withdrawal system from both surge hoppers and fly ash silos for disposal.	Yes	BOP	Yes
7.	HCSD system comprising mixing vessels (with inside rubber liner, agitator and density meter), slurry tanks, water supply for conditioning and preparing the slurry, slurry tanks, piston diaphragm pumps, ash disposal, pipeline flushing system, with all accessories.	Yes	BOP	Yes
8.	Recovery of water from the bottom ash system, ash water decantation, clarification and recovery etc.	Yes	BOP	Yes
9.	Control, protection and monitoring system with necessary interfacing with centralised Distributed Control System (DCS).	Yes	BOP	Yes
10.	Ash pipelines beyond, upto Ash Dump Yard.	Yes	BOP	Yes
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REF
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
1.	Conveyor galleries, tunnels, transfer points.	Yes	BOP	YES
2.	Two (2) Track hoppers, crusher houses, transfer towers etc.	Yes	BOP	YES
3.	Complete dust extraction, dust suppression, ventilation and air-conditioning system.	Yes	BOP	YE
4.	Control, protection and monitoring system with necessary interfacing with centralised Distributed Control System (DCS).	Yes	BOP	YE
5.	Coal wagon weigh bridges for weighing loaded and empty rail-wagons.	Yes	BOP	YE
6.	One Road weigh bridges of 100 Te, Two Railway weigh bridges 120 Te each one at each side of the track hopper complex.	Yes	BOP	YE
7.	Conveyor belt weigh scales upstream of coal crushers/stackers as well as downstream before entry to the power house bunkers.	Yes	BOP	YE
8.	Coal sampling unit upstream of coal crushers/stackers as well as downstream at power house raw coal bunker entry.	Yes	BOP	YES
9.	Rain protection shed with structures above track hopper, also, sidewalls for rain protection.	Yes	BOP	YES
10.	Coal unloading and stockpile area storm drainage system, including the arrangement for collection, clarification, recycle and disposal of the drain water.	Yes	BOP	YES
11.	Railway Tracks	No	No	No
12.	Air compressors with piping for operating bottom opening rail wagons.	Yes	BOP	YE
13	Metal detectors on the conveyor before each crusher and before coal bunkers of each unit.	Yes	BOP	YE
14	Elevator (lift) on each crusher house and one common for transfer towers of track hopper before bunker provided with reversible cabin in the same lift.	Yes	BOP	

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REPI
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
	with pumps & piping for effluent disposal up to guard pond/effluent treatment pond.			
11.	Condensate make-up water storage tank for each unit.	Yes	BTG	YES
12.	Boiler filling system (pumps, piping etc.)	Yes	BTG	YES
13.	Service water, drinking water (for both plant and township) and other auxiliary water systems, including piping, pumps, storage tanks, etc.	Yes	BOP	YES
14.	All pumps, piping, gates, screens, trash racks etc. for the complete system.	Yes	BOP	YES
15.	All sump pumps/drainage pumps for the entire plant.	Yes	BOP	YES
16.	All piping, valves etc required for the water systems.	Yes	BOP	YES
17.	Drinking water supply to colony (up to Plant Boundary)	Yes	BOP	YES
18.	RO Plant of adequate capacity (Min. 200 m3/hr each stream) including following : 1. Chlorination system, Clarifiers, Multi Grade filters etc. 2. Chemical conditioning system 3. RO modules, RO feed pumps, Ultra filter 4. Related piping, fittings for completion of system	Yes	BOP	YES
19.	Guard Pond as required.	Yes	BOP	YES
20.	Control, protection and monitoring system with necessary interfacing with centralised Distributed Control System (DCS).	Yes	BOP	YES
E.	**COAL HANDLING PLANT**			
	Complete with coal wagon unloading system, coal crushing and screening plant with metal detector and inline magnetic separators, coal stacker & reclaimer for crushed coal stock piles, coal conveyors from unloading station to crushing plant, to stock pile and to power house raw coal bunkers, as also:	Yes	BOP	YES

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REP
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
3.	Raw water reservoir of 5 days storage (12,00,000 Lakhs Cu.m) capacity at plant site. In two compartments with pumps, pipeline as required	Yes	BOP	YES
4.	Raw water treatment plant.	Yes	BOP	YE
5.	Clarified water reservoir.	Yes	BOP	YES
6.	Fire water reservoir (Clarifier water tank)	Yes	BOP	YE
7.	All circulating water, auxiliary cooling water and any other cooling water systems as required, including :		BOP	
	a) Natural Draft Cooling towers	Yes	BOP	YE
	b) CW pumps for main condenser cooling.	Yes	BOP	YES
	c) Cooling water pumps for TG and SG island coolers (e.g. auxiliary cooling water pumps, closed cycle cooling water pumps using demineralised water.)	Yes	BOP	YE
	d) Heat exchangers with closed cycle DM water primary cooling system and secondary circuit auxiliary cooling water pumps, as necessary	Yes	BOP	YE
	e) Blow-down and make-up water system.	Yes	BOP	YE
	f) Chemical dosing for the protection of cooling water system to control growth of algae/barnacle etc along with chlorine dosing unit.	Yes	BOP	YE
	g) Internal chemical control for the CW/ ACW system for prevention of corrosion and scale deposition on piping/heat exchanger surfaces.	Yes	BOP	YE
8.	Rain water harvesting system including piping and other accessories required,	Yes	BOP	YE
9.	Filtration plant with filtered water reservoir.	Yes	BOP	YES
10.	Demineralisation plant with necessary Demineralised water storage tank and transfer pumps for make-up to heat cycle system and make-up to closed DM water cooling system, as required, along with neutralising pit	Yes	BOP	YES

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REPI
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
17.	Coal sampling system and air-flow measurement system at mill outlet	Yes	BTG	YES
18.	Fuel oil supply from Fuel oil storage tank outlet up to the boilers, with necessary pumping and heating units.	Yes	BTG	YES
19.	Any other accessories as required	Yes	BTG	YES
B.	**STEAM TURBINE ISLAND**			
1.	Steam turbines with emergency stop and governing valves, gland sealing system, extraction steam systems, HP-LP bypass, all control, protection and monitoring devices, lubricating and governing/control oil systems etc.	Yes	BTG	YES
2.	Boiler feed pump sets with variable speed drive units (turbine driven working pumps and motor driven standby pumps) and booster pumps.	Yes	BTG	YES
3.	Regenerative feed water heating system including feed water heaters and deaerator, chemical dosing, condensate make-up and dump, reserve feed water tank etc.	Yes	BTG	YES
4.	Condenser with air evacuation system, condensate extraction pumps, continuous on-line tube cleaning system, etc.	Yes	BTG	YES
5.	Turbine oil receiving, storage, transfer and purification system.	Yes	BTG	YES
6.	Condensate polishing units	Yes	BTG	YES
C.	**Complete Power Cycle piping**, valves etc. as well as all auxiliary system piping, valves with hangers and supports etc. as required for the boiler and steam turbine islands and connected systems.	Yes	BTG	YES
D.	**WATER SYSTEM**			
1.	Intake at Mahanadi river, Raw Water intake Pumps, intermediate reservoir and pipelines up to the plant boundary.	No	No	No
2.	Effluent water collection, treatment and reuse system to achieve zero discharge.	Yes	BOP	YES

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REF
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
9.	Coal mill reject handling system. By means of conveyor system or pneumatic dense phase system as per Bidder's standard and proven design. The pneumatic /Hydraulic system shall comprise:	Yes	BTG	SEPC agree provi Mecha Mill r handli syste base Scrap chai conve Vibrat convey additi buck elevato mill r silo for unit. WPCI deci syste during engine
	1. Mill Discharge Spout with Pneumatically/Hydraulically operated isolation gate and Pyrite Hopper.	Yes	BTG	
	2. Pneumatic Conveying System of Mills Reject Material from Pyrite Hopper to Reject Storage Silos.	Yes	BTG	
	3. Mills Rejects Conveying Piping, Bends, Fittings & Accessories.	Yes	BTG	
	4. Mills Rejects Silos & Accessories.	Yes	BTG	
	5. Air Compressors with Air Receivers	Yes	BTG	
	6. Compressed Air, Cooling Water & Drain – Piping, Valves, Fittings & Accessories.	Yes	BTG	
	7. All structural works for steel silos, pipe racks, supports including pyrite hoppers, support galleries/walk ways etc. Foundation for trestles, storage silos, air compressor, air receiver etc.	Yes	BTG	
	8. Bag Filters	Yes	BTG	
	9. Pneumatic Cylinder Operated & Manually Operated Plate Valves as required for the System.	Yes	BTG	
	10. Necessary lifting devices for handling the Mills reject system equipment.	Yes	BTG	
10.	Raw coal bunkers emergency emptying system and arrangement for the disposal of the emptied coal.	Yes	BOP	YE
11.	Air pre-heater and coal mill fire fighting system	Yes	BTG	YES
12.	Chemical dosing system	Yes	BTG	YE
13.	Blow down system (continuous, with steam recovery, and also intermittent)	Yes	BTG	YE
14.	Fuel oil support system	Yes	BTG	YE
15.	Boiler structural steelwork with all necessary stairs, galleries with roofs and side covers	Yes	BTG	YE
16.	Pent house on furnace roof with weatherproof enclosure and pressurised ventilation	Yes	BTG	YE

ANNEXURE-E

SECTION-IV
SCOPE OF WORK AND TERMINAL POINTS

The offer shall comprise the design, material selection, manufacturing, testing at works, supply, installation, performance testing at site, commissioning and other related items of work for all plant and equipment, inclusive of all civil, structural and architectural works necessary for a complete working power station, including but not limited to the following (one set per unit, except for systems common for all the units).

The bidder may note that a complete EPC offer including all BTG (Boiler, Turbine & Generator) activities and BOP (Balance Of Plant) activities including all civil and structural works is preferred. If any Bidder prefers to offer only BTG or only BOP equipments, accessories and services, the scope shall include the relevant civil and structural work and other services also. The offer shall clearly identify all the following items in terms of scope of work and services:

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
A.	**BOILER ISLAND**			
1.	Complete steam generating unit with milling and draught plant for pulverised coal firing system, along with ignition and support firing system and low NOx burner; refractories and insulation as required.	Yes	BTG	Yes
2.	Particulate extraction equipment (Electrostatic Precipitators).	Yes	BTG	Yes
3.	Multi-flue Chimneys. One for each phase	Yes	BOP	Yes
4.	Goods-cum-Passenger Elevators for approach to boiler galleries, one elevator for each phase with interconnecting platform).	Yes	BTG	Yes
5.	Elevators for the maintenance of the chimney (One for each chimney)	Yes	BOP	Yes
6.	Coal Feed System, Boiler cleaning system, soot blowing system for the furnace and air pre-heaters	Yes	BTG	Yes
7.	Raw coal bunkers with bunker level monitoring.	Yes	BOP	Yes
8.	Auxiliary boiler	Yes	BTG	Yes

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SECTION-IV

SCOPE OF WORK AND TERMINAL POINTS

CONTENTS

ITEM	DESCRIPTION
A.	BOILER ISLAND
B.	STEAM TURBINE ISLAND
C.	POWER CYCLE AND AUXILIARY PIPING
D.	WATER SYSTEM
E.	COAL HANDLING PLANT
F.	ASH HANDLING PLANT
G.	FUEL OIL SYSTEM
H.	FIRE PROTECTION SYSTEM
I.	OTHER AUXILIARY SYSTEMS
J.	ELECTRICAL SYSTEM
K.	CONTROL AND INSTRUMENTATION
L.	CIVIL, STRUCTURAL AND ARCHITECTURAL
M.	SERVICES AND GENERAL ITEMS
N.	TERMINAL POINTS

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SECTION-IV

SCOPE OF WORK AND TERMINAL POINTS

29	II/S-4 L 7	15	Demolishi removal of debris for any existing structure/foundation	it shall be in bidder's scope	SEPCO informed that they shall exclude the same from their scope. WPCPL agreed
30	II/S-4 L 8	16	Breaking/cleaning of any existing concrete/paving etc.	it shall be in bidder's scope	SEPCO informed that they shall exclude the same from their scope. WPCPL agreed
31	II/S-4 L 9	16	Landscaping including green belts	it shall be in bidder's scope	SEPCO informed that they shall exclude the same from their scope. WPCPL agreed
32	II/S-4 M 16	17	Development of green belt around power plant, ash dump area and township	it shall be in bidder's scope	SEPCO informed that they shall exclude the same from their scope. WPCPL agreed
33	II/S-4 N 7	19	Ash dump yard is also in bidder's scope	it shall be in bidder's scope	Shall be addressed under Mechanical Section

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ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
5.	Co-ordination & Project Management.	Yes	BTG/BOP for their respective plants/ equip	Yes
6.	Shop tests & Quality Assurance.	Yes	BTG/BOP for their respective plants/ equip	Yes
7.	Site temporary services (telecom, water, power, discharges etc.) during construction period.	Yes	BTG/BOP for their respective plants/ equip	Yes
8.	Complete Construction (including supply of material and labour, construction of site office, canteen, construction stores, residential accommodation of contractor's staff and labour etc.), Fabrication, Erection, chemical cleaning, steam blowing, Trial run, Commissioning and Testing of entire Plant.	Yes	BTG/BOP for their respective plants/ equip	Yes
9.	Supply of lubricants/consumables and all temporary provisions till handing over of the plant/ successful completion of Reliability test of each unit	Yes	BTG/BOP for their respective plants/ equip	Yes
10.	Spare parts, as required, for the entire plant for five (5) years (covering defects liability period).	Yes	BTG/BOP for their respective plants/ equip	Yes
11.	Mandatory Spare parts as per Annexure-X attached	Yes	BTG/BOP for their respective plants/ equip	Yes
12.	Tools and tackle including all special tools and tackle, calibration and testing instruments etc. as required, for the entire plant.	Yes	BTG/BOP for their respective plants/ equip	Yes
13.	After Sales Services during & after warranty period.	Yes	BTG/BOP for their respective plants/ equip	Yes

ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
	drains from contaminated water drains (such as oily water, sanitary Sewer, effluents from water treatment plant etc).			
5.	Roads and Paving	Yes	BOP	Yes
6.	Boundary wall and fencing around the plant boundary with gates.	Yes	BOP	[redacted]
7.	Demolishing/removal of debris for any existing structure/foundations	Yes	BOP	[redacted]
8.	Breaking/clearing of any existing concrete/paving etc.	Yes	BOP	[redacted]
9.	Landscaping including green belts	NO	NO	NO
10.	Topographical survey.	Yes	BOP	Yes
11.	Geo-Technical Investigation	Yes	BTG/BOP for their respective plants/ equip	Yes
12.	WPCPL temporary construction office at site with toilets of 500 Sq. M without furnishing.	-	-	Yes
M.	**SERVICES & GENERAL ITEMS**			
1.	Obtaining Statutory/Regulatory clearances/approvals from concerned government agencies regarding the project.	Yes	BTG/BOP for their respective plants/ equip	Yes
2.	Consents, licenses and permissions other than those to be obtained by the Owner.	Yes	BTG/BOP for their respective plants/ equip	Yes
3.	Complete design & engineering.	Yes	BTG/BOP for their respective plants/ equip	Yes
4.	Packing & transportation (ocean and inland), custom/port clearance, reconciliation with custom authorities, receiving and unloading at site.	Yes	BTG/BOP for their respective plants/ equip	Yes

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
	plant, Compressed Air Plant etc. with facility to interface with main DCS.			
	b) Integration of BOP C&I Systems with Plant DCS	Yes	BTG	Yes
15.	Fire detection and Alarm System	Yes	BOP	Yes
16.	Inter communication system with dedicated UPS for Inter communication system	Yes	BOP	Yes
17.	Redundant UPS for DCS	Yes	BTG	Yes
18.	Redundant UPS for each offsite system	Yes	BOP	Yes
19.	Training Simulator	Yes (Bidder shall quote optional price)	BTG	Yes
20.	CCTV system for plant surveillance	Yes (Bidder shall quote optional price)	BOP	Yes
L.	**CIVIL, STRUCTURAL AND ARCHITECTURAL**			
	Design and construction, including supply of all materials and labour of:	Yes	BTG/BOP for their respective plants/ equip	Yes
1.	All civil, structural and Architectural works related to system/plant requirement covering all main plant buildings [redacted].	Yes	BTG/BOP for their respective plants/ equip.	Yes
2.	[redacted] and structures, such as, Administrative buildings, Service building, Gate office, Time office, Fire station, Weigh bridge, Workshop, Vehicle repair and Bull dozer Maintenance building, Stores buildings, Open store yard, Telephone exchange, Canteen, Medical centre, Watch Towers, Security buildings, Car park, Cycle shed, Scooter shed, Petrol Pumps etc. as per sizes mentioned in list of building.	Yes	BOP	[redacted]
3.	Site grading including construction roads and drains.	Yes	BOP	[redacted]
4.	Drainage system with required segregation of clear water	Yes	BOP	Yes

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
			respective equipment.	
5.	All final control elements like Control valves and drives.	Yes	BTG/BOP for their respective equipment	Yes
6.	Steam and Water Analysis System (SWAS).	Yes	BTG	Yes
7.	Continuous emission monitoring system (CEMS).	Yes	BTG	Yes
8.	Continuous ambient air quality monitoring system	Yes	BOP	Yes
9.	Machinery Monitoring System (MMS).	Yes	BTG/BOP for their respective equipment	Yes
10.	All boiler integral instrumentation including Furnace Safeguard & Supervision System (FSSS), Flame monitoring system, Boiler & Auxiliaries Control & interlock, Soot blower control system, ESP Control System, etc. with connectivity to DCS.	Yes	BTG	Yes
11	All turbine integral instrumentation like Turbine supervisory instruments, Condition monitoring system, Automatic Turbine Run up System (ATRS), Turbine Stress Control (TSC), Electro hydraulic Governor Control (EHG), Automatic Turbine Testing System ATT, Turbine Protection system, HP-LP bypass system etc. and interface with DCS.	Yes	BTG	Yes
12	All junction boxes, cubicles, enclosures, local panels, marshalling panels, pneumatic and process hook up hardware, cables and other erection materials and accessories.	Yes	BTG/BOP for their respective equipment	Yes
13.	Maintenance and Calibration Equipments for Instrumentation Laboratory.	Yes	BTG	Yes
14.	a) Complete control, monitoring and protection system of all auxiliary systems and offsite like Coal Handling plant, Ash Handling plant, Water Treatment	Yes	BOP	Yes

ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
21.	Neutral Grounding Resistors	Yes	BTG/BOP for their respective areas.	Yes
22.	AC Motors, DC Motors & Motors Actuators	Yes	BTG/BOP for their respective areas.	Yes
23.	Electrical system for auxiliary plants & other peripherals such as CHP, AHP, CWP etc.	Yes	BOP	Yes
24.	24V DC for C&I loads	Yes	BTG	Yes
25.	48V DC system for switchyard PLCC system and Plant communication system	Yes	BOP	Yes
26.	Construction power supply system at one point within plant boundary at 33 kV by owner. Bidder to do further distribution.	Yes	BTG/BOP for their respective areas.	Yes
27.	SCADA for switchyard control and interface with main DCS	Yes	BOP	Yes
K.	**CONTROL AND INSTRUMENTATION SYSTEM**			
1.	Distributed Control System (DCS) comprising data acquisition sub-system, closed loop and open loop controls, data highways, OPC server/gateways for connecting packaged control systems, operator stations with Visual Display Units and control devices, printers, engineering work station, large video screen, historical storage unit, master clock system, necessary application, documentation, diagnostic and engineering software.	Yes	BTG	Yes
2.	Control room panels and racks including supervisor's console.	Yes	BTG	Yes
3.	All primary sensors like Flow elements, Temperature sensors etc.	Yes	BTG/BOP for their respective equipment	Yes
4.	All field instruments - process switches, transmitters, local gauges etc.	Yes	BTG/BOP for their	Yes

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
12.	Illumination system of whole plant including Non-plant buildings with accessories and dry type lighting transformers .	Yes	BTG/BOP for their respective areas.	Yes
13.	Control, protection and metering systems including control/relay panels & synchronization panel for generator & transformers.	Yes	BTG	Yes
14.	All Local panels, local P.B. stations, Junction boxes & Local Control stations.	Yes	BTG/BOP for their respective areas.	Yes
15.	400 kV switchyard complete with all equipment, safety devices, protective relaying, controls, metering etc.	Yes	BOP	Yes
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17.	Cables and cable raceway system with necessary fire barriers, fire proof sealing and coating systems	Yes	BTG/BOP for their respective areas. Interface cabling shall be in scope of BOP	Yes
18.	Grounding and Lightning protection systems	Yes	BTG/BOP for their respective areas. Interconnection shall be under scope of BOP	Yes
19.	Electrical laboratory equipment	Yes	BOP	Yes
20.	DG sets for emergency power supply	Yes	BOP	Yes

ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
2.	Generator Transformers with required tap-changer and all other fittings & accessories and Lightning Arrestors.	Yes	BTG	Yes
3.	Station and Unit Transformers with required tap-changers and all other fittings & accessories, neutral grounding resistors and Lightning Arrestors.	Yes	BTG	Yes
4.	HT & LT Auxiliary Distribution Transformers complete with all fittings and accessories.	Yes	BTG/BOP for their respective areas.	Yes
5.	Generator Bus duct of isolated phase design, consisting main, tap-off sections and delta ducts complete with associated equipment.	Yes	BTG	Yes
6.	HV Busducts.	Yes	BTG/BOP for their respective areas.	Yes
7.	LV Busducts.	Yes	BTG/BOP for their respective areas.	Yes
8.	MV and LV Switchgears/Power Control Centres, Emergency Switchboard, Motor Control Centres, Distribution Boards, Starters for AC/DC drives, Fuse Boards etc.	Yes	BTG/BOP for their respective areas.	Yes
9.	Battery, Battery Charger and DC Supply Distribution system complete with interconnection facility.	Yes	BTG/BOP for their respective areas.	Yes
10.	AC uninterruptible power supply system complete with battery inverter, etc.	Yes	BTG/BOP for their respective areas.	Yes
11.	Plant Intercommunication and Telephone system including UHF/cable connection with DOT network within plant boundary.	Yes	BOP	Yes

ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER' REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
12.	Diesel generator set(s) as required for the safe coasting down of the units.	Yes	BOP	YES
13.	Goods cum passenger elevators for boilers (one for each boiler), TG building elevators (two), Capsule type high speed elevator one for each control room suitable for 10 persons.	Yes	BTG	YES
14.	Passenger lift for Administrative building (one) suitable for 10 persons, and stack elevators one for each stack suitable for 6 persons.	Yes	BOP	YES
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16.	Supply and application of paints and thermal/acoustic insulation as required for the entire power station as well as all non-plant buildings.	Yes	BTG/BOP for their respective equipments and plants.	YES
17.	Coating, Wrapping and cathodic protection (if required) of underground piping	Yes	BOP	YES
18.	Drive motors with gear reducer and coupling for all equipment wherever required.	Yes	BTG/BOP for their respective equipments.	YES
19.	Six bulldozer, Four fork lifts, Four fire tenders, Two Hydra Crane each of 12 Te and two Hydra Crane each of 10 Te as per relevant specification.	Yes	BOP	YES
20.	All the lab equipments (Mech/Elect/Inst), Workshop equipments, Mandatory spares as per specification.	Yes	BOP	YES
21.	Any other supply items not specifically mentioned but deemed necessary for safe, reliable & satisfactory operation of the plant.	Yes	BTG/BOP for their respective equipments.	YES
J.	**ELECTRICAL SYSTEM**			
1.	Main Generators with Excitation system, Automatic Voltage Regulation, Surge Protection and Neutral Grounding Equipment and necessary controls.	Yes	BTG	YES

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REPI
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
	monorails for other plant and equipment such as mills, ID, FD & PA fans, coal handling and ash handling plant equipment etc. Also, slide rails and pulling systems required for equipment handling where applicable and trolleys for feed heater tube/shell and boiler feed pump impeller removal. Portable hoists/platforms/fork lifts shall be provided, as required, for maintenance/overhauling of items below 1000 kg.			
5.	a) Effluent collecting, sampling, monitoring, treatment, recirculation and reuse system meeting zero effluent discharge norms.	Yes	BOP	YES
	b) All necessary equipment for testing, monitoring and control of pollution from within the plant to the environment for meeting stipulations, as required.	Yes	BOP	YES
6.	Flue gas desulphurisation plant.	No (Space to be provided in layout)	No (Space to be provided in layout)	No (Space t provide layou
7.	Hydrogen generation plant with adequate number of cylinders, storage and distribution system.	Yes	BOP	YES
8.	Nitrogen cylinders (adequate number for refilling) storage, handling and distribution system for preservation purpose.	Yes	BOP	YES
9.	Carbon Dioxide bottles (adequate number for refilling) storage, handling and distribution system.	Yes	BOP	YES
10.	Laboratory for testing coal, fuel oil, turbine oil, transformer oil, ash, ambient air quality, stack emission, & other effluents; also steam and water analysing and sampling units including necessary samplers and monitoring kits etc.	Yes	BOP	YES
11.	Ventilation and Air conditioning systems as required, for power house and other auxiliary buildings as well as for non plant buildings within plant boundary.	Yes	BTG/BOP for their respective plants and buildings	YES

ANNEXURE-E

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDE REF
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
G.	**FUEL OIL SYSTEM**			
1.	Fuel oil system for unloading (from railway wagons and also from road tankers) and storage with necessary unloading pumps, storage tanks with tank heating system, dykes etc. for heavy fuel oil and light fuel oil.	Yes	BOP	YE
2.	Oil-water separator to treat rainfall run off etc. from fuel oil tank farm and handling area.	Yes	BOP	YE
3.	Railway Tracks	No	No	N
H.	Complete fire detection and fire protection system for the protection of the entire power station, including all buildings, transformer, coal handling & fuel oil handling systems, coal stock piles, open yard storage etc. This shall also include portable fire extinguishers. Fire detection panels with all provisions in central control room, fire station and fire water pump house.	Yes	BOP	YES
I.	**OTHER AUXILIARY ITEMS**			
1.	Compressed air (service air/instrument air) station with air compressors, drying plant, distribution system (throughout the power station) etc.	Yes	BOP	YES
2.	Auxiliary system piping. (e.g. auxiliary steam, fuel oil, drinking, water, effluent etc.)	Yes	BOP	YE
3.	Pipe supports and associated civil/structural works, including pipe racks, trestles, trenches etc. as required including all temporary frames for transport and erection.	Yes	BOP	YE
4.	All lifting and handling equipment to facilitate the handling and transportation of all plant and equipment (heavier than 1000 kg) that may need maintenance/overhaul during the plant's lifetime. This shall include the cranes on rails for - a) TG Hall, b) Boiler feed pumps c) feed heater bay d) CW pump house, e) Raw water pump house, f) Clarified/ Fire water pump house, g) DM plant, h) Workshop & store etc., as also hoists, trolleys &	Yes	BTG/ BOP for their respective equipment	YE

ANNEXURE-E

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
13	V.II/S-VI 6.9 b)	p6	Carbon steel conforming to International Standard with ceramic lining Minimum thickness - 8 mm in lined portion. Minimum wear allowance - 4 mm.	since in d) has required the life of 12000 hours, this item deleted	The ceramic lining as specified shall be included. The lining is required in the piping downstream of bends/ change in direction.	Refer Resolution on Point No.165 of Annexure-A1	
14	V.II/S-VI 6.9 c)	p6	Ceramic - Min. 15 mm thick and min. 85% alumina content. thick and min. 85% alumina	since in d) has required the life of 12000 hours, this item deleted	The ceramic lining as specified shall be included. (The bends are subjected to erosion due to coal particles.)	Refer Resolution on Point No.165 of Annexure-A1	
15	V.II/S-VI 6.16 b)	p9	Air 16 m/sec.	Air 15~20 m/sec.	Acceptable. (As per Amendment-1, air velocity shall be up to 20 m/sec.)	SEPCO Noted.	
16			Gas 13 m/sec.	Gas 10~15 m/sec.	Gas velocity limit shall be as per specification. This is due to erosive nature of ash from Indian coal.	SEPCO agreed.	
17	V.II/S-VI 6.17 a)	p9	ii) For storage volume capacity ash density to be considered as 650 kg/Cu.m.	ii) For storage volume capacity ash density to be considered as 800 kg/Cu.m.	Spec to be followed. This is as per CEA recommendation.	SEPCO agreed.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
9	V.II/S-V J 6 ii) a)	p12	1 1/2hours	continues operation	Acceptable for scraper conveyor System.	SEPCO agreed to comply with Bid specification.
10	V.II/S-V J 6 ii) b)	p12	4 hours	5 hours	Spec to be followed.	Refer Resolution on Point No.98 of Annexure-A1
11	V.II/S-VI 6.6 a)	p5	2 x 100% capacity	1 x 100% capacity gate valve	Spec to be followed.	1 x 100% motorized gate valve is acceptable. SEPCO to provide system details for maintaining adequate attemperation flow for different loads and confirm without Kicker stage in the BFP, they can maintain the required spray. SEPCO to revert by 10.10.08
12	V.II/S-VI 6.8 e)	P6	Lubrication system shall have standby pump and filter	Lubrication system shall have standby filter	Spec shall be followed. Standby pump also shall be included.	Refer Resolution on Point No.162 of Annexure-A1

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
2	V.II/S-IV A 9	P3	1. Mill Discharge Spout with Pneumatically operated isolation gate and Pyrite Hopper.	1. Mill Discharge Spout with Pneumatically & hydraulic operated isolation gate and Pyrite Hopper.	Hydraulically operated gates are also acceptable.	Hydraulically operated gates are also acceptable.
3	V.II/S-IV A 9	P3	2. Pneumatic Conveying System of Mills Reject Material from Pyrite Hopper to Reject Storage Silos.	2. The pneumatic /mechanical conveying System of Mills Reject Material from Pyrite Hopper to Reject Storage Silos.	Please refer Sr. No. 1.	Please refer Sr. No. 1. of this annexure
4	V.II/S-IV A 9	P3	3. Mills Rejects Conveying Piping, Bends, Fittings & Accessories.	delete	The alternative scheme proposed to be indicated.	Refer Resolution on Point A-9 on Scope of Supply Annexure-E.
5	V.II/S-V H 4 b)	p4	b) NOx (expressed as NO2) in stack gas, corrected to 6% Oxygen.260 gm/GJ heat input	b) NOx (expressed as NO2) in stack gas, corrected to 6% Oxygen. 262 PPM	Acceptable.	Noted.
6	V.II/S-V J 1 b)	P8	50% to 100% BMCR	60% to 100% BMCR	Acceptable.	Noted.
7	V.II/S-V J 2 b) ii)	P9	700 nos	500 nos	Spec to be followed. This is as per CEA recommendation.	SEPCO agreed as per Specification.
8	V.II/S-V J 6 i) a)	p12	6 hours in case of scraper conveyor System and 8 hours in case of Bottom ash hopper system.	4 hours in case of scraper conveyor System and 8 hours in case of Bottom ash hopper system.	Spec to be followed.	Refer Resolution on Point No.80 and 89 of Annexure-A1

VOLUME II – COMMERCIAL AND TECHNICAL

SECTION 3 – TECHNICAL PART

IV - SCHEDULE FOR TECHNICAL DEVIATIONS

We confirm that all the Technical Deviations are listed in this Schedule. Any other deviations observed in our offer shall be withdrawn by us without any price implication

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
	Section-I 3.1 iv			Plant access should be in Owner's scope	To be included in Scope.	SEPCO agreed to provide access road.
	MECHANICAL PART1					
1	V.II/S-IV A 9	p2	Coal mill reject handling system. By means of conveyor system or pneumatic dense phase system as per Bidder's standard and proven design. The pneumatic system shall comprise:	Coal mill reject handling system. By means of conveyor system or pneumatic dense phase system as per Bidder's standard and proven design. The pneumatic /mechanical system shall comprise:	The deviation is not clear. The 'Mechanical' system is to be elaborated with scheme/ GA drawings.	Refer Resolution on Point A-9 on Scope of Supply Annexure-E.

	a) Basic design data and foundation drawings for static and rotary equipments.		
	b) However, entire design TG foundation including detail drawings, BOQ, etc shall be in the scope of Bidder.		
	c) VOID		
	d) BTG structural works - All technological structures, platforms, galleries, staircases, cranes, girders - Design, supply, erection shall be in the scope of Bidder.		
	e) Base plate/sole plate, special and additional packers for all equipment in BTG vendor scope. Supply of all foundation bolt and grouting material for all equipment in BTG scope shall be in scope of BTG vendor.		
9.	**Service Air and Instrument Air Supply**	Service Air and Instrument Air Supply shall be made available by the BOP contractor at a single point near Turbine ground floor at 7 Kg./Sq.cm (g) with isolation valve. The BTG bidder shall specify requirement of Air Supply in the Bid.	
10.	**ACW System**	ACW Inlet and outlet pipes shall be terminated by BOP contractor at a single point near turbine building. The pressure at the terminal point will be 2.0 kg/cm^2g. Further routing of the cooling water pipes is in the Bidder's scope, who shall indicate the requirement of ACW for his equipments.	
11.	**Service and Potable Water System**	Service and potable water shall be made available by owner at user point in BTG plant, by BOP contractor.	
12.	**Construction power supply**	33 kV CSEB Construction Power at one point inside plant boundary. Emergency DG set will not be provided for Construction power by Owner.	

			FOR EPC
		The BOP supplier will arrange all low-pressure piping comprising instrument air, Service air, CW system piping as necessary for the operation of the BTG package. The detail terminal points of these L.P. piping are at Turbine Building A Row beyond which the required piping for BTG plant is in scope of BTG contractor.	
6.	**Electricals**		NOT APPLICABLE FOR EPC
	a) Generator, Generator transformer & Station transformer	Outdoor HT bushing of Generator transformer, station transformer (however, supply, installation and connection of L.A on HT side of transformer included in the scope of BTG package).	
	b) 11 & 6.6 kV Switchgear	11 kV main plant switchgear outgoing feeder terminals for BOP.	
	c) 415 V Switchgear	415 V switchgear outgoing feeder terminals for BOP.	
	d) Earthing	Earthing of equipments from pigtails developed for BTG package.	
	e) Construction power	Construction power – 33 kV supply at a single location near plant boundary.	
7.	**Control & Instrumentation**	**Terminal points**	
	a) CCW/ACW system (supplied by BOP)	DCS/marshalling cabinet (supplied by BTG)	
	b) Signals between MCC / Switchgear (supplied by BOP)	Marshalling cabinet / control panel (supplied by BTG)	
	c) Offsite systems like CHP, AHP, WTP, compressed air etc. (supplied by BOP)	a) OPC server of DCS (supplied by BTG) b) Ethernet network (supplied by BTG)	
	d) Switchyard SCADA (supplied by BOP)	Ethernet network (supplied by BTG)	
	e) Numerical relays & load managers of BOP	OPC server of DCS (supplied by BTG)	
	f) Vibration Monitoring of outside BTG package HT Motors like CCW pump & coal crusher etc. (supplied by BOP)	Plant Machinery Monitoring Station Analyser Cabinet (Supplied by BTG)	
8.	**Civil**		NOT APPLICABLE FOR EPC
	BTG and BOP supplier shall include the respective civil works in their scope.		

		heating shall be supplied by BTG contractor at one point near the fuel oil storage area/pump house. The Fuel forwarding pumping and heating system to be supplied by BTG Contractor will be located near the Fuel Oil Pump House	
3.	**Turbine Generator**		NOT APPLICABLE FOR EPC
	a) CW piping	Outside Turbine Building A Row about 2 m away, for both CW inlet and outlet connections.	
	b) Supply DM Make up water to Primary Closed loop DMCW system Circuit	-	
	c) Auxiliary cooling water (Secondary Circuit)	Outside Turbine Building A Row, about 2 m away for both inlet and outlet connections.	
	d) Condensate Make-up water	BOP contractor will supply DM water near each condensate water tank.	
	e) Steam Vent	At suitable location, 1m above Turbine building roof including silencer by BTG supplier.	
	f) Carbon-dioxide and Hydrogen	Carbon-dioxide and Hydrogen cylinders, outlet manifold and subsequent distribution under BTG supplier's scope. The cylinder are under scope of BOP supplier.	
	g) Turbine oil	At storage tank inlet flange. The storage tank is in scope of BTG supplier.	
4.	**Power Cycle Piping and valves**		NOT APPLICABLE FOR EPC
		Power Cycle Piping is basically the inter-connecting systems between steam generator and turbine-generator along with turbine cycle piping, hence, there is no specific terminal point in respect of the contract under this specification for the BTG supplier. However, all drains including trap discharge outlet shall be supplied with drain funnels or drain receivers and pipelines from such funnel discharge upto the nearest plant drainage system at zero elevation.	
5.	**Low Pressure Piping**		NOT APPLICABLE

1.	**Steam Generator**		NOT APPLICABLE FOR EPC
	a) Coal	Raw coal at inlet of coal bunkers (i.e. raw coal bunkers is in the BTG scope)	
	b)	Void	
	c) Flue duct	Flue duct upto 1m away from Chimney shell. (Chimney including flues are under BOP scope.)	
	d) Bottom Ash	Furnace header seal plate (S.S). (The system beyond seal plate is under scope of BOP)	
	e) Fly Ash	Fly and coarse ash hoppers outlet flanges. (These hoppers are under BTG Scope.)	
	f) Boiler header blow down	Intermittent Boiler header blow down upto nearest effluent pit. Cooling of hot blow down prior to disposal in BTG Bidder's scope.	
	g) Initial system filling line for BTG Systems	By BTG supplier.	
	h) Steam vent	1m above boiler roof including silencer, if required. (By BTG Supplier)	
	i) AH Washing	One point at first column of boiler for each boiler. (BOP supplier shall furnish Service Water near the equipment.)	
	j) Fire fighting for APH	Fire water to be provided by BOP Contractor at one point at first column of boiler for each boiler	
	k) Counter flanges	All flange interface terminals should be provided with counter flanges, nuts, bolts, gaskets etc. by the Bidder.	
2.	**Fuel Oil System**		NOT APPLICABLE FOR EPC
	a) HFO	Outlet flange connection in day tank near P&H unit.	
		Return oil connection flanges on day tank near P&H unit.	
	b) LDO	Light oil Day tank outlet flange connection.	
		Return light oil connection flange on light oil day tank for return oil from pressure regulating valve. **(Note) Condensate piping for heating steam line is in BTG's scope.**	
	c) Fuel oil storage and unloading system	The fuel oil storage, unloading and pump house is in BOP scope. Auxiliary steam for	

N.	**TERMINAL POINTS (FOR COMPLETE EPC PACKAGE)**	
1.	Approach roads from NH-200 to Plant (Two numbers around 600 m length each)	Yes
2.	Rail - MGR rail-track with railway siding will be provided by the Owner.	Yes
3.	Raw water supply – at one point at the plant boundary.	Yes
4.	Drinking water supply point to WPCPL colony at the plant boundary.	Yes
5.	Coal - outlet from BOBR wagons.	Yes
6.	Fuel Oil - at fuel oil wagon/road tanker outlet flange (Rail by Owner).	Yes
7.	Ash - at ash dump yard. (Ash dump yard is also in Bidder's scope)	[redacted]
8.	Storm water drainage system - at plant boundary.	Yes
9.	Tele communication - at Plant boundary.	Yes
10.	Outgoing gantries in 400 kV switchyard complete with line-connections	Yes
11.	Construction Water by Bidder	Yes
12.	Land - in as acquired condition for plant area would be made available to the EPC contractor.	Yes
13.	4 Nos. of 11 kV terminals at 11 kV switchgear for power supply to WPCPL colony and river water pump house.	Yes
14.	33 kV CSEB Construction Power at one point inside plant boundary. Emergency DG set will not be provided for Construction power by Owner.	Yes

O.	**TERMINAL POINTS (FOR SEPARATE BTG AND BOP PACKAGES)**	NOT APPLICABLE FOR EPC
	In case of separate offer for BTG + Civil and BOP + Civil work, the following interfacing terminal points shall be considered between the BTG Island and BOP Island. For all interfacing terminal points, scope for making the joint including welding, support structures, supply of mating flanges, gaskets, bolts, nuts etc. including Engineering, Procurement and Erection in entirety shall be with BOP contractor.	NOT APPLICABLE FOR EPC

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER REPL
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
14.	Plant stores for consumables and spares.	Yes	BTG/BOP for their respective plants/ equip	[redacted]
15.	Water and power supply for the colony at plant boundary	Yes	BOP	Yes
16.	Development of green belt around power plant, ash dump area and township	NO	BOP	NO
17.	Furnishing all documents, drawings, design basis reports, Optimization Study reports, design calculations, data sheets, quality assurance plans, testing procedures, operating and maintenance instruction manuals, commissioning documentation etc including "As-built" drawings.	Yes	BTG/BOP for their respective plants/ equip	Yes
18.	Training of the plant Owner's personnel on plant operation and maintenance.	Yes	BTG/BOP for their respective plants/ equip	Yes
19.	Carrying out river/well water analysis	Yes	BOP	Yes
20.	Carrying out pump sump model studies for CW Pumps and Raw Water pumps, wind tunnel studies for chimneys and N. D. Cooling Towers	Yes	BOP	[redacted]
21.	Route survey for transport of large and heavy equipment up to site	Yes	BTG/BOP	Yes

NOTE :

The above list of work is not exhaustive. Any additional works, whether or not specifically described in this document, incidental to complete the power plant in all respects shall be deemed to be in the scope of work the EPC Contractor.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
5	VOLUME II SECTION XVIII 3.09.03		Motor Control Centers Voltage measured on each bus. Current measured on each feeder.	Current measured on feeder of Motor rated above 55kW.	Not acceptable. Current shall be measured on feeder of motor rated above 30kW and all important motors rated below 30kW.	Refer Resolution on Electrical Deviation.
6	VOLUME II SECTION XVIII 4.04.13		Differential protection (87M) for motor rated above 1000kW	Differential protection (87M) for 11kV motor rated above 2000kW.	Not acceptable. Differential protection shall be provided for all motors rated above 1000 kW.	Refer Resolution on Electrical Deviation.
7	VOLUME II SECTION XVIII 4.11.02		All outgoing line feeders bus side breakers, isolators shall be controlled from both switchyard control room & central control room where as generator transformer and station transformer feeder shall be controlled from central control room and also all central breakers with isolators shall be controlled from both the control room.	Switchyard control room will be supplied, but nobody will be on duty normally in switchyard control room, 400kV circuit breakers and isolators will be controlled by DCS and/or NCS (network control system) in central control room.	Control Philosophy shall be as per Tender Specification.	Refer Resolution on Electrical Deviation.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
2	WPCPL-TPP-ELEC-SEC-18 3.03.00		The unit auxiliary loads associated directly with running of a unit like, BF Pump, ID Fan, FD Fan, CW Pump etc shall be fed from the 11 kV & 6.6 kV unit switchboards. Boiler Feed Pump (BFP) motor shall be fed from 11kV switchboard and all other motors rated above 200kW shall be fed from 6.6kV switchboard.	The unit auxiliary loads associated directly with running of a unit like, BF Pump, ID Fan, FD Fan, CW Pump etc shall be fed from the 11 kV unit switchboards.	Electrical auxiliary system shall have three voltage level – 11kV, 6.6kV & 415V/240V as per Tender SLD (Drg.No.K7V12-000-DWG-E-0101). Bidder to provide and confirm that BFP drives shall be fed from 11kV switchboard and all other HT motors rated above and including 200 kW shall be fed from 6.6kV switchboard. Bidder to also note that all LT service transformers shall be fed from 11kV switchboard only in both the cases mentioned above.	Refer Resolution on Electrical Deviation.	
3	VOLUME II SECTION XVIII 3.07.01		Accordingly, Local Push button stations shall be provided near all motors for starting & stopping.	Only emergency push button will be provided near each motor.	Not acceptable. Tender Specification prevails.	Refer Resolution on Electrical Deviation.	
4	VOLUME II SECTION XVIII 3.09.02		Separate sets of CTs and PTs shall be provided for the back-up metering system.	No CTs and PTs for the back-up metering system	Not acceptable. Separate CT & PT for Tariff metering system shall be provided.	Refer Resolution on Electrical Deviation.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
13	Vol-□ Sec-7 5	P1	Condensate extraction pumps: 3 x 50% pumps shall be provided.	2 x 100%(1 working and 1 standby).	The purpose of this deviation shall be clarified. 3 x 50% pumps are desired for operation at low loads. Otherwise, recirculation at low load will be very high.	2 x 100%(1 working and 1 standby).
14	Vol-□ Sec-7 7	P2	Circulating water pumps: 5 x 50% pumps for two units, one common standby for two units.	2 x 50% pumps for one units. One common standby for three units.	Specification shall be followed.	Refer point 11 above
15	Vol-□ Sec-7 8	P2	Auxiliary cooling water pumps/ DMCW system pumps: 3 x 33-1/3% pumps for each unit.	2x 100% pumps for each unit.	Specification shall be followed.	2x 100% pumps for each unit.
	Design institute					
1	WPCPL-TPP-ELEC-SEC-1 8 4.11.01			Set two more single-phase Potential Transformer between two bus sectionalizers on each bus	Not required. However, this may be discussed further during clarification meeting.	Refer Resolution on Electrical Deviation.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
10	Vol-II Sec-6 J-1	P19	TURBINE LUBE OIL PURIFICATION SYSTEM Type : Bowser/centrifuge	coalesced separated type	The proposed scheme drawing may be furnished.	[redacted]
11	Vol-□ Sec-6 S-3	P40	½ 2 x 50% CW pumps for each unit with one common standby for two units, and 3 x 50 % ACW pumps for each unit.	2 x 50% AC pumps for one units with one common standby for three units, and 2 x 100 % ACW pumps for each unit..	The number of CW pumps shall be 2 x 50% for each unit with one common standby for two units, as specified. (As per offer – book 2 of 4 - Cl.7.1, page 381, 2 x 50% CW pumps for each unit with one common standby for two units are considered. 3 x 50 % ACW pumps shall be provided for each unit. This is advantageous for operation of the units at lower loads and also for system filling.	CW pumps – one common standby for 3 units is acceptable to WPCPL. 2 x 100 % ACW pumps for each unit..
12	Vol-□ Sec-7 4	P1	Two turbine driven and one motor driven pumps shall be provided, each of 50% capacity.	2 x 50% turbine driven and 1 x 30% motor driven	The specification shall be followed. The motor driven boiler feed pump shall be of 50% capacity.	Two turbine driven and one motor driven pumps shall be provided, each of 50% capacity.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
8	Vol-II Sec-6 G-1.2	P15	Boiler Feed Pumps : 3 x 50%, two turbine driven and one motor driven	2 x 50% turbine driven and 1 x 30% motor driven	The specification shall be followed. The motor driven boiler feed pump shall be of 50% capacity. (This is required so that in case of non-availability of any Turbine driven BFP, the motor driven BFP is available as standby.) As per offer – book 2 of 4 - Cl.3.3.5, page 366, 50% capacity motor driven pump is considered.	SEPCO agreed as per specs
9	Vol-II Sec-6 G-2	P16	Condensate Extraction Pumps: 3 x 50%	2 x 100%(1 working and 1 standby).	The purpose of this deviation shall be clarified. 3 x 50% pumps are desired for operation at low loads. Otherwise, recirculation at low load will be very high. As per offer – book 2 of 4 - Cl.3.3.5, page 366, 3 x 50% capacity Condensate Extraction pumps are considered.	2 x 100%(1 working and 1 standby) acceptable to WPCPL

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
6	Vol-II Sec-3 23.07.00	P49	The Bidder shall make provisions to ensure compliance with these limits and shall provide the necessary monitoring instrumentation.	If appropriate	The deviation is not understood. The specification shall be followed.	SEPCO agreed as per specifications	
7	Vol-II Sec-6 E-1	P13	Stator winding - hydrogen in closed circuit/closed loop DM water core & rotor - hydrogen in closed loop, hydrogen cooled by DM water.	hydrogen cooled by ACW	The deviation is not acceptable. Specification shall be followed.	Stator winding DM water cooled. DM water shall e cooled by plate heat exchanger with ACW water. Rotor and core - hydrogen in closed loop, hydrogen cooled by ACW water.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
2	Vol-II Sec-3 19.15.05	P30	Each motor driven boiler feed pump shall be with Hydraulic coupling (of VOITH make only) for controletc.	VOITH or other excellent manufacturers in China make	Only Voith Germany make is acceptable.	SEPCO agreed
3	Vol-II Sec-3 19.16.02	P31	Each Unit shall be provided with three (3) nos. 50% capacity condensate extraction pumps (2 working and 1 standby).	2 x 100% (1 working and 1 standby).	The purpose of this deviation shall be clarified. 3 x 50% pumps are desired for operation at low loads. Otherwise, recirculation at low load will be very high.	2 x 100% (1 working and 1 standby). Is acceptable to WPCPL
4	Vol-II Sec-3 19.17.00	P33	The condenser inlet and outlet branches shall be joined to the associated cooling water pipe work by pressure balanced type flexible bellows.	(as necessary)	Not acceptable. The specification shall be followed.	SEPCO agreed as per specifications
5	Vol-II Sec-3 23.07.00	P48	The pump forebay design shall allow operation of any permitted pump combination whilst ensuring reasonably uniform flow conditions to each pump inlet.	(as necessary)	The specification shall be followed. (The intended deviation is not clear.)	SEPCO agreed as per specifications

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
29			100% BMCR generation (with provision for maximum blow-down and surge flow) at maximum working pressure when one (1) pump is out of service. Two turbine driven and one motor driven pumps shall be provided, each of 50% capacity.	100% BMCR generation (with provision for maximum blow-down and surge flow) at maximum working pressure when one (1) pump is out of service. Two 50% turbine driven and one 30% motor driven pumps shall be provided.	The specification shall be followed. The motor driven boiler feed pump shall be of 50% capacity.	SEPCO agreed	
	MECHANICAL PART						
1	Vol-II Sec-3 19.11.00	P26	The use of compression type couplings in hydraulic lines conveying high pressure control fluid shall not be permitted. All pressurized oil pipes should be surrounded by the Return oil lines so that oil leakage in pressurized lines will not cause any fire in the Turbine Area.	The use of compression type couplings in hydraulic lines conveying high pressure control fluid shall be permitted. Lubricating Oil pipes should be surrounded by the Return oil lines so that oil leakage in pressurized lines will not cause any fire in the Turbine Area.	The use of compression type couplings in hydraulic lines conveying high pressure control fluid **shall not be permitted.** (This is desired to prevent chance of oil leakage.)	For control oil system fire resistant fluid shall be used. Lubricating Oil pipes should be surrounded by the Return oil lines so that oil leakage in pressurized lines will not cause any fire in the Turbine Area	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
24	V.II/S-VI C	11	NEW ITEM	11.Fabric Filter Bag Shall have operating temperature 160°C and life not less than 30000 Hrs	Acceptable.	SEPCO noted
26	V.II/S-VI C	11	[redacted]	[redacted]	[redacted]	[redacted]
28	V.II/S-VII 2	1	[redacted]	[redacted]	[redacted]	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
19	V.II/S-VI C 3,4,5	P11		To be decided by the manufacture to ensure the requested emission.	It may be noted that the parameters indicated are minimum requirement to suit ash from Indian Coal, based on experience from design of ESPs for Thermal Power Stations in India.	SEPCO is offering ESP with bag filters and hence this clause is not applicable.	
20	V.II/S-VI C	P11	NEW ITEM	9 Maintenance Requirement Any of the parallel sections can be taken under maintenance in safely isolated condition without sacrificing limit of particulate emission. Bag filter house shall be sectionalize so that any of the Bag filter section can be taken out of service without affecting the performance much.	The concept is acceptable. However, the details of the combination of ESP and Bag Filters (Number of parallel paths and number of fields in each path for ESP, number of ba filter units and number of nags in each unit) to be submited	SEPCO to provide at detailed engineering stage	
22	SECTION-III/ C	11	NEW ITEM	10.Fabric filter (Air to Cloth ratio) 1.0 m/min (minimum) (Air to Cloth Ratio) With Four passes and three sections. Each section with two subsections. Filters shall be housed in subsections.	Acceptable. Please furnish scheme drawing and layout drawing showing the combination of ESP and Bag Filters.	SEPCO to provide at detailed engineering stage. Complete system shall be accommodated in power block quadrant as per vastu.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
25	II/S-4 M 14	17	Plant stores for consumables and spares	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	SEPCO agreed. Refer list of building data sheet.	
26	II/S-4 M 15	17	Water and power supply for colony	This should be in Owner's scope	Acceptable. However, Bidder shall provide 4 No., 2000 A, 11kV feeders.	SEPCO agreed	
27	II/S-4 M 16	17	Development of green belt around power plant, ash dump area and township.	This should be in Owner's scope	Acceptable.	noted	
28	II/S-4 N 7	19	Ash dump yard civil works is also in bidder's scope.	This should be in Owner's scope	The specification shall be followed. The EPC bidder shall include this in his scope. Area calculation of bottom and fly ash dump yard is enclosed for bidder's reference.	SEPCO to quote optional price for this by 10.10.08	
29	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
18	II/S-4 L 2	15	Miscellaneous non-plant building and structures.	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	SEPCO agreed to provide all Miscellaneous non-plant building and structures. Internal furniture for non-plant building by Owner
19	II/S-4 L 3	15	Site grading	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	Refer civil MOM
20	II/S-4 L 6	15	Boundary wall and fencing around the plant boundary with gates.	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	Refer civil MOM
21	II/S-4 L 7	15	Demolishing/removal of debris for any existing structure/foundation.	This should be in Owner's scope.	Acceptable. However, shifting of Electrical transmission lines existing in the site are in Owner's scope.	Not required
22	II/S-4 L 8	16	Breaking/cleaning of any existing concrete/paving etc.	This should be in Owner's scope.	Acceptable.	SEPCO noted
23	II/S-4 L 9	16	Landscaping including green belts	This should be in Owner's scope.	Acceptable.	Greenbelt by Owner. Site grading in SEPCO scope.
24	II/S-4 M 13	17	After sales services during & after warranty period	Separate cost for after sales services after warranty period.	Acceptable.	noted

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
13	I/S-2B 22.1	12	All such goods shall, from the time of their being brought vest in the Owner	except for which belongs to contractor e.g. tower crane	Acceptable.	SEPCO noted.
14	II/S-4 E 2	6 OF 23	Three track hoppers, crusher houses, transfer towers etc.	Two track hoppers, crusher houses, transfer towers etc.	Acceptable.	SEPCO noted.
15	II/S-4 F 10	8 OF 23	Ash pipelines beyond up to and including Ash Dump Yard.	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	Refer Resolution under Scope of Supply
16	II/S-4 I 14	10 OF 23	Passenger lift for administrative building (one) suitable for ten persons, and stack elevators.	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	SEPCO agreed
17	II/S-4 I 15	10 OF 23	Plant maintenance workshop equipped with necessary equipment & facilities for best upkeeping of the entire plant. Bulldozer and other Vehicle maintenance shop	This should be in Owner's scope.	The EPC bidder shall include this in his scope.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
8	II/ S-VI G 2	16	Condensate extraction pump 3×50%	2×100%	Accepted.	noted
9	II/ S-VI N 9 c)	30	Eight (8) hours of storage capacity for rate of bottom ash generation with worst coal firing.	Three (3) hours of storage capacity for rate of bottom ash generation with worst coal firing.	The specification shall be followed.	Refer resolution in annexure
10	II/ S-VI N 9 f)	31	Submerged scraper chain conveyor One (1) working and one (1) standby for each unit	Submerged scraper chain conveyor One (1) working for each unit	Bidder shall provide water impounded Jet slurry system for Bottom ash. Submerged scraper chain conveyor is not preferred though it is indicated in the specs.	Refer annexure
11	II/ S-VI Q-6. (b)	34 of 68	Effective capacity minimum **1,200,000** cub m	Three (3) days requirement for whole plant.	Specification (Amendment-1) shall be followed.	Refer annexure
12	II/ S-VII	[redacted]	[redacted]	[redacted]	[redacted]	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
4	II/ S-III 19.16.02	31	Each Unit shall be provided with three (3) nos. 50% capacity condensate extraction pumps (2 working and 1 standby)	Each Unit shall be provided with two (2) nos. 100% capacity condensate extraction pumps (1 working and 1 standby)	Accepted	Deviation accepted by WPCPL
5	II/ S-III 19.17.00	33	Water box c) The condenser inlet and outlet branches shall be joined to the associated cooling water pipe work by pressure balanced type flexible bellows.	The condenser inlet and outlet branches shall be joined to the associated cooling water pipe work by rigid connection. There will be flexible type connection between LP cylinder and condenser.	The specification shall be followed. The expansion joints shall be pressure balanced type.	SEPCO agreed to provide expansion joint for CW branches except pressure balanced type.
6	II/ S-VI B 6.17	9	Fly ash hopper below economizers a) capacity Minimum twelve (12) hours' storage when operating at Boiler MCR, considering 100% of fly ash collected inside ESP hoppers.	Fly ash hopper bellow economizers a) capacity Minimum eight (8) hours' storage when operating at Boiler MCR, considering 100% of fly ash collected inside ESP hoppers.	The specification shall be followed.	Fly ash hopper bellow economizers a) capacity Minimum eight (8) hours' storage when operating at Boiler MCR and considering worst coal with 100% of fly ash collected inside ESP hoppers

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
21	II/ S-III 19.15.00	21 of 65	h) The air heaters shall be provided with steam soot blowers as well as sonic soot blowers.	h) The air heaters shall be provided with steam soot blowers.	The specification shall be followed.	Deviation accepted by WPCPL	
	Additional						
1	II/ S-III 18.02.00 g)	15	The scanner shall be able to detect both coal flame and discriminating flame and it shall be at minimum two levels with 100% redundancy.	The scanner shall be able to detect both coal flame and discriminating flame	The specification shall be followed.	Deviation accepted by WPCPL. SEPCO shall provide spare scanner as per list	
2	II/ S-III 19.14.00	21	Motor fan operated isolation gates with sealing shall be provided at inlet and outlet of ESP [illegible]	No isolation gate	The specification shall be followed.	SEPCO to revert on 28.9.08	
3	II/ S-III 19.15.01	27	Hydraulic operated NRV shall be provided in all the extraction lines.	Pneumatic operated NRV shall be provided in all the extraction lines.	Not acceptable. Hydraulic operated NRV shall be provided in all the extraction lines in order to ensure quick action.	SEPCO to provide the system drawing of Pneumatic operated NRV for WPCPL study and give approval for the scheme if satisfied.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
16			12.00.00	"DIFFERENTIAL PRESSURE GAUGE 06. Accuracy ±1.0% of span"	Deviation not clear. Please mention the accuracy envisaged.	Refer Resolution on Instrumentation Deviation.
17			K7V12_WPCPL_VOL-II-SEC-XIXB1 SEC-XIXB1: 10 of 50 6.01.00	"All inputs shall be taken through interposing relays for isolation and contact multiplication"	Inputs are required to be taken through interposing relays for isolation and contact multiplication. Deviation not clear. To be discussed.	Refer Resolution on Instrumentation Deviation.
19	VOL II SEC 17BC 8.04.00		Design software used for the designing shall be GEO STUDIO-2004 from GEOSLOPEINTERNATIONAL LTD of Canada in the bid. The software of China will be used for seepage and slope stability of embankment.	The china softwares are satisfied the request	The specification shall be followed.	Deviation accepted by WPCPL
20	2.0.00		Design following India Codes and Standard in the bid, Design following China Codes and Standard	The china Code and Standards are satisfied the request	The deviation is not acceptable. The specification shall be followed.	Refer civil MOM.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
13			Page 12 5.16.00 5.18.00	"Hardwired back-up panel shall be provided to mount Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator. "	Deviation not clear. Provision of hard wired back-up panel housing Drum level TV, Furnace Flame TV, EWLI, Pushbuttons, Multifunctional meter (Master clock, MW, Frequency and Speed etc.), Window Annunciator has been already agreed by you in the offer in the Data Sheet Cl. 9.5.16, vol II, sec 3-III, technical requirements, page 398 of 1003 and cl. 9.9.2, page 426 of 1003.	Refer Resolution on Instrumentation Deviation.	
14			Page 13 5.23.00	"The designation and legends for all instruments, valves etc., interconnection drawings and data sheets shall be as per ISA format. "	Instrument Society of America (ISA) format is acceptable.	Refer Resolution on Instrumentation Deviation.	
15			10.00.00	"PRESSURE GAUGE 07. Accuracy: ±1.0% of span"	Deviation not clear. Please mention the accuracy envisaged.	Refer Resolution on Instrumentation Deviation.	

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
12			VOLUME – II I0: C&I TECHNICAL SPECIFICATIONS SECTION-XIXA CONTROL DESIGN CRITERIA Page 7 3.12.00	"Condensate Polishing Unit, H_2 Generation Plant, Condenser on line tube cleaning system (COLTCS), Online steam leak detection system, Mill reject handling system etc., shall be PLC based and interfaced to DCS through OPC server for monitoring. The HP & LP dosing system shall be PLC based and interfaced to DCS through OPC server for monitoring. This system shall be supplied with an ES cum OS station."	Deviation not clear as provision of PLC based systems for the condensate polishing unit, H2 generation plant, condenser online tube cleaning system, online steam leak detection system have already been agreed in cl. 9.3.12, page 393 of 1003 of your offer. What is the type of interface envisaged between these control systems and DCS? Please clarify. Deviation not clear as interfacing of PLC based HP&LP dosing system to DCS through OPC server has already been agreed by you in cl.9.3.12 of pg 393 of 1003 of your offer. Please clarify how the HP & LP dosing control systems are interfaced to DCS.	Refer Resolution on Instrumentation Deviation.

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution	
8	VOLUME-II SECTION-II 23.11.00 RO Plant		The schematic arrangement of the treatment of residual effluents by UF/RO system	We will not provide UF/RO system	This system shall be provided in order to achieve zero effluent discharge by recycling & reusing the plant effluents.	SEPCO agreed to meeting Zero discharge with UF and RO system.	
9	1		29.00.00 The Contractor shall supply dual fired (light and heavy fuel oil), package boiler,	Light fuel oil will be used to start up of the boilers and ignition of the coal burners.	As clarified during the pre-bid conference, the main boiler shall use LDO for start-up and HFO for combustion support at low load. The auxiliary boiler shall be HFO fired, using LDO for start-up.	WPCPL accepted the auxiliary boiler using LDO only.	
10	2		18.01.00	According the Coal Analysis, at present Medium Speed Mill Coal pulverizing system will be applicable to adopt medium speed pulverizer with positive pressure direct coal pulverizing system.	Please clarify whether this is MPS type mill.	MPS type mill (bowl) shall be provided	

UNRESOLVED ISSUES

ANNEXURE-J

53	Volume-II, Section-3-V	-	Consumables	Contractor shall include all the consumables till completion of successful Reliability tests in their scope. Except for the following four (4) inputs from the Owner which shall be supplied free subjected to guaranteed cap (for quantities). • Coal in MT • LDO/HFO in kilo litres • Raw Water in cu.m • Start up power in kWh and peak in kVA. For considering the total bid price these quantities will be evaluated at the following rates and added with the Bid price. Any excess consumption beyond guaranteed quantities shall be recovered from the bidder at the following rates. • Coal at the rate of Rs. 900/MT at Track hopper • LDO/HFO at the rate of Rs. 40000/kl at Fuel oil tanks • Raw Water at the rate of Rs. 2.0/Cu.m at Raw Water reservoir • Start up power at the rate of Rs. 10.0/ kWh at 400 kV Bus of power plant switchyard.	SEPCO shall submit these values by 10.10.08
56	Volume-II, Section-3-VII	-	Data sheets	Bidder to note that majority of information in Datasheets is either "LATER" or "By MANUFACTURER". Bidder is requested to furnish all the data.	SEPCO agreed to furnish the data sheets complying with specifications for WPCPL approval during detailed engineering stage.
57	Volume-II, Section-3-III	-	Systems Description	Bidder to furnish detailed writeup on all equipments/systems as called for in tender. Brief description as provided are insufficient.	SEPCO agreed to furnish the data sheets complying with specifications for WPCPL approval during detailed engineering stage.
58	Volume-II, Section-3-V	Pt.28 Pg.487	Aux. Power	Please provide break-up of auxiliary power consumption	SEPCO shall submit during Detailed Engineering
60	Specs. Vol. II Sec. III	Cl. 10.00.00	Codes and Standards	The major applicable codes and standards have been referred in the specification under various sections. The Bidder shall furnish a comprehensive list of all codes and standards proposed to be referred and used for this project.	SEPCO shall follow applicable codes and standards as per specifications. In case they choose to follow other standards, such standards shall be equal or superior/stringent than the codes and standards as per specifications. SEPCO agreed

UNRESOLVED ISSUES

ANNEXURE-J

35	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please note that width and number of roads shall be followed as indicated in the drawings. It is observed that roads between Boiler & bunkers, ESP & ID Fan, CW pipes & Transformer bay is not provided. Please provide the same.	SEPCO indicated roads as per Bid specification requirement. Moreover, 4mt wide road between coal mills and boiler shall be incorporated in revised layout.
37	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please reroute approach road to material gate (2) around N-1450. Please note that approach roads from NH-200 is in the scope of Bidder.	SEPCO agreed to incorporated in revised layout.
38	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate Hydrogen generation plant close to the boundary, away from plant area for ensuring safety.	SEPCO shifted H2 generation plant near boundary.
47	Volume-II, Section-3-V	-	Guaranteed data	Bidder to note that the Turbine Heat rate indicated is on higher side. Bidder to optimise, check and confirm the same.	SEPCO to revert on optimized heat rate by 10.10.08
48	Volume-II, Section-3-V	-	Guaranteed data	Bidder to note that aux. power consumption is on the higher side. Bidder to optimise and reconfirm the value. Aux. power consumption shall be calculatied as follows : Gross power measured at Generator terminals minus power evacuated at 400 kV outgoing bus/export gantry minus energy recorded at 4 nos of 11kV feeders for PCPL colony and WPCPL river water pump house.	SEPCO to revert on optimized heat rate by 10.10.08
50	Volume-II, Section-3-V	-	Guatantee Curves	Steam generator, Steam Trubine gurantee curve as well as Correction curves shall be submitted.	WPCPL agreed for submission within 1 month from the award of contract.
52	Volume-II, Section-1-V	-	Vendor List	Bidder to provide list of equipments which will be sourced from India and from third country (other than China and India)	Refer point 3 above

UNRESOLVED ISSUES

ANNEXURE-J

Unresolved of Annexure-A2 (Layout and General Comments)

1	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout/ Vastu Requirement	The Overall plot plan shall be developed/planned incorporating the latest contour survey drawing forwarded through Amedment-1. It should also show ash dyke area and space behind the construction space upto the Boundary. It is observed that the proposed Plot plan does not meet fully the VASTU requirement, which is the most important consideration. The VASTU rectangle of power plant block in the proposed layout will be from W-100 to E-1300 (1400 m) and N-000 to N-1500 (1500 m). Hence the centreline of this Vastu rectangle will be E-600 and N-750 which will form four quadrants and centre-line of main plant raod. In such case, the const. space shall be located outside this VASTU rectangle. To follow VASTU principles the Switchyard should be shifted beyond E-600. For quick reference, VASTU annexure of Specification are attached herewith.	WPCPL has explained the VASTU requirements and proposed few changes to the layout offered by SEPCO. SEPCO has understood the requirements and revised the layout accordingly. Further, WPCPL provided comments on layout, SEPCO to submit revised layout.
10	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please indicate and include ash disposal area of 100 Ha for Bottom ash suitable for 25 years and 95 Ha of fly ash suitable for fly ash disposal (for 5 years and 50% utilisations). Please also indicate ash bund, roads, green belt and other relevant details.	SEPCO to incorporate Ash dyke area and piping arrangement in revised plot plan.
11	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Ash silo area around 100 m radius shall be completely paved; each silo unloading shall be suitable for unloading into two trucks (closed/open), one railway (pneumatically operated ash feeding arrangement over railway line) and feeding HCSD system. Space provision for movement of trucks shall be provided. One spare unloading connection with valve suitable for railway wagon feeding shall be provided for two silo.	SEPCO agreed to incorporated in revised layout.
13	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please locate bore wells all around ash dump area for monitoring ground water quality. It should be atleast twelve (12) and evenly space around fly ash and bottom ash bund.	SEPCO agreed to incorporated in revised layout.
14	Volume-IV, Section-5-II	Drg.No. F625KB-Z-01	Plant Layout	Please provide location of Service/ Instrument air compressor house.	SEPCO agreed locate in revised layout.

118	Volume-II, Section-3-III	Cl. 12.0, Pg. No.439	HVAC Plant	Air Conditioning system shall be designed to maintain 24.4Deg.C ± 1.1Deg.C DB & RH of 50% ± 5% with only exception of area housing microprocessor based equipment, which will be maintained at 22 Deg.C ± 1.1 Deg.C & RH of 50% ± 5%.	SEPCO agreed
119	Volume-II, Section-3-III	Cl. 12.0, Pg. No.440	HVAC Plant	All other parameters such as air change, temp. difference, redundancy of the different areas shall be followed as per specification for calculation of HVAC requirement.	SEPCO agreed
120	Volume-II, Section-3-III	Cl. 12.0, Pg. No.440	HVAC Plant	Separate FRP type cooling tower shall be provided for HVAC as per specification.	SEPCO agreed
136			Boiler	HP/LP bypass valve shall be of electro hydraulic actuation type.	SEPCO agreed
148			Boiler	HP dosing system (Phosphate) and LP dosing system (Ammonia and Hydrazine) comprising of one tank and two pumps shall be provided for each unit.	SEPCO agreed.
167			ESP	Please furnish the ESP sizing details giving the following : a) Inlet dust burden.b) Outlet dust conc.	SEPCO confirmed that ESP with bag filter shall meet the guarantee requirements. SEPCO to provide details during detail engineering.
171			ESP	Bidder to note that Guillotine type dampers for ESP pass isolation is to be provided.	SEPCO agreed o provide guillotine dampers at the inlet and outlet of each pass of ESP.
182			Condensate Polishing Unit	Separate external regeneration system with resin transfer facility, resins separation, separate vessels for Anion and Cation regeneration and remixing of resins shall be provided.	SEPCO agreed
183			Condensate Polishing Unit	One resin mixing/storage tank to be provided.	SEPCO agreed
185			Condensate Polishing Unit	Regeneration mode and regeneration cycle for the Condensate Polishing vessels shall be as per specification.	SEPCO agreed

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WARDHA POWER COMPANY PVT. LTD. 6 x 600 MW POWER PLANT

UNRESOLVED ISSUES

ANNEXURE-J

Unresolved of Annexure-A1 (Mechanical and General Comments)

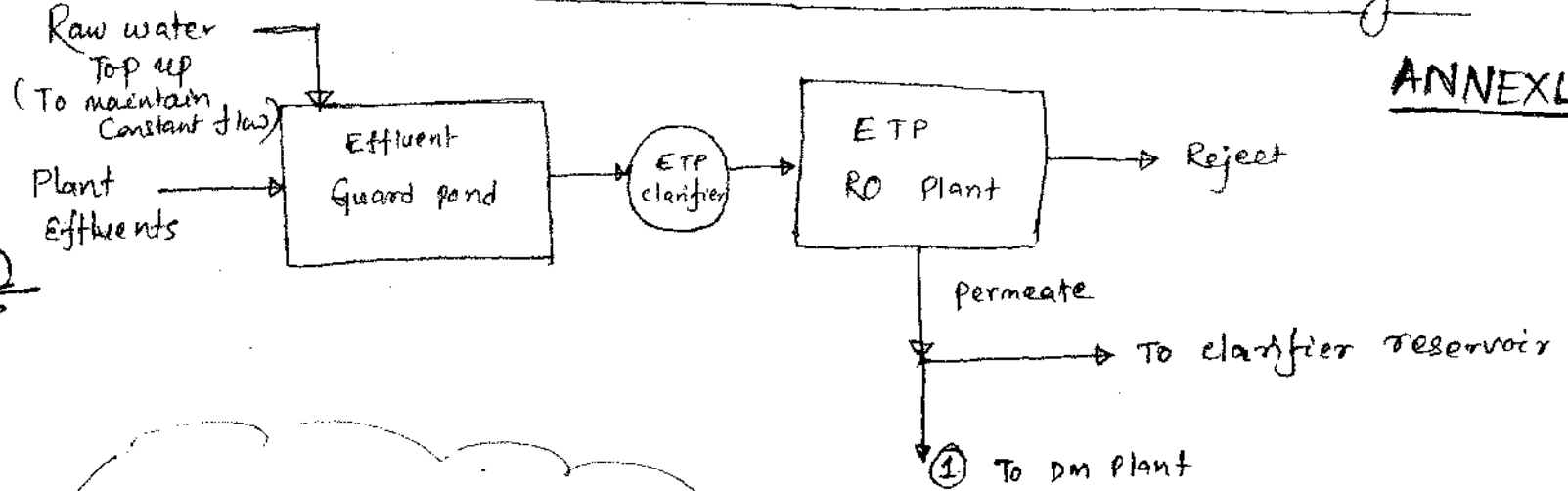
Sl No	Bid Reference		Brief subject	Comments	Resolution as per EPC basis
	Volume/Section/ Part/ Chapter no	Clause no / Page no			
1	Volume-II, Section-3-III	-	Scope of supply	Bidder to indicate his confirmation against each item of Sec-IV (Scope of Work) of Volume-II of Bid Specification.The section is attached herewith for bidders ready reference. It should also be noted that Green Belt plantation/land scaping is excluded from Bidder's Scope. However, grading of the area within Green Belt shall be part of EPC bidder's scope.	Refer Annexure-E for resolution on Scope of supply. SEPCO confirmed grading of entire area including green belt area included in their scope.
3	Volume-II, Section-3-III	-	Vendors List	Vendors List format is attached which shall be filled up by the Bidder. This will be discussed mutually for approval. Vendors list for Balance of plant items also shall be furnished.	WPCPL provided coments on vendor list provided by SEPCO. SEPCO will revert by 10.10.08
26	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	Please cofirm the following feature for turbine initial pressure regulator and unloading gear "The turbine shall be provided with an initial pressure regulator to start closing the steam control valves when the main steam pressure falls below a predetermined low value and the turbine shall be completely unloaded when the pressure falls to a further preset low point and it shall admit only sufficient steam to keep the machine running at full speed on house load. Provision shall be made to adjust or bypass this initial pressure regulator at start up condition to facilitate starting with low steam pressure. Contacts shall be provided on the initial steam pressure regulating gear for signaling pressure unloading gear operation and pressure unloading gear reset."	SEPCO to get written details from the manufacturers about technical non-feasibility of house load condition operations by 15.10.08.
27	Volume-II, Section-3-III	Cl. 3.3.2, Pg. No.365	Steam Turbine	For non-return valves of extraction lines, hydraulic actuators instead of pnumatic actuators is preffered for quick actuation. Please check	WPCPL accepted pneumatic actuators

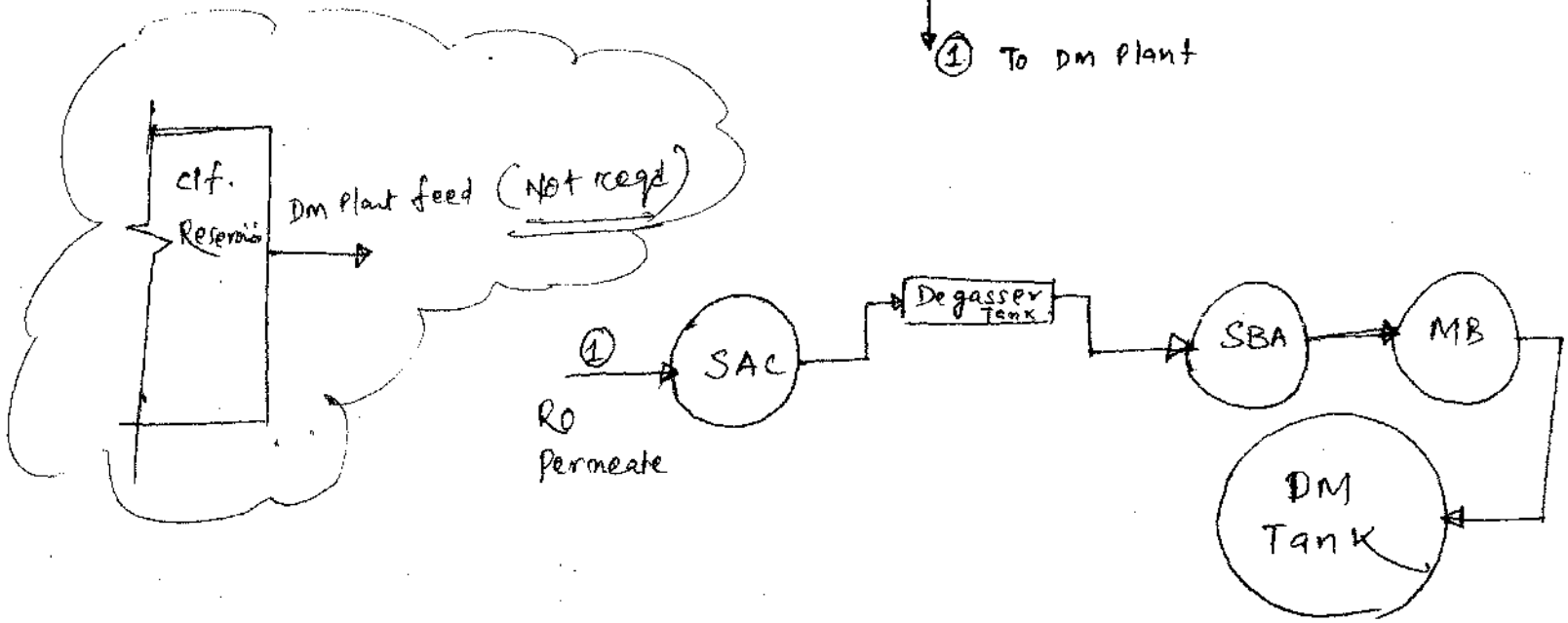
29/9/08

24.9.2008

ETP & DM Plant Schematic for 6x600 MW WPCPL, Narayana

ANNEXURE-I





Note: 1) Minimum Permeate to be Supplied to Proposed DM Plant is 480 m³/hr for 18 hrs/day

2) To maintain min^m output of 480 m³/hr Permeate from ETP, Raw water top up ~~supp~~ to be Supplied to Effluent Guard pond in Case Effluent is not sufficient.

45	START UP BOILER HOUSE	As Required.		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
46	OPEN TRUCK PARKING	60	60	-	6	1				RCC PAVED	
47	SLURRY DISCHARGE PUMP HOUSE	As Required.		-	1	6	RCC	RCC	RCC	RCC	BRICK WORK
48	CONCENTRATOR	As Required.		-	1	6					
49	COAL WASHING WATER POND & PUMP HOUSE	20	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
50	COAL SETTLING POND	20	20	-	6	1					
51	RAW WATER DOSING PLANT	20	20	-	1	6	RCC	RCC	RCC	RCC	BRICK WORK
52	FIRE FIGHTING PUMP HOUSE	Incl. in Raw Water Pump House		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
53	HYDROGEN GENERATION PLANT	60	40	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
54	FLUE GAS DESULPHURISATION PLANT (FUTURE)	160	50	-	6	6					
55	AHP CONTROL ROOM (HCSD)	70	25	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK

Note:
1. The area indicated above is minimum requirement. In case of conflict, layout and area for plant equipment building shall be mutually agreed as per O & M requirement.
2. For non-plant buildings, area mentioned shall be provided. All Non-plant building are marked with '#'.

21	TOILET BLOCKS (TWO NOS) (#)	10	10	-	6	2	RCC	RCC	RCC	RCC	BRICK WORK
22	CAR PARK (#)	100	8	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
23	CYCLE & SCOOTER SHED (#)	100	8	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
24	PLANT AMENITIES AND CANTEEN (#)	25	60	1	6	1	RCC	RCC	RCC	RCC	BRICK WORK
25	TRACK HOPPER CONTROL ROOM	15	10	-	3	2	RCC	RCC	RCC	RCC	BRICK WORK
26	ENVIRONMENTAL MONITORING ROOM	10	10	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
27	RAW/FIRE WATER PUMP HOUSE	60	40	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
28	COOLING WATER TREATMENT ROOM	40	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
29	ELECTRIC ROOM FOR CW PUMP HOUSE	20	10	-	2	3	RCC	RCC	RCC	RCC	BRICK WORK
30	TRANSFER TOWERS	12	12	-	6	AS REQUIRED	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
31	CRUSHER HOUSE	30	20	-	3	2	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
32	R.O. PLANT	As Required.		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
33	GUARD POND	100	100	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
34	WASTE WATER TREATMENT	As Required.		-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
35	RAW WATER RESERVOIR	480	250	-	6	1	RCC / EARTHEN TYPE				
36	BOILER AREA	As Required.		-	6	6	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
37	FLY ASH SILO	20	20	-	6	4	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
38	SWITCH YARD AREA	360	260	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
39	COOLING TOWERS (SIX NOS) DIA X HT	120	160	-	1	6	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
40	TRACK HOPPER (TWO NOS)	As Required.		-	3	2	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
41	ASH POND (FLY ASH)	9,50,000 SQM		-	6	1	EARTHEN EMBANKMENT				
42	ASH POND (BOTTOM ASH)	10,00,000 SQM		-	6	1	EARTHEN EMBANKMENT				
43	STACKER RECLAIMER DRIVER HOUSE	As Required.		-	3	2	RCC	RCC	RCC	RCC	BRICK WORK
44	SWITCH YARD RELAY BUILDING (#)	70	30	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK

BUILDINGS DATA SHEET

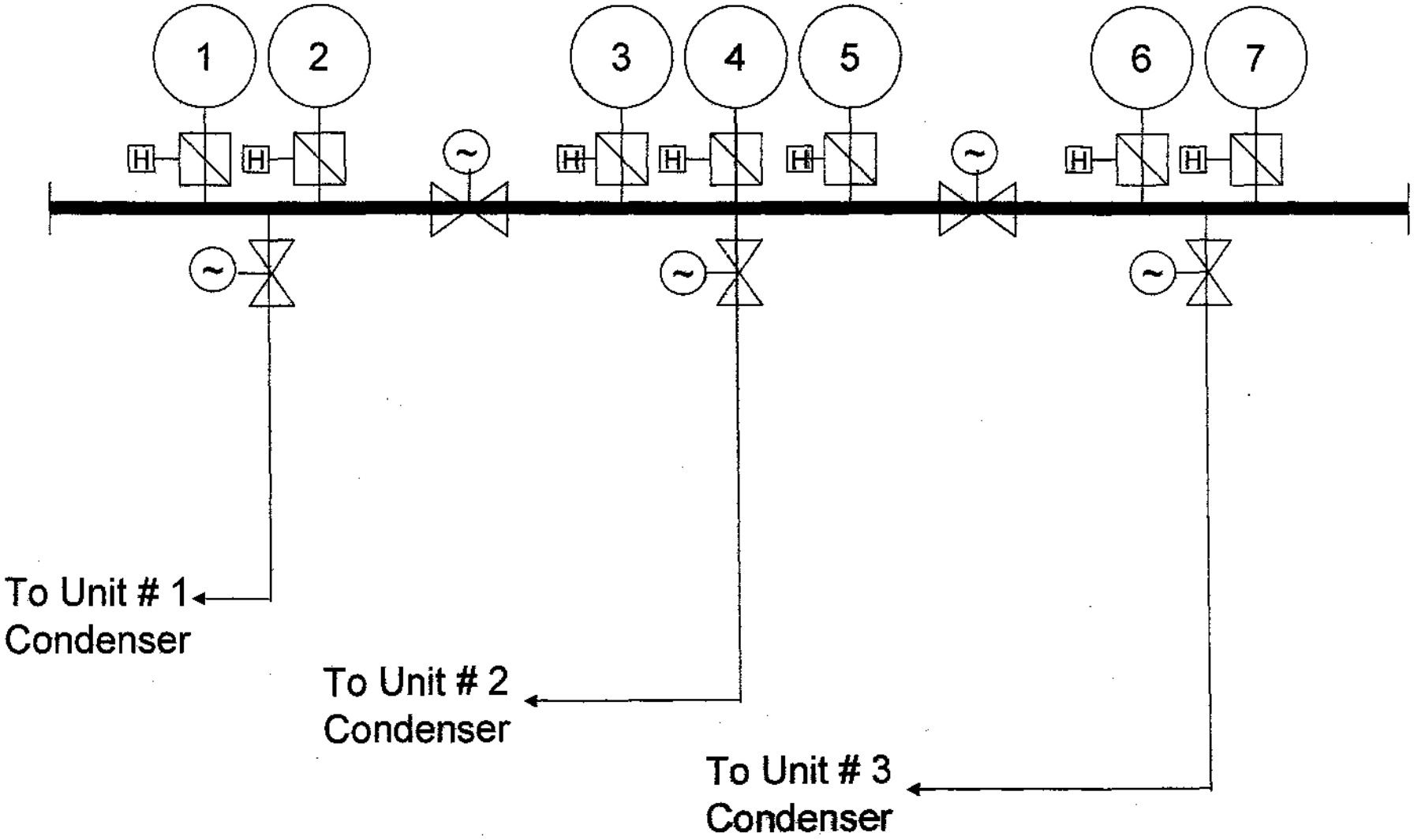
MINIMUM SIZING OF BUILDING

SL.NO	Area	LENGTH (IN M)	BREADTH (IN M)	NO. OF FLOORS	FOR NO.OF UNITS	TOTAL NOS.	TYPE OF CONSTRUCTION DESIRED				
							FOUNDATION	FRAMES	ROOF	FLOOR	ENCLOSURE
1	T.G.HOUSE	As per Agreed by Owner/Bidder to suit O&M		3	6	1	RCC	STR. STEEL	STR. STEEL	RCC	SANDWICH PANEL
	COAL BUNKER BAY			-	6	1	RCC	STR. STEEL	STR. STEEL	RCC	BRICK WORK
	DEAERATOR BAY			-	6	1	RCC	STR. STEEL	STR. STEEL	RCC	BRICK WORK
2	ESP/ AHP CONTROL ROOM	35	16	3	3	2	RCC	RCC	STR. STEEL	RCC	BRICK WORK
3	ELECTRIC ROOM FOR CHP	35	25	2	3	2	RCC	RCC	STR. STEEL	RCC	BRICK WORK
4	ADMIN BUILDING (#)	25	50	2	6	1	RCC	RCC	RCC	RCC	BRICK WORK
5	SECURITY POST,TIME OFFICE (#)	16	8	2	6	1	RCC	RCC	RCC	RCC	BRICK WORK
6	SECURITY POST (#)	8	8	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
7	OIL PUMP HOUSE & TANK YARD	As Required.		-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
8	BULLDOZER STORE HOUSE (#)	18	54	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
9	DM PLANT AND AUXILIARIES	As Required.		2	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
10	PRE TREATMENT PLANT	As Required.		-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
11	COOLING WATER PUMP HOUSE	60	30	-	3	2	RCC	RCC	RCC	RCC	BRICK WORK
12	LOCO SHED (#)	20	15	-	3	2	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
13	AUTO GARAGE (#)	20	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
14	STORES (#)	150	60	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
15	WORK SHOP (#)	150	60	-	6	1	RCC	RCC/STR. STEEL	RCC/SHEETING	RCC	BRICK WORK
16	PLANT SERVICE BUILDING (#)	50	25	2	6	1	RCC	RCC	RCC	RCC	BRICK WORK
17	FIRE STATION (#)	40	20	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
18	AIR COMPRESSOR /DG ROOM	40	30	-	3	2	RCC	RCC	RCC	RCC	BRICK WORK
19	FUEL OIL PUMP HOUSE	25	10	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK
20	WEIGH BRIDGE CONTROL ROOM	10	10	-	6	1	RCC	RCC	RCC	RCC	BRICK WORK

WARDHA POWER COMPANY PRIVATE LIMITED-6 x 600 MW

Annexure-G

CW PUMP HOUSE SCHEMATIC



Note: This schematic is for Phase-I, For Phase-II similar arrangement to be repeated

25-09-2008

f) All required hoses including pump suction hoses, supply hoses, attack lines, and hose on the booster hose reel.
g) All discharge outlets as required by NFPA 1901 or TAC.
h) All required nozzles. Nozzles shall be UL listed variable pattern ball shutoff type. Nozzles shall be hard anodized aluminum alloy.
i) Standard 4.3 meter roof and 7.3 meter aluminum extension ladders shall be provided.

02.02.00 One (1) Foam CO_2 tender shall come complete with, but not limited to, the following:

a) One number of centrifugal pump with around 1800 litr/min capacity, min 7 kg/cm2 pressure, suction lift 3.0 m.
b) One number (1) rectangular water tank having capacity around 4500 litre located at suitable place on the chassis and other necessary requirements.
c) One (1) number of rectangular shape foam compound tank with 500-ltr capacity.
d) One (1) demountable monitor nozzle to allow 360 degree operation complete with 2250 liter per minute combination straight stream/fog nozzle.
e) One number of Foam Compound Proportionator Inductor.
f) One number of Foam Water Monitor.
g) Two Number of Hand Lines/ Pick-up tube.
h) 2x22.5 Kg (4 nos.) CO_2 cylinder on both side of the vehicle with common manifold into a single CO2 hose.
i) CO_2 Equipment
j) One number of control panel equipped with other requirements as specified.
k) Supply of first fill of consumables i.e., foam, CO_2 etc.

02.03.00 One (1) Dry powder tender shall come complete with, but not limited to, the following:

a) Two number of Cylindrical DCP tank with capacity 1000 kg each at pressure 22 kg/cm^2.
b) 8 No of Nitrogen cylinders with 50 litr. Capacity and at 200 kg/cm^2 pressure each.
c) Two number of Hose Reel with discharge capacity 5 kg/sec and at 14 kg/cm^2 of pressure.
d) One No of monitor having 40kg/sec, 25kg/sec, & 15 kg/sec discharge rate at three position.
e) One number of control panel equipped with other requirements as specified.
f) Supply of first fill of consumables i.e., dry powder etc.

ANNEXURE-L

SPECIFICATION FOR FIRE TENDER

01.00.00 **FIRE TENDER**

Four tanker type fire tenders/trucks shall be provided. The truck shall meet the requirements of all applicable codes and standards including NFPA 1901. Bidder to consider following break-up of four (4) fire tender mentioned above.

- Two (2) nos of water tender,
- One (1) CO_2 and Foam Tender,
- One(1) Dry powder tender

01.01.00 The design, material of construction, workmanship & finish, performance testing, accessories and equipments of Water tender type-B, Foam CO_2 tender, Chemical Powder tender specified herein shall comply with the requirements of codes/standard as follows:

IS: 950	-	Functional requirements for water tender, type B for fire brigade use.
IS: 10460	-	Functional requirements for Foam CO_2 tender for fire brigade use.
IS: 10993	-	Functional requirements for Chemical Powder tender for fire brigade use.

01.02.00 Each fire tender shall meet the minimum following criteria :

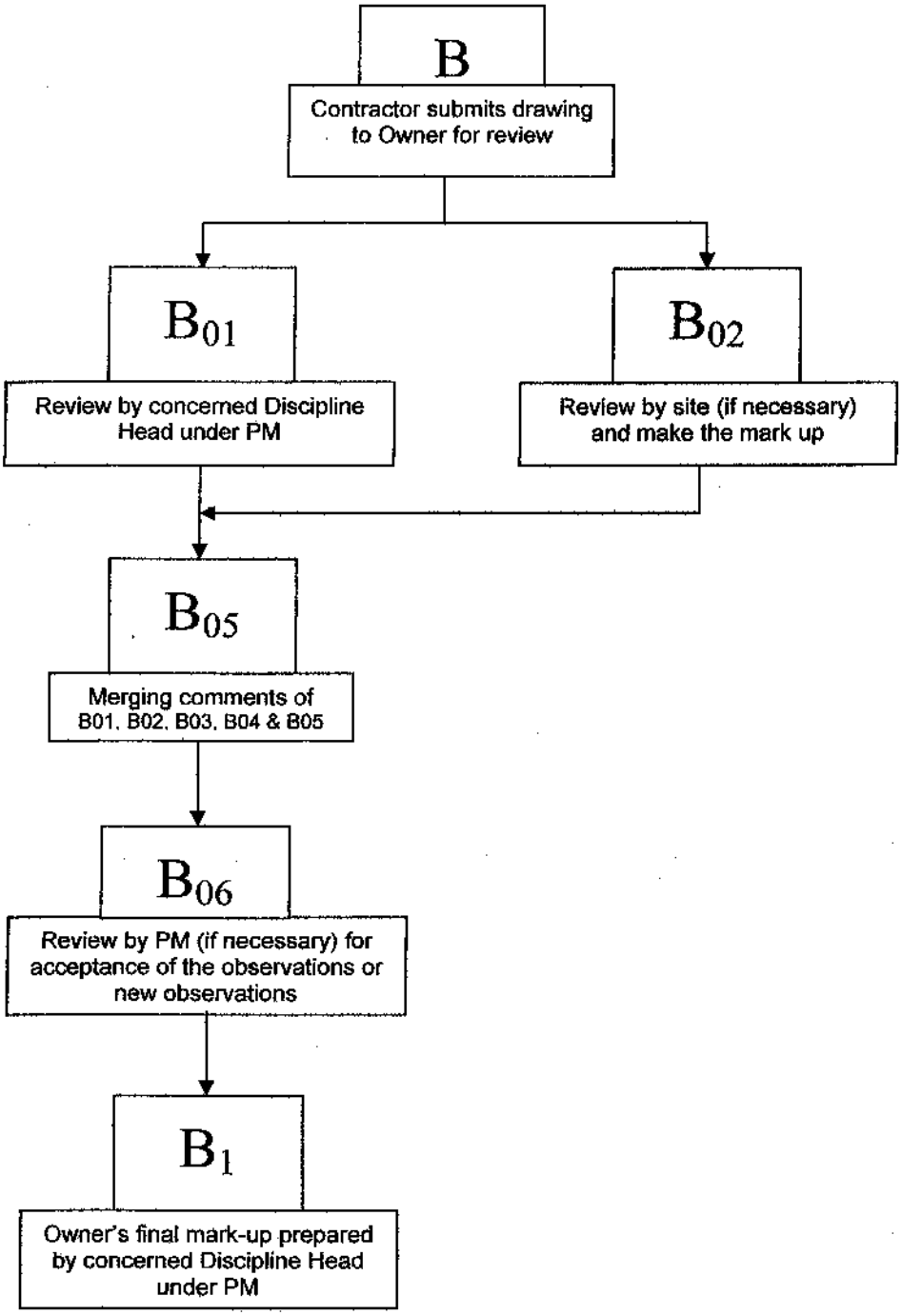
a) Each of the fire tender shall be furnished with trailer fire pump driven by Kirloskar HA494 air-cooled diesel engine or approved equal.
b) The centrifugal pump with reciprocating priming system shall have a capacity of not less than 1800 lpm at 7 bar.
c) The trailer chassis shall be constructed out of MS channels mounted on 2 detachable wheels having semi-eliplical springs and shock absorber.
d) The tyres shall be pneumatic; and the weight of the engine and pump is equally distributed on the chassis to ensure free movement.
e) Provision shall be made to carry suction hose and ancillary equipment with unit.
f) The trailer shall be provided with front and rear stands for steady operation.
g) Hook type towing arrangement with spring loaded bracket and over-run device automatically the break mechanism shall be provided.
h) Tenders shall carry an extension ladder of 10.5M length.
i) Acceleration from a standing start through the gears (fully laden): 64 km/h in 55 seconds.

02.01.00 Each Water tender of the Two (2) provided shall come complete with, but not limited to, the following:

a) One (1) 3000 litre (min.) water tank.
b) One (1) 2250 litre per minute (min.) single stage centrifugal pump rated at 7 bar.
c) One (1) demountable monitor nozzle to allow 360 degree operation complete with 2250 liter per minute combination straight stream/fog nozzle.
d) Five (5) 30 minute duration OSHA approved self-contained breathing apparatus.
e) One (1) portable hydrant type gated wye, one inlet by four gated male outlets.

ANNEXURE-K

Internal review on the Owners side of the drawings submitted by the contractor.



The contractor by an E-mail informs the owner as well as the consultant that he has placed a drawing in the Citrix server under folder A, B & C. Folder B is for review by owner

The folder B is copied by Discipline Head (B01), Site (B02), Chennai Engg.(B03) [or directly received from EPC contractor in the FTP server] & Specialists (B04) in HO if any.

The concerned department informs by mail of their completion of comments in B01, B02, B03, B04 based on which the comments are merged by the Discipline Head under the PM to arrive at Drawing in folder B05

The drawings placed in B01, B02, B03, B04 so received under folder B and intimated to the Project Head and concerned Disciplined Head will be opened by the Disciplined Head for marking / modification , etc.

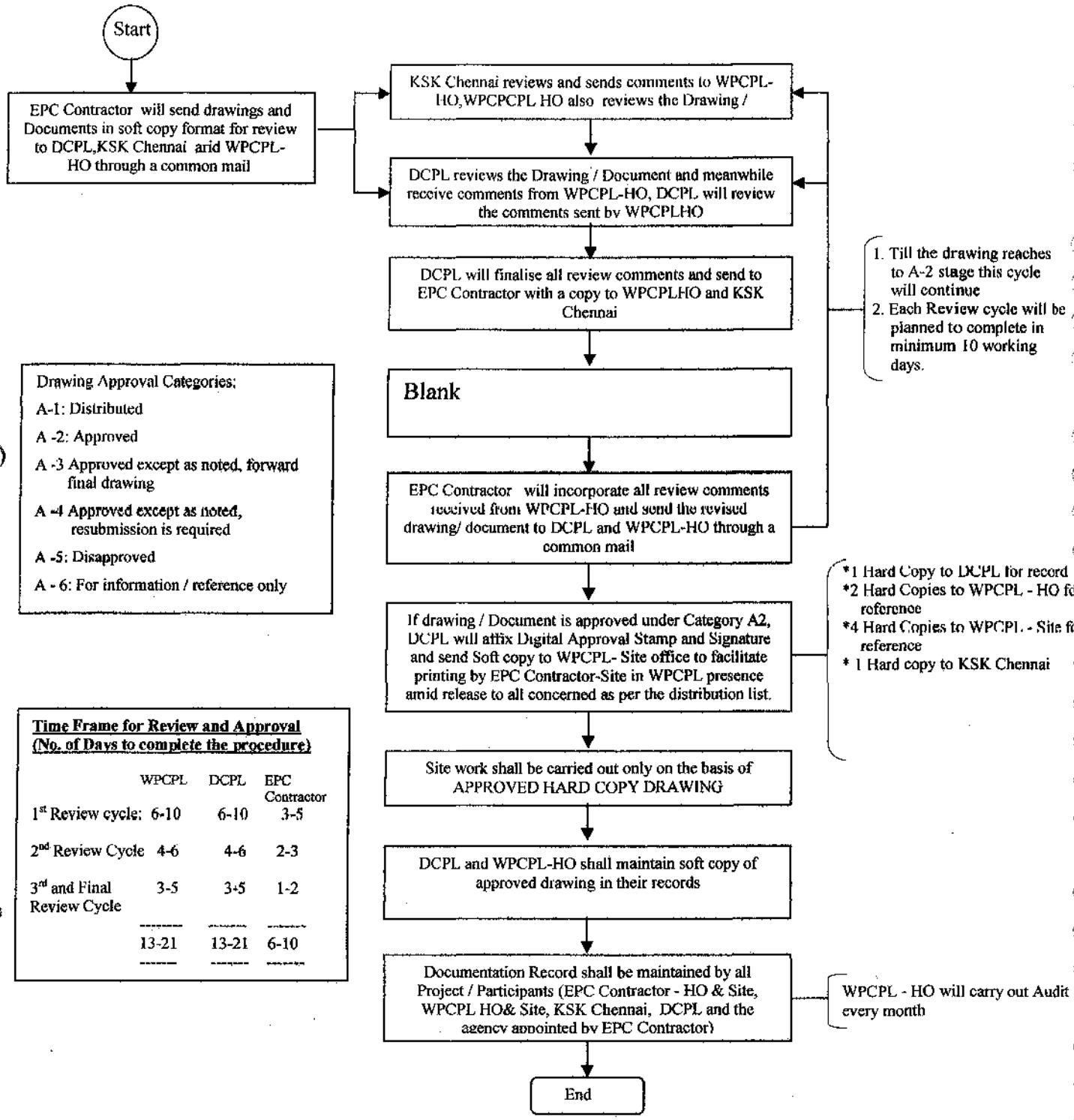
The drawing thus marked will be intimated to the Project Head for his review, if any. Then placed in folder B1 for owner's final mark-up drawing.

Note: Drawing in B folder is copied from B01 to BO4 folders for review by the Owners participants namely- 1. Concerned Discipline head under Project Head (HO), 2. Review by Site as necessary 3. Review by any HO –Specialist as necessary 4. Review by Engineering Office – Chennai. . The copying into respective folders is done by Owners coordinator for drawings.

B1 then goes to DCPL for incorporation and further sending to EPC Contractor .

ANNEXURE-K

WPCPL – Typical Drawing Submission and Approval Procedure



Time Frame for Review and Approval (No. of Days to complete the procedure)

	WPCPL	DCPL	EPC Contractor
1st Review cycle:	6-10	6-10	3-5
2nd Review Cycle	4-6	4-6	2-3
3rd and Final Review Cycle	3-5	3-5	1-2
	13-21	13-21	6-10

Note:

1. All the Project Participants (WPCPL, SEDC and DCPL shall follow the above procedure for implantation of all aspects
2. The EPC contractor shall submit the drawings to the FTP server of DCPL Mumbai, WPCPL-HO and KSK Chennai.
3. EPC Contractors submits thee drawings to DCPL,KSK Chennai, and WPCPCPL HO on their FTP servers with corresponding emails indicating submission on the server .

WARDHA POWER COMPANY PVT. LTD. 6 x 600 MW POWER PLANT

UNRESOLVED ISSUES

ANNEXURE-J

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
2	II/ S-III 18.14.00	21	Motor/ air operated isolation gates with seal air shall be provided at the inlet and outlet of each ESP path.	No this gate.	The specification shall be followed.	SEPCO agreed
7	II/ S-VI D 3	12	60% Boiler MCR HP bypass & matching LP bypass for parallel operation with T.G. under part load/house load condition.	No house load condition.	House load condition also shall be included.	Refer electrical MOM
12	II/ S-VII	1 of 4 3.	Coal mills (based on loading not to exceed 80% of the design load of mill)	Coal mills (based on loading not to exceed 90% of the design load of mill)	The specification shall be followed.	SEPCO will check with mill manufacturer and confirm by 10.10.08
29	II/S-8 2.01.00	2	F) Load Rejection from full load or any load level to house load	N/A	The specification shall be followed.	Refer electrical MOM

WARDHA POWER COMPANY PVT. LTD. 6 x 600 MW POWER PLANT

UNRESOLVED ISSUES

ANNEXURE-J

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER'S REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
	(FOR COMPLETE EPC PACKAGE)			
7.	Ash - at ash dump yard. (Ash dump yard is also in Bidder's scope)		Yes	

Further Resolved of Annexure-F (Technical Deviations)

SL. No.	Clause No. of Tender Document	Page No.	Bid Reference Spec.	Deviation	KSK/DCPL comments	Resolution
26	V.II/S-VI C	11	NEW ITEM	11.Performance Suspended solids at ESP +FF outlet shall be within 50 mg/Nm3 with one field out.	Suspended solids at ESP +FF outlet shall be within 50 mg/Nm3 one bag filter out also.	WPCPL agreed for Suspended solids at ESP +FF outlet shall be within 50 mg/Nm3 with one field out.
28	V.II/S-VII 2	1	Particulate emission maintained within the specified/guaranteed limit on continuous basis when first field in each gas path is out of service.	Particulate emission maintained within the specified/guaranteed limit on continuous basis when one field is out of service.	The deviation is not clear. The performance should be guaranteed with first field out also.	WPCPL agreed Particulate emission maintained within the specified/guaranteed limit on continuous basis when one field is out of service.
10	Vol-II Sec-6 J-1	P19	TURBINE LUBE OIL PURIFICATION SYSTEM Type : Bowser/centrifuge	coalesced separated type	The proposed scheme drawing may be furnished.	The particle size after lube oil purification unit shall be less than 5 microns or as recommended by Turbine manufacturer

UNRESOLVED ISSUES

ANNEXURE-J

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER'S REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
	equipment & facilities for best up Keeping of the entire plant. Bulldozer and other Vehicle maintenance shop.			price for this by 10.10.08
J.	**ELECTRICAL SYSTEM**			
16.	Separate C.T., P.T., tariff metering system and telemetering equipment for feeding State Grid and Power Grid, India.	Yes	BOP	Refer electrical MOM
L.	**CIVIL, STRUCTURAL AND ARCHITECTURAL**			
1.	All civil, structural and Architectural works related to system/plant requirement covering all non plant buildings as per list of building and structures.	Yes	BTG/BOP for their respective plants/ equip.	Yes
3.	Site grading including construction roads and drains, green belt, CHP and AHP area.	Yes	BOP	Yes
5.	Roads and Paving	Yes	BOP	Yes
6.	Boundary wall and fencing around the plant boundary with gates.	Yes	BOP	Boundary wall excluded
20.	Carrying out pump sump model studies for CW Pumps and Raw Water pumps, wind tunnel studies for chimneys and N. D. Cooling Towers	Yes	BOP	Yes
N.	**TERMINAL POINTS**			

ANNEXURE-J

129	Volume-II, Section-3-III	-	Availability, Reliability	Bidder to provide elabore notes on this along with back-up operating data on the equipments offered instead of brief write-up provided in offer.	SEPCO to revert by 10.10.08
131	Spec. Section-XVI	-	Drawing Submission	Bidder to submit GA and Section drawing of all Rotating equipments such as Fans, Pumps, Blowers etc. indicating clearly Material of construction of different parts and design criteria (apart from the drgs/documents listed in Section-XVI).	SEPCO to provide during detailed engineering
137	-	-	General	Bidder shall comply with Main Specs & all amendments issued till date except for the deviations approved by Owner in writing.	SEPCO to revert on confirmation by 10.10.08
138	-	-	General	Velocity of operating medium in all the systems shall not exceed the limits specified in the Bid specs.	SEPCO to revert on confirmation by 10.10.08
139	-	-	General	Bidder to provide clause wise compliance on VOLUME-VI " DESIGN REQUIREMENT" and VOLUME-VII " REDUNDANCY REQUIREMENT".	SEPCO to revert on confirmation by 10.10.08

Unresolved of Annexure-E (Scope of Supply)

SL. NO.	ITEMS	WHETHER REQUIRED		BIDDER'S REPLY
		IN CASE OF COMPLETE OFFER (BTG +BOP)	WHETHER UNDER BTG OR BOP (IN CASE OF OFFER FOR BTG OR BOP)	
F.	**ASH HANDLING PLANT**			
11.	Civil Work for Ash Dyke development	Yes	BOP	SEPCO shall give optional price for this by 10.10.08
I.	**OTHER AUXILIARY ITEMS**			
15.	Plant maintenance workshop equipped with necessary	Yes	BOP	SEPCO shall give optional

					reusable oil filters and 1X100% duplex filter with online changeover, for each unit of 600 MW.
98	Volume-II, Section-3-III	-	Condenser	Please confirm design of condenser for VWO condition.	SEPCO confirmed that although condenser is designed for TMCR condition, they will demonstrate VWO condition
102	Volume-II, Section-3-III	Cl. 7.1 Pg.381	CW Pumps	Kindly specify margin over capacity and head at VWO condition. Please confirm one standby pump for CW pump house of every three units as shown in layout	WPCPL informed margin and head at TMCR condition shall be 5%. SEPCO to check and revert on technical infeasibility by 10.10.08. Otherwise SEPCO to include. SEPCO confirmed one standby pump for CW pump house of every three units
103	Volume-II, Section-3-III	-	CW Pumps	Bidder to confirm that CW pumps should be sized for VWO condition heat load and with minimum 5% over the required capacity.	WPCPL informed margin and head at TMCR condition shall be 5%. SEPCO to check and revert on technical infeasibility by 10.10.08. Otherwise SEPCO to include.
104	Volume-II, Section-3-III	Cl.3.3.4 Pg.366	ACW system	Please specify capacity and head margins considered for the pumps.	SEPCO agreed for Flow - 10 % and Head-20%
116	Volume-II, Section-3-III	Cl. 6.2.1 Pg. 379	Ash handling system	Please provide details of ash distributed per hopper	SEPCO confirmed during detailed engineering
119	Volume-II, Section-3-III	Cl. 12.3 Pg.440	HVAC	Please confirm design condition as per specification in the turbine hall will be maintained under all units in operating condition.	SEPCO agreed
120	Volume-II, Section-3-III	Cl. 12.3 Pg.440	HVAC Turbine Hall Ventilation	It is observed that Natural ventilation is provided for TG Hall. Bidder to note that Roof exhausters shall be provided for TG Hall as specified in the Bid documents. Bidder to also confirm that the ventilation system meets the stipulation "TG hall internal temperature is not more than 3 Dec. C above the ambient temp." as per Factories act of India.	SEPCO to revert by 10.10.08
124	Volume-II, Section-3-III	Table 13.3	Effluent Data	Please refer Table 13.3 of the offer, please indicate the values for various parameters in the final effluent.	As plant will be designed considering Zero discharge concept, this is not applicable. However final effluent if generated shall confirm to environment guidelines. SEPCO confirmed

UNRESOLVED ISSUES

ANNEXURE-J

63	Volume-II, Section-3-XII	-	Environment Monitoring Car	One completely automatic micro-meteorological data collection and recording environmental car comprising wind-vane, anemometer, thermometer, Hygrometer, sunshine recorder, evaporimeter, rainfall recorder etc. shall be provided. The station shall be equipped with arrangement for measurement of all relevant parameters on hourly basis.The entire station shall be of automatic recording type connected with logic controller and programmable microprocessor. Continuous recording system with provision for instantaneous display of different parameters including the wind rose shall be provided. The system shall be provided with independent power supply arrangement.	SEPCO agreed
67	Volume-II, Section-3-VII	-	Steam Generator	Please funish all the parameters in the data sheet for other conditions also. The offer indicates the data for BMCR condition only.	SEPCO to resubmit the revised HMBDs after optimizing the heat cycle by 10.10.08. SEPCO will furnish Data sheets during detailed engineering.
68	Volume-II, Section-3-VII	-	Steam Generator	Bidder to confirm margin is available as specified in BMCR flow offered.	SEPCO has provided 5 % margin over TMCR. VWO and BMCR flow is same, no margin is provided over VWO. WPCPL explained that BMCR flow shall be 2% over VWO condition. SEPCO shall discuss with boiler manufacturer and confirm by 10.10.08
70	Volume-II, Section-3-VII	Cl. 1.02.02 Data sheet	Steam Generator	Boiler design for explosion / implosion at 67% yield strength shall be at design pressure 6600 Pa and transient design pressure 8700 Pa instead of 5500 Pa.	SEPCO confirmed compliance as per NFPA 85 standard
82	Volume-II, Section-3-III	-	Pump Curves	Please furnish characteristic Curves for BFP and CW Pumps	SEPCO to provide during detailed engineering
87	Volume-II, Section-3-III	-	Steam Turbine	Bidder to furnish max. continuous operating hours at VWO condition.	As per IEC 45 guidelines
96	Volume-II, Section-3-VII	Cl. VII-A Pg.561	Turbine Lube oil system	Please confirm 2 x 100% Vapor extraction fan, Oil cleaning (separator/centriguge), 1 x 100% AC driven Aux. Oil pump and 2 x 100% reusable oil filters for each unit of 600 MW.	SEPCO clarified that following pumps and systems are provided 1 X 100% Shaft driven Main Oil Pump, 1 x 100% AC driven Aux. Oil pump, 1 No DC driven Emergency oil pump with 2X100% oil coolers, 2 x 100% Vapor extraction fan, Oil cleaning (separator/centriguge), and 1 x 100%

SR. NO.	ITEM		VENDORS	
			Beiiing Guodian Futong Science and Technology Development Co.Ltd. is	
			Zhejiang Huaguang Electric Equipment Co,.Ltd	
7.	VERTICAL TURBINE PUMPS		LATER	
8.	HORIZONTAL CENTRIFUGAL PUMPS		~~LATER~~	
			Shanghai KSB	
			Changsha Water Pump	
			Shanghai Power Equipment Manufacture and repair Co	
9.	METERING/ DOSING PUMPS		LATER	
			Milton Roy	
10	SUMP PUMPS		LATER	
11	FUEL OIL PUMPS		Sichuan Zigong Shengda CO,.LTD	Yes
			Sichuan Fine Purication Equipment CO,.LTD	Yes
			Beijing Haishengda Pump CO,.LTD	Yes
			Zigong Dongfang Strainer Mahine Manufacture CO,.LTD	Yes
			Tianjin Pump Machinery Group	Yes
12	AIR BLOWER (LOBE TYPE)		Shandong Zhangqiu Blower Co., Ltd	
			Changsha Blower Co., Ltd	
			Zhenjiang Power Station Auxiliaiy Machinery Plant	
			Tianjin Blower Co., Ltd	
13	Carbon Steel PIPES - ERW		LATER	

SR. NO.	ITEM		VENDORS	
	c) Vibro Feeders	crushers	Shenyang Electric Power Machinery Genral Factory	Yes
			Mudanjiang Beifang Power Equipment Co,.ltd	Yes
			Shenyang Huaneng Electric Power Machinery Genral Factory Shanxi Power Equipment Works	Yes
		Vibro Feeders	Jiangsu Saimo group	Yes
			Xuzhou Sanyuan Electic M £ C Technology Co,.ltd	Yes
			Xinxiang Weiyuan Machinery CO,.LTD	Yes
			Haerbin Hetai Electicr Equipment CO,.LTD	Yes
			Wuhan Xinhuayuan Electicr Equipment CO,.LTD	Yes
			Shanxi Pulande Technology Co,.ltd	Yes
			Jilin Shuanglong Power Station Equipment Co,.ltd	Yes
		Screens	Henan Winner Vibrating Equipment Co., Ltd	Yes
			Xinxiang Gaofu Sievine Machine CO,.LTD	Yes
			Xinxiang Weiyuan Machinery CO,.LTD	Yes
4.	ASH HANDLING PLANT		Clyde Bergemann Materials Handing CO,.LTD, Shanghai	Yes
			Shanghai SINOFINN Electric Company	
			Alstom Sizhou Electric Power Equipment (Qingdao) Co., Ltd.	Yes
			Zhejiang Feida Environmenta Science & Technology CO.,LTD	
			Fujian Lonfking Environment Conservation CO,.LTD	
			~~Zhenjiang Pnuplan Pneumatic Co.Ltd~~	
	High Concentration Slurry Disposal Pump		GEHO, Netherland	
5.	Fuel OIL HANDLING PLANT		LATER	
6.	MILL REJECT HANDLING		Wuxi Huayuan Power Plant CO,.LTD	
			Jiangsu Haifeng Electric Eqipment Co,.Ltd	
			Zhejian Electric Eqipment Co,.Ltd	
			Qingdao Sizhou Boiler Eqipment CO,.LTD	

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SL. NO.	Equipments/ Services	SL. NO.	Sub-Contractors Name	Visit to vendor required
			~~Shandong luneng intelligence technology CO.,LTD.~~	
			~~Xj international engineering corporation~~	

LIST OF VENDORS – MECHANICAL-BOP

SR. NO.	ITEM		VENDORS	
1.	CONDENSATE POLISHING UNIT (Complete System)		China Huadian Engineering Co., Ltd	Yes
			SUZHOU DONGFANG WATER TREATMENT CO.,LTD	Yes
			Nanjing Zhongdianlianbao Entironment Engineering CO,.LTD	Yes
			Xian Thermal Power Research Institute Co,.ltd	Yes
			Wuhan Kaidi Water Sevice Co,.ltd	Yes
			Wuxi Huaguan Water Treatment Engineering Co., Ltd	Yes
			Shanghai Safbon Water Treatment Engineering Co., Ltd	Yes
			Beijing Zhongdian Jiamei Environment Engineering T Co., Ltd	Yes
			China Datang Technologies & Engineering Co., Ltd.	Yes
			Liaoning Yingsheng Industrial CO,.ltd	Yes
2.	WATER TREATMENT PLANT		LATER	
3.	COAL HANDLING PLANT a) Crushers b) Screens		Shanxi Power Equipment Works	
			Shandong Huiying Machinery Plant Co,.ltd	Yes

SL. NO.	Equipments/ Services	SL. NO.	Sub-Contractors Name	Visit to vendor required
			Shenyang Huadian Power Station Engineering CO,.LTD	Yes
13	Generator Transformer			
			Baoding Tianwei Baobian Electic CO., Ltd	Yes
			Xi'an Xidian Transformer Co.,Ltd	Yes
			Tebiandiangong Shengyang Transformer Group Co.,Ltd	Yes
14	Unit Auxiliary Transformer		Shandong Power Equipment Works	
15	Station Service Transformer		TBEA Xinjiang Transformer Factory	
16	Bus Duct		Jiangsui dago group Corporation	
			Beijing Power Equipment Group	
			Alfa Standard- Shandong dachi	Yes
			Fuxin Enclosed Busbar Co.Ltd	Yes
			Huapeng Group Corp.	Yes
17	Switch Gear		Tianshui chancheng	Yes
			Beijing Beikai Electric Co.Ltd	Yes
			Shandong taikaipower engineering Co.,Ltd.	Yes
			Beijing huadong electric Co.,Ltd.	Yes
			Ningbo tianan group	
			Jiangsu Changjiang Electric Co Ltd.	
			Shanghai Huatong Switchgear Co Ltd.	
			Jiangsu nanzi tonghua electrical group	Yes
			Hyundai heavy industries(china) electric Co.,Ltd.,	Yes
			Shandong huashuo	Yes
			Shanghai general guangdian engineering Co.,Ltd.	Yes
			Shandong luyitong electric Co.,Ltd.	Yes
18	Numerical Relays(400 KV)	a)	ABB	
		b)	AREVA	
		c)	SIEMENS	
			~~Nanjing nanri relays engineering technology CO.,LTD.~~	
			~~Guodian Nanjing automatism company limited; Co. Ltd.~~	
			~~Beijing sifang electric (group) Co.,Ltd.~~	
			~~GE~~	
			~~VANP~~	

SL. NO.	Equipments/ Services	SL. NO.	Sub-Contractors Name	Visit to vendor required
			Ltd.	
			hitachi-pump (wuxi)	Yes
			Ebara Boshan Pumps Co., Ltd	Yes
			Shanghai Pump Machinery Works	Yes
8	General Service Pumps		LATER	
9	Air Compressors		Shanghai Ingersoll-Rand Company	Yes
			Beijing Fusheng Machinery CO,.LTD	Yes
			Atlas Copco Group(wuxi)	
			Shanghai Feihe Industrial Group Co., Ltd	
			Kunxi Compressor CO,.LTD	Yes
10	FD Fan / ID Fan / PA Fan		Shanghai Blower Works LTD.	Yes
			Shenyang Blower Group CO.,LTD	
			Chengdu Power Mechinery Works	Yes
			Shaanxi Blower Group CO,.LTD	Yes
11	ESP (+ Fabric Filter)		Zhejiang Feida Environmenta Science & Technology CO.,LTD	Yes
			Fujian Lonfking Environment Conservation CO,.LTD	
			Zhejiang Sunyard Environment Project CO,.LTD	
12	Coal Mills & Feeders	Coal Mills	Shenyang Heavy Machinery Group Co., Ltd	Yes
			shanghai Heavy Machinery Group Co., Ltd	Yes
			Beijing Electric Equipment Works CO,.LTD	
			Changchun ~~Electric~~ Generating Equipment CO,.LTD	
		Feed ers	Shanghai Power Equipment Research Institute (SPERI),	Yes
			Jiangsu Saimo Group CO,.LTD	Yes
			Xuzhou Sanyuan Electric M&C Technolocy CO,.LTD	Yes
			Beijing Electric Equipment Works CO,.LTD	
			Shenyang Stock Electric Power Equipment CO,.LTD	Yes

SL. NO.	Equipments/ Services	SL. NO.	Sub-Contractors Name	Visit to vendor required
			Dongfang Eletric Machinery Co,Ltd	
			Dalian Hitachi Machinery & Equipment Co.,LTD	yes
			~~Hangzhou Boiler Group Co.,Ltd~~	
			~~DEC Henan Station Auxiliary Equipment CO,.LTD~~	
		Dea erato r	Shanghai Electric Power Generation Group	
			Harbin Boiler Co.,Ltd	
			Dongfang Boiler Group Co.,Ltd	
			~~Hangzhou Boiler Group Co.,Ltd~~	
			Dalian Hitachi Machinery & Equipment Co.,LTD	yes
			~~DEC Henan Station Auxiliary Equipment CO,.LTD~~	
			~~Jinan Pressure Vessel Factory~~	
			~~Qingdao Qingli Boiler Auxiliary Equipment Co.,Ltd~~	
6	a) Condensate Extraction Pumps b) Boiler Feed Pumps	Con dens ate Extr actio n Pum ps	~~Shenyang Blower Group CO.,LTD~~	
			KSB Shanghai Pumb CO., Ltd	
			Changsha Pumb CO., Ltd	
			Shanghai Pump Machinery Works	Yes
		Boile r Feed Pum ps	~~Shenyang Blower Group CO.,LTD~~	
			KSB Shanghai Pumb CO., Ltd	
			Shanghai Electric Equipment Repair Factory	Yes
			Beijing Power Equipment Works	Yes
			hitachi-pump (wuxi)	Yes
			Shanghai Power Equipment Manufacturing & Repair factory Co	
			Ebara Boshan Pumps Co., Ltd	Yes
7	Circulating Water Pumps		Shenyang Blower Group CO.,LTD	Yes
			KSB Shanghai Pumb CO., Ltd	
			Changsha Pumb CO., Ltd	Yes
			Changsha Tiane Water Pump Co.,	Yes

13. LIST OF VENDORS – MECHANICAL-BTG

SL. NO.	Equipments/ Services	SL. NO.	Sub-Contractors Name	Visit to vendor required
1	Steam Generator (Boiler)		Dongfang Boiler Group Co.,Ltd	
			Shanghai Electric Power Generation Group	
			Harbin Boiler Co.,Ltd	
2	Steam Turbine		Dongfang Steam Turbine Works	
			Shanghai Electric Power Generation Group	
			Harbin Turbine Co. Ltd	
			~~Beizhong Alstom(beijing) Electric Industries CO,.LTD~~	
3	Generator		Shanghai Electric Power Generation Group	
			Harbin Eletric Machinery Co,Ltd	
			Dongfang Eletric Machinery Co,Ltd	
			~~Beizhong Alstom(beijing) Electric Industries CO,.LTD~~	
4	HP Heaters / LP Heaters	HP	Shanghai Electric Power Generation Group	
			Harbin Boiler Co.,Ltd	
			Dongfang Boiler Group Co.,Ltd	
			~~Hangzhou Boiler Group Co.,Ltd~~	
			Dalian Hitachi Machinery & Equipment Co.,LTD.	yes
			~~Qingdao Qingli Boiler Auxiliary Equipment Co.,Ltd ?~~	
		LP	Shanghai Electric Power Generation Group	
			Harbin Turbine Co. Ltd	
			Dongfang Steam Turbine Works	
			Dalian Hitachi Machinery & Equipment Co.,LTD.	yes
			~~Hangzhou Boiler Group Co.,Ltd~~	
			~~DEC Henan Station Auxiliary Equipment CO,.LTD~~	
5	Condenser / Deaerator	Condenser	Shanghai Electric Power Generation Group	
			Harbin Eletric Machinery Co,Ltd	

VENDOR LIST DATE: 28.09.08

Bidder to confirm following points with respect to vendor selection/finalization.

1. All the vendors offered in the bid shall be manufacturer of equipments of proven design of similar size and model which shall be in satisfactory operation in at least two installations under similar operating conditions at PLF of 89% and above for a period not less than two (2) years as on the date of submission of the bid. Bidder to produce certificate for the same.
2. Vendors for all the six units for a particular item shall be same (except for Civil works). For Ex. If Vendor 'A', 'B' & 'C' is approved under Vendor list. Then, six boilers in any ratio can not be split between three vendors. All the boilers shall be provided from either Vendor 'A', Vendor 'B' or Vendor 'C'. This limitation will be applicable to all the items even for small items for which vendors are not mentioned under this list.
3. Further, Turbines & Generators shall be from same manufacturer.
4. [redacted]
5. Bidder to submit their Vendor evaluation procedure for all the equipment and works to be carried out under this project. [redacted]
6. Bidder to confirm that all the contract along with data sheets of sub-vendors will be sent for approval to the owner before ordering.
7. EPC contract along with necessary details shall be handed over to the sub-vendor before placement of order.
8. Approved Vendor list for complete Instrumentation package is attached herewith. Any Vendor outside this list will not be entertained.
9. Approved Vendors for some of the electrical items are indicated in the following items which shall binding for that particular equipment.
10. Any deviation from approved drawings or vendor shall be taken prior approval. With out drawing approval, equipments shall not be shifted to the site or dispatched. In case, Bidder proceeds with such deviation for ordering, such equipment or vendors will be rejected outright.
11. [redacted]
12. Bidders shall give preference to those parties who have technical collaboration with reputed international manufacturers.

29/9/08 BBarbade

ANNEXURE-M

Sr. No.	Test Samples	Design Raw Water Analysis
34	Manganese as Mn, mg/l	<0.01
35	Chromium as Cr, mg/l	<0.01
36	Copper as Cu, mg/l	<0.01
37	Nickel as Ni, mg/l	<0.01
38	Zinc as Zn, mg/l	<0.01
39	Aluminium + as, mg/l	<0.01
40	Cadmium as Cd, mg/l	<0.01
41	Arsenic as As, mg/l	<0.01
42	Boron as B, mg/l	0.05
43	Mercury as Hg, mg/l	<0.001
44	Lead as Pb, mg/l	<0. 01
45	Dissolved Oxygen, mg/l	6
46	Cyanides as CN, mg/l	<0.01
47	Fluoride as F, mg/l	0.5
48	Barium as Ba, mg/l	Nil
49	Strontium as Sr, mg/l	<0.01
50	Total Kjeldahl Nitrogen, mg/l	1
51	Vanadium as V, mg/l	<0.01
52	Selenium as Se, mg/l	<0.01

ANNEXURE-M

DESIGN RAW WATER ANALYSIS REPORT FOR 3600 MW POWER PLANT AT NARIYARA

Sr. No.	Test Samples	Design Raw Water Analysis
1	Colour (Pt Co Units)	20
2	Temperature °C	27
3	pH Value	8.4
4	Odour	Un-objectionable
5	Total Suspended Solids, mg/l	1500 (During Monsoon)
6	Turbidity NTU	1000 (During Monsoon)
7	Residual free chlorine / oxidants	Nil
8	Total Dissolved Solids, mg/l	400
9	E C (micro Siemens/cm)	600
10	Total Hardness as $CaCO_3$, mg/l	185
11	Calcium hardness as $CaCO_3$, mg/l	115
12	Magnesium Hardness as $CaCO_3$, mg/l	70
13	Sodium as Na, mg/l	30
14	Potassium as K, mg/l	5
15	Carbonate hardness as $CaCO_3$, mg/l	185
16.	Non carbonate hardness as $CaCO_3$, mg/l	Nil
17	Alkalinity to Phenolphthalein as $CaCO_3$, mg/l	Nil
18	Alkalinity to methylorange as $CaCO_3$, mg/l	185
19	Sulphate as SO_4, mg/l	35
20	Chloride as Cl, mg/l	22
21	Nitrate as NO_3, mg/l	3
22	Sulphide as H_2S, mg/l	0.01
23	Phosephates as PO_4, mg/l	0.03
24	Reactive Silica as SiO_2, mg/l	14
25	Colloidal silica, mg/l (Non-reactive)	8
26	BOD_5, mg/l	7
27	COD, mg/l	35
28	T O C	-
29	Phenol/any other aromatic hydrocarbons	<0.01
30 a	Oil & grease, mg/l	<1
b	Free floating, mg/l	<1
c	Emulsified, mg/l	<1
31	Carbon dioxide as CO_2, mg/l	0.9
32.	Free ammonia, mg/l	Nil
	HEAVY METALS :	
33	Total Iron as Fe, mg/l	<0.5

SR. NO.	ITEM		VENDORS	
14	Carbon Steel / Alloy Steel PIPES - SEAMLESS		LATER	
15	CAST IRON PIPES		LATER	
16	CS PIPES (SPIRAL WELDED/ LONGITUDINAL WELDED)		LATER	
17	BUTTERFLY VALVES (MANUAL/PNEUMATIC)		LATER	
18	DIAPHRAGM VALVES (MANUAL/ PNEUMATIC)		LATER	
19	PLUG VALVE		LATER	
20	CAST IRON GATE / GLOBE / CHECK VALVE		LATER	
21	CAST STEEL VALVES		LATER	

SR. NO.	ITEM		VENDORS	
22	FORGED STEEL VALVE (UPTO 50NB SIZE)		LATER	
23	BALL VALVES		LATER	
24	RO SYSYTEM a) RO Membrane b) UF Membrane c) HP Pumps		LATER HP Pumps : only Grundfoss	
25	WASTE WATER TREATMENT PLANT		LATER	
26	FLANGES & FITTINGS		LATER	
27	GUN METAL /BRASS / BRONZE VALVE		LATER	
28	SAFETY RELIEF VALVE		LATER	
29	STRAINERS		Zigong Vacuum Strainer Equipment CO,.ltd	
			Zigong Chuanlv Mahine Manufacture CO,.LTD	
			Zigong Dongfang Strainer Mahine Manufacture CO,.LTD	
			Qingdao Huatai Electric Equipment Co.,Ltd	

SR. NO.	ITEM		VENDORS	
30	AIR DRYING UNIT (Refrigerant Type)		LATER	
31	ELEVATOR		Shanghai Xunda elevator co,.ltd	Yes
			Xizi otis elevator co,.ltd	Yes
			Changzhou Elevator Factory Co., Ltd.	Yes
			Shanghai Building Equipment Co.,Ltd.	Yes
			Hitachi Elevator (China) Co.,Ltd.	Yes
			Shanghai Mitsubishi Elevator Co.,Ltd.	Yes
31A.	EOT CANE (More than 100 Ton)		Shandong Finehope Group CO,,LTD	
31B.	EOT CRANE (Less than 100 T)		LATER	
32.	MANUAL HOIST & CHAIN PULLEY BLOCK		LATER	
33.	ELECTRICAL HOIST		LATER	
34.	PAINTS		LATER	

SR. NO.	ITEM		VENDORS	
35.	GEAR BOX		LATER	
36.	PRESSURE REDUCING VALVE		LATER	
37.	OIL / STEAM HOSES		LATER	
38.	FLAME ARRESTER		LATER	
39.	STEAM TRAP		LATER	
40.	FLUID COUPLING (SCOOP TYPE)	a)	VOITH, Germany ~~LATER~~	
41.	FLUID COUPLING (TRACTION TYPE)		LATER	
42.	FLEXIBLE COUPLING		LATER	
43.	INSULATION		LATER	

SR. NO.	ITEM		VENDORS	
46.	HYDRAULIC ACTUATOR / CYLINDER		LATER	
45.	PNEUMATIC ACTUATOR / CYLINDER		LATER	
46.	POWER PACK		LATER	
47.	**FIRE FIGHTING EQUIPMENT**		**- complete system from TYCO/ Vijay Fire/ Tecnofab / Newfire / Techno Fire**	
	PUMPS		Mather & Platt	
			Kirloskar Brothers Limited	
			Worthington Pumps India Limited	
			Flowmore	
B	HIGH VELOCITY NOZZLES			
C	MEDIUM VELOCITY NOZZLES			
D	DELUGE VALVE		Shah Bhogilal	
			Technico(I) Pvt Ltd	
E	FIRE HOSE			
F	DETECTORS (IONISATION)		Kiddie	
			Tyco	
G	DETECTOR PHOTO ELECTRIC			

SR. NO.	ITEM		VENDORS	
H	HEAT DETECTOR (Fire Sensor)			
I.	WATER MONITORS			
J.	BRANCH PIPES & NOZZLES			
K.	FIRE FIGHTING SYSTEM			
L.	L.D. PIPING			
48.	COAL HANDLING EQUIPMENT			
A	STACKER RECLAIMER		Shenyang Heavy Machinery Works	Yes
			Changchun Electric Equipment CO,.LTD	
			DHI·DCW Group Co., Ltd.	Yes
B	INTEGRAL WEIGH BRIDGE		LATER	
C	APRON FEEDER		LATER	
D	IMPACTOR / CRUSHER		LATER	

SR. NO.	ITEM		VENDORS	
E	MAGNETIC SEPARATOR		Fushun Longji Electiromagnetic Separators Factory CO,.LTD	
			Shandong Huate Electiromagnetic Separators Factory CO,.LTD	
			Zhenjiang Electiromagnetic Separators Factory CO,.LTD	
			Zhenjiang Jiangnan Electromechanical Mining Equipment Co., Ltd	
			Zhenjiang Hongxing Magnetic Plant CO,.LTD	
F	ELECTRIC BELT WEIGHER		Xuzhou Sanyuan Electric M&C Technology CO,.LTD	
			Zhejiang Hangzhou Drilling Machine Manufactory CO,.LTD	
			Beijing TONYTECH Science CO,.LTD	
			Jiangsu Saimo Group	
			Jinan Jinzhong Electronic Scale Co., Ltd.	
G	CONVEYOR BELT (Fire resistant)		~~Shandong Shankuang Machinery CO,.LTD~~	
			Tangshan Mining & Metallurgical Machinery Plant	Yes
			Northern Heavy Shenyang Mining Machinery Group Co.,Ltd	Yes
			Hengyang Conveying Machinery CO,.LTD	Yes
H	IDLERS		LATER	
I	PULLEYS		LATER	

SR. NO.	ITEM		VENDORS	
J	WOBLER FEEDER		LATER	
K	PADDLE FEEDER		LATER	
L	FLAP GATE		LATER	
M	a) DUST EXTRACTION SYSTEM b) DUST SUPPRESSION SYSTEM		LATER	
N	DRY FOG DS SYSTEM		LATER	
O	WATER MONITORS		LATER	
P	ULTRASONIC BUNKER LEVEL INDICATOR		LATER	
Q	METAL DETECTOR		Fushun Longji Electiromagnetic Separators Factory CO,.LTD	

SR. NO.	ITEM		VENDORS	
			Shandong Huate Electiromagnetic Separators Factory CO,.LTD	
			Zhenjiang Electiromagnetic Separators Factory CO,.LTD	
			Zhenjiang Jiangnan Electromechanical Mining Equipment Co., Ltd	
			Zhenjiang Hongxing Magnetic Plant CO,.LTD	
R	BELT CLEANER		LATER	
S	HOLD BACK		LATER	
T	BEARINGS		LATER	
U	IMPACT PADS		LATER	
V	HYDRAULIC MOTORS & POWER PACK		LATER	
W	BELT SCRAPERS		LATER	

49.	ASH HANDLING PLANT EQUIPMENT		

A	CASTABLE REFRACTORY		Clyde Bergmann Huatong Materials Handing Company Limited Shanghai SINOFINN Electic Engineering CO,.LTD Guangdong Foushan Pump Works Hubei TFHI-TECH Pump CO,.LTD Gardner Denver Nash Machine CO,.LTD	Yes
B	POROUS TILES			
C	KNIFE GATE VALVES (CHUTE ISOLATION)			
D	KNIFE GATE VALVES (SLURRY DUTY)			
E	PLUG VALVE (SLURRY DUTY) (FULL BORE, REGULAR PATTERN)			
F	CONVEYING COMPRESSOR		Atlas Capco Shanghai Feihe Industrial group Co Ltd.	
G	FLUIDISING BLOWER			
H	a) TUBE SETTLER			
	b) PLATE SETTLER			
I	BASALT LINED FITTING AND PIPING.			

	DRC LINING			
J	METALLIC EXPANSION BELOWS			
K	SLURRY PUMPS			
L	HIGH CONC. SLURRY DISPOSAL PUMPS (Piston Diaphram pumps)	A B	GEHO,Netherland	
M	ACI FITTINGS /CASINGS /LINERS			
N	BAG FILTERS / VENT FILTER			
O	VACUUM PUMP			
P	AIR HEATER			
Q	CONVENTIONAL TYPE CLARIFIER			

50	AIR CONDITIONING/ VENTILATION EQUIPMENT			
A.	VENTILATION SYSTEM		Guangdong Shenling Air-Conditiong CO,.LTD Jiangsu Jiangping AC purification equipment Ltd. Dezhou Yatai Group Guangdong Jirong Air-Conditioning Equipment Co.,LTD Shandong Zhongda Air-Conditioning Equipment Co.,LTD Shanghai King Industry Co., Ltd Nanjing Wuzhou Refrigeration Group Co., Ltd Jiangsu Shuangyi Group Changzhou Kwell Cooling Equipment Co., Ltd Zhejiang Lianfeng Stock Co., Ltd Jiangsu Seagull Cooling Tower Co., LTD	
B	i) REFRIGERATION RECIPROCATING COMPRESSOR II) VAPOUR ABSORPTION CHILLER			
C	CONDENSER & CHILLER			
D	COOLING COILS			
E	AIR HANDLING UNITS			
F	CONDENSER CHILLED WATER PUMPS			

G	FRESH AIR BLOWERS / FANS			
H	AIR FILTER			
I	COLD INSULATION MATERIAL			
J	FAN COIL UNITS			
K	BEARINGS			
L	V. BELTS & PULLEY			
M	FALSE CEILING MATERIAL			
N	MOTORISED DAMPERS			
O	COOLING TOWERS			
P	FIRE DAMPER			

Q	MIXING VALVES			
R	MODULATING MOTORS			
S	MODULATING THERMOSTAT			
51	CONDENSER ON-LINE TUBE CLEANING SYSTEM AND DEBRIS FILTER		LATER	

LIST OF VENDORS – ELECTRICAL

SL. NO.	ITEMS		VENDORS	Visit Vendo Requir
1.	MOTOR ACTUATORS	a	ROTORK	
		b	AUMA	
		c	LIMITORQUE	
			~~Yangzhou Electric Power Equipment Repair & Manufacture Factory~~	
			~~EMG~~	
			~~SIPOS~~	
			~~Shanghai Automation Instrumentation Co.Ltd~~	
			~~Chongqing Chuanyi Instrument Complex Co. Ltd.~~	
			~~Yangzhou hengchun~~	
			~~Changzhou power station auxiliary equipment works Ltd.~~	
			~~Wenzhou ruiji~~	
			~~Yangzhou Electric Power Equipment Repair Manufacture Factory~~	
			~~Yangzhou Lianggong~~	
			~~Tianjin Jinda~~	
			~~Shanghaoi Autork~~	
2.	DRY TYPE TRANSFORMERS		Shandong luneng mount.tai electric equipment CO.,LTD.	YES
			Jiangsui daqo group Corporation	
			Hainan jinpan electric	YES
			CEEG	YES
			Shandong jinmanke electric	YES
			TBEA tianjinshi transformer group CO.,LTD	

SL. NO.	ITEMS		VENDORS	Visit t Vend Requir
			Shandong luneng rihe holdings CO.,LTD.	YES
			Shandong luneng mount.tai electric equipment CO.,LTD.	YES
3.	OIL FILLED POWER TRANSFORMER		Baoding Tianwei Baobian Electic CO., Ltd	Yes
			Xi'an Xidian Transformer Co.,Ltd	YES
			Tebiandiangong Shengyang Transformer Group Co.,Ltd	YES
			TBEA Xinjiang Transformer Factory	
			Shandong Power Equipment Works	YES
4.	MOTOR 415 V, 6.6 kV, 11 Kv		Shanghai Electric Co.	
5.	LT POWER AND CONTROL CABLES		LATER	
6.	HT POWER CABLE		LATER	
7.	VFD (LT / HT)		ABB	

SL. NO.	ITEMS	VENDORS	Visit Vend Regu..
		L & T	
		Siemens	
8.	TRANSDUCER	LATER	
9. a	Isolated Phase Bus Duct	Jiangsui daqo group Corporation	
		Beijing Power Equipment Group	YES
		Alfa Standard- Shandong dachi	YES
		Fuxin Enclosed Busbar Co.Ltd	YES
		Huapeng Group Corp.	Yes
9. b	LT Bus Duct	Jiangsui daqo group Corporation	
		Beijing Power Equipment Group	YES
		Alfa Standard- Shandong dachi	YES
		Fuxin Enclosed Busbar Co.Ltd	YES
		Huapeng Group Corp.	YES
10.	BATTERY	LATER	
11.	BATTERY CHARGER	LATER	
12.	PROTECTION RELAYS FOR SWITCHGEAR	ABB	
		ALSTOM	
		AREVA	
		SIEMENS	
		~~Dongda jinzhi~~	
		~~Nanjing nanri relays engineering technology CO.,LTD.~~	
		~~Guodian Nanjing automatism company limited; Co. Ltd.~~	
13.	THERMAL O/L RELAYS	LATER	

SL. NO.	ITEMS	VENDORS		Visit t Vendo Requir
14.	a) TARIFF METER b) INDICATING METER	a	Securemeter, India	
		b	Enercon, India	
			Automatic Electric India	
15.	CT 400 KV		ABB, China	
			Siemens, China	
			Areva, China	
16.	PT 400 KV		ABB, China	
			Siemens, China	
			Areva, China	
17.	POWER SWITCH		LATER	
18.	SELECTOR SWITCH		Salezer, India	
19.	TIMERS		LATER	
20.	FUSES		LATER	
21.	MCCB		LATER	

SL. NO.	ITEMS	VENDORS		Visit Vend Regu
22.	MCB		LATER	
23.	NUMERIC RELAY FOR LT SWTICHGEAR		LATER	
24.	NUMERIC RELAY FOR 6.6 KV		LATER	
25.	LIGHTING FIXTURES		LATER	
26.	DIESEL GENERATOR		Cummins	
			Stanford	
			Perkins	
			Volvo	
			DEUTZ	
			VERYPOWER	
			KOHLER	
27.	LT PCC & MCC		Beijing Beikai Electric Co.Ltd	Yes
			Shandong taikaipower engineering Co.,Ltd.	Yes
			Beijing huadong electric Co.,Ltd.	Yes
			Ningbo tianan group	
			Jiangsu Changjing Electric Co. Ltd	
			Shanghai HuatongSwitchgear Co Ltd.	
			Jiangsu nanzi tonghua electrical group	Yes
			Hyundai heavy industries(china) electric Co.,Ltd.	Yes
			Shandong huashuo	Yes
			Shanghai general guangdian engineering Co.,Ltd.	Yes
			Shanghai power transmission&distribution CO.,LTD.	Yes
			Shandong luyitong electric Co.,Ltd.	Yes
28.	UPS system		Acpower	
			Cnc group	
			Gutor	
			LDC power	
			Emerson	
			PCM	

SL. NO.	ITEMS	VENDORS	Visit t Vend Requir
29.	400kV Circuit Breaker	ABB	
		AREVA	
		SIEMENS	
		~~New Northeast Electric(Shenyang)High voltage Switchgear Co.,Ltd.~~	
		~~Henan pinggao electric sales ltd.~~	
		~~Xian xd high voltage apparatus CO.,LTD.~~	
30.	400kV Disconnecting Switch	LATER	
31.	400kV Current Transformer	LATER Refer Sr. No. 14	
32.	400kV Voltage Transformer	LATER Refer Sr. No. 15	
33.	400kV Insulator	LATER	
35.	400kV Lightning Arrester	LATER	
40.	400kV CVT	ABB Siemens Areva	
41.	Switchyard SCADA	LATER	
42.	PLCC	ABB Model ETL 41 0r 42	
43.	400kV Wave Trap	LATER	

LIST OF VENDORS – CONTROL & INSTRUMENTATION

Sr. No.	Item	Sub-vendor
1.	DCS	ABB, WESTINGHOUSE, FOXBORO, ~~YOKOGAWA, TOSHIBA, Siemens, GE, EMERSON~~
2.	PLC	ALLEN BRADLEY, SIEMENS, SCHNEIDER, MODICON
3.	Pressure/DP transmitter	ROSEMOUNT, HONEYWELL, ABB, YOKOGAWA, ~~SIEMENS~~, ~~FOXBORO~~
4.	Level transmitter	E & H, SOR, MOBREY, MAGNETROL,~~FOXBORO~~

5.	Temperature/pressure gauge	WIKA, GLUCK, BOURDAN, ASHCROFT/CHINESE MAKE,ASHCROFT
6.	Temperature element	DEGUSSA, OMEGA/CHINESE MAKE
7.	DP/Flow/Level switch	MAGNETROL, E & H, SOR, UE
8.	Temperature/Pressure switch	SOR, UE, ~~DANFOSS,ASHCROFT~~
9.	Control valve	A)~~LATR~~ FISHER, MASONEILAN,COPES,CCI,HOPKINSON B) Non-Critical applications: CHINESE MAKE(OWNER APPROVAL IS REQUIRED)
10.	Solenoid valve	ASCO, HERION , SMC , Rexroth
11.	Mass flowmeter	ROSEMOUNT, E & H, KROHNE, YOKOGAWA
12.	Magnetic/Vortex flowmeter	ROSEMOUNT, E & H, KROHNE, YOKOGAWA
13.	Tank gauging	Later
14.	Analyzer	POLYMETRON, EMERSON, KROHNE, E&H
15.	Electric actuator	ROTORK
		AUMA
		LIMITORQUE
		~~Yangzhou Electric Power Equipment Repair & Manufacture Factory~~
		~~EMG~~
		~~SIPOS~~
		~~Shanghai Automation Instrumentation Co.Ltd~~
		~~Chongqing Chuanyi Instrument Complex Co. Ltd.~~
		~~Yangzhou hongchun~~
		~~Changzhou power station auxiliary equipment works Ltd.~~
		~~Wenzhou ruiji~~
		~~Yangzhou Electric Power Equipment Repair Manufacture Factory~~
		~~Yangzhou Lianggong~~
		~~Tianjin Jinda~~
		~~Shanghai Autork~~
16.	EWLI	~~LATER~~ HYDRASTEP,KEYSTONE,YARWAY
17.	CEMS	AMETEK H&B, SICK,ABB,DURAG , ~~siemens~~
18.	TSI -Vibration monitoring & Analysis	BENTLEY NEVADA, BNC-3500 & SYSTEM-1 , ~~strongwish~~
19.	EPABX / PA system	Later
20.	SWAS	POLYMETRON, EMERSON, KROHNE, E&H,
21.	Flow Nozzle / Orifice / Aerofoil	Later
22.	Anubar / Pitot tube	Later
23.	CC TV	Later
24.	Turbine Bypass System	~~Later~~ CCI,
25.	PRDS	~~Later~~ CCI,
26.	Gravimetric Feeders	~~Later~~ STACK

27.	Panels / Cabinets	Later
28.	Ambient Environment Monitoring System	~~Later~~ EMERSON, ABB,

LIST OF CONTRACTORS – CIVIL WORKS

Sr. No.	Item	Contractor
1.	Main Plant	L&T, GDC, SIMPLEX
2	Non-Plant	L&T, GDC, IVRCL, INDU Projects, SIMPLEX, PETRON, NCC
3	NDCT	L&T, GAMMON, NBCC
4	Chimney	L&T, GAMMON, NBCC

LIST OF CONTRACTORS – Erection & Commissioning

Sr. No.	Item	Contractor
1.	BTG	L&T, Universal Erectors, Indwell, Petron, Tata Projects
2	Mechanical - Balance of Plant	L&T, Universal Erectors, Indwell, Petron, Tata Projects, SPICGEL
3	400 kV Switchyard	L&T, ABB, Areva, Siemens, CGL
4	Electrical – Main plant & BOP	L&T, Tata Projects, ABB, Areva, Siemens, CGL
5	C&I	L&T, Tata Projects, Petron, Chemin, Technimont-ICB