



NFCL Fertilizer Plant Technical Due Diligence

Final Report

16 September 2021
Confidential

Final Report

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1 Introduction

1.1 The Client

IDBI Bank (hereinafter 'Bank' or 'Client') was established under Industrial Development Bank of India Act, 1964 to provide credit and other financial facilities for the development of the fledgling Indian industry. It has 1,995 branches, including one overseas branch at Dubai, and 1382 centres.

1.2 About the Project

Nagarjuna Fertilizers & Chemicals Limited (NFCL or the Company), is a leading manufacturer and supplier of plant nutrients in India. The Company has urea production capacity of 1.19 MMTPA and provides Farm Management services and Micro Irrigation solutions. The Company is operating a natural gas-based fertilizer complex at Kakinada, Andhra Pradesh which consists of HTAS technology based 2x1050 TPD Ammonia unit and Saipem technology based 2x1810 TPD urea unit along with required offsite and utility facilities including captive power generation units.

IDBI Bank Limited ("IDBI" or the "Bank") is the lead lender in the consortium of lenders for the Company. The Company is facing financial stress and evaluating various options for Debt settlement of the Company, one of the critical measures is to take necessary steps in relation to assess the technical capability of the Company and potential to meet energy norms and target set by Department of Fertilizers. The scope involves technical assessment of plant, capacity and asset conditions. In this context NFCL has approached Mott MacDonald Private Limited (hereinafter referred to as 'MM' or 'the Consultants') to provide their services for carrying out technical due diligence study. In this regard, MM is pleased to submit the draft technical due diligence report.

1.1 Mott MacDonald in India

For over 45 years Mott MacDonald has been at the forefront of management, engineering and development consultancy in India. With over 1400 staff engaged in planning, developing and delivering projects from six (Ahmedabad, Bangalore, Chennai, Hyderabad, Mumbai and Noida) principal offices and over 45 project offices, we are working on a range of projects in the industry, transport, water, buildings, energy, environment, health, education, communications, climate resilience and institutional development sectors.

We provide an array of key services in the entire project development cycle for India's major markets – from business case planning to design engineering, project management and post commissioning assistance. We do this through innovative thinking and by mobilising cross-sector, international perspectives, drawing on the immense talent and energy of our people – designers, engineers, project and programme managers, management consultants, environmentalists, planners, economists, business strategists, infrastructure finance advisors, public private partnership experts, cost consultants, low carbon specialists, technology experts, safety advisors, health and education specialists, development policy advisors and more.

Our Indian business is the Group's lead focus of industrial expertise, especially in chemicals, pharmaceuticals, automobiles, FMCG and textiles where we lead the field in business case planning, business conceptualization, strategy, financial and demand modelling, engineering design, project management, and procurement and validation services.

Finding opportunities in complexity, turning obstacles into elegant, sustainable solutions, we aim to add value at every stage, for our clients – national and local governments, public and private utilities, industrial and commercial companies, investors, developers, banks and financial institutions, international as well as bilateral funding agencies and private entrepreneurs.

With our best technical skills and thought leaders bringing international best practice to enhance value for our clients, stakeholders and society, we respond to even the shortest lead times with a fast track, quality-focused approach on landmark Indian projects like Delhi Metro, Delhi International Airport, Dedicated Freight Corridor, Sustainable Urban Transport Project, Karnataka Urban Development and Coastal Environmental Management Project, Uttarakhand Urban Sector Development Investment Program, over 1000 industrial and many a social development projects..

1.1.1 Contact Details of Main Offices

Table 1.1: MM Main Offices in India

S. No.	Main Offices	Address	Phone/Fax
1	Mumbai (Head Office)	Unit No. 101, 1st Floor, Nomura Building, Hiranandani Gardens, Powai, Mumbai - 400 076, Maharashtra, India	+91 (0)22 4908 0100
2	Ahmedabad	301/A, 3rd Floor, Block-A, Westgate Business Bay, S.G. Highway, Makarba, Ahmedabad - 380 051	+91 (0)79 4911 1600
3	Bangalore	315 Work Avenue Spaces, 5th Floor, Block N1 Balsa, Embassy Manyata Business Park, Outer Ring Road Bengaluru 560045	+91 (0)80 4641 6416
4	Chennai	Ground Floor, Block No. 8, 1/124, Shivaji Gardens, DLF-SEZ, Mount Poonamallee Road, Ramapuram, Manapakkam Chennai 600 089	+91 (0)44 3054 2700
5	Delhi-NOIDA	5/6th Floor, Logix Techno Park, Tower C, Plot 5, Sector 127, Noida, Uttar Pradesh 201301	+91 (0)120 254 3582
5	Mumbai	Unit No. 101, 1st Floor, Nomura Building, Hiranandani Gardens, Powai, Mumbai - 400 076, Maharashtra, India	+91 (0)22 4908 0100

Source: MM

Mott MacDonald globally follows STEP system for delivering projects. The same has been adopted for delivering the Project. Under the STEP system, the Project Manager and Project Principal are responsible for successful delivery of the Project. In case there is a need for escalation, the contact details are provided in Table 1.2.

Table 1.2: Organisation Profile and contact details

Name	Mott MacDonald Private Limited
Parent Company	Mott MacDonald, UK
Registered Address	Unit No. 101, 1st Floor, Nomura Building, Hiranandani Gardens, Powai, Mumbai - 400 076, Maharashtra, India
Address for Correspondence	Unit No. 101, 1st Floor, Nomura Building, Hiranandani Gardens, Powai, Mumbai - 400 076, Maharashtra, India
Number of Years of Existence	50 years
Contact Name	Mr. Hitesh Dama - Account Leader
Phone	+91-99204 45512
Email	hitesh.dama@mottmac.com

Source: MM

1.2 Ethics Policy

The Group Board is committed to promoting the highest standards of ethical behaviour and requires employees to act according to our ethical principles. Offering, giving, solicitation or acceptance of any bribe, whether cash or any other inducement or engaging in any other corrupt practice is strictly prohibited.

We undertake appropriate due diligence in evaluating business partners to assess risk and avoid dealing with prospective partners where there is any suspicion of corruption. We seek contractual arrangements with major suppliers that allow us to withdraw from the contract in the event of unethical business practices.

1.3 Scope of Work

1.3.1 Study Objective

The objective of the assignment is to conduct the technical due diligence of the two ammonia-urea units with an annual capacity of 5,97,300 MTPA (330 stream days) each – reassessed by Government.

1.3.2 Scope of Work

Consultants envisage following tasks to address the scope of work –

- Physical verification of the two manufacturing units, assessment of current operating condition of the units
- Plant condition based on maintenance and downtime records of the major critical equipment
- Review and assessment of the maintenance and energy saving capital expenditure plan based on the Saipem Energy Reduction study and Life assessment study report, items approved by Board and data information provided by the Company

1.4 Approach & Methodology

1.4.1 Approach

- In approaching this assignment, MM will undertake the assessment of the Company's assets, with a view to ascertain material issues and risks. Assuming that all relevant documents are made available when MM is given instruction to proceed, MM will provide a review of the project as envisaged in the scope of services, and highlight any issues giving MM cause for concern in the draft report.
- Following issue of the draft report MM will work with the Client and the Company to resolve issues raised on the draft report to finalise the report after going through the documents in further details.
- MM envisage commencing the work with discussions with the Client and Company and then undertaking analysis of documents in our offices, followed by visit to the sites, leading to issue of the draft report.
- A detailed methodology adopted for various components involved during this stage is explained in the subsequent sections.

1.4.2 Methodology

- The Company will provide complete details including without being limited to, detailed project report, business plan, critical contracts and agreements, complete project cost break-up, techno-commercial quotations, annual reports, existing operations MIS data, historical

financial statements (in MS excel), list of equipment, raw material, spares, manpower details, repairs and maintenance schedules along with cost for past 5 years, breakdown details (existing ops), capex requirement etc. prior to and during the assignment. The consultant will rely upon this information for this exercise.

- The Consultant will critically assess the asset condition through Saipem Energy Reduction study and Life assessment study report, items approved by Board and data information provided by the Company. Further plant condition based on maintenance and downtime records of the major critical equipment.
- The approach for this assignment, the Consultant would undertake technical evaluation of the project to a level appropriate to validate the aspects covered in Scope of Work.
- It is considered that the Consultant shall be provided with all the relevant documents after receipt of LOI / Work Order, the Consultant shall provide a review of the project with respect to the scope of work and highlight major issues of concern in the draft report.

1.5 Caveats

- Notwithstanding the vaccination drive and the recent tapering of the more severe second wave of Covid-19 infections, warnings are being issued about a likely third wave soon. Hence uncertainty persists. The extent of uncertainty and its impact on estimated timelines and costs remain cannot be assessed presently.
- This report is based on the information and particulars furnished with MM by NFCL. The report reflects MM's best estimate of prevailing conditions, policies, practices and its professional judgement based on the explanations and information made available to MM. Hence MM is limited by the accuracy of data provided.
- The inferences and opinions presented, and conclusions expressed in this report are of the nature of Opinion only. These should not be construed as our "Guarantee" or "Undertaking". No professional liability in this respect is either implied or accepted by MM.
- The Consultants are not offering or inviting or advising any entity to invest on the basis of this Report. The conclusions drawn on the basis of this Report will be that of the entity and the Consultants do not assume any responsibility of whatsoever nature merely by providing the Report. Neither the Consultants nor any representative or employee of the Consultants accepts any liability.
- The success of the Project in meeting the energy norms is contingent upon endorsement of validity/ guarantee of technical scheme suggested by Saipem – Process Licensor – in their 2016 assessment, even now. Any deviations could have a corresponding impact on the cost and timelines.

2 Technical Assessment

2.1 Introduction

Nagarjuna Fertilizers and Chemicals Ltd. (NFCL) is operating a Natural gas-based fertilizer complex at Kakinada, Andhra Pradesh which consists of HTAS technology based 2x1050 TPD Ammonia unit and Saipem technology based 2x1810 TPD urea unit along with required offsite and utility facilities including captive power generation units. Brief details of the plant is given in Table 2.1

Table 2.1: Plant Details

S. No	Particulars	Description		
1	Location	Kakinada, Andhra Pradesh – 533003		
2	Land Area	1040 acres		
4	Products manufactured and Capacity (MTPD)	Capacities	Installed	GoI Reassessed
		Ammonia	2 x 900	2 x 1050
		Urea	2 x 1500	2 x 1810
5	Year of Commissioning of Plant	Plant 1 – 1992 Plant 2 – 1998		
6	Plant Facilities	Water treatment plant, DM water plant, Inert gas plant, Cooling tower, Steam & power generation, Effluent treatment plant, Ammonia storage, urea silo, bagging building, Railway siding		

Source: NFCL

For the purpose of analysis in this report, we have considered reassessed capacity as the basis.

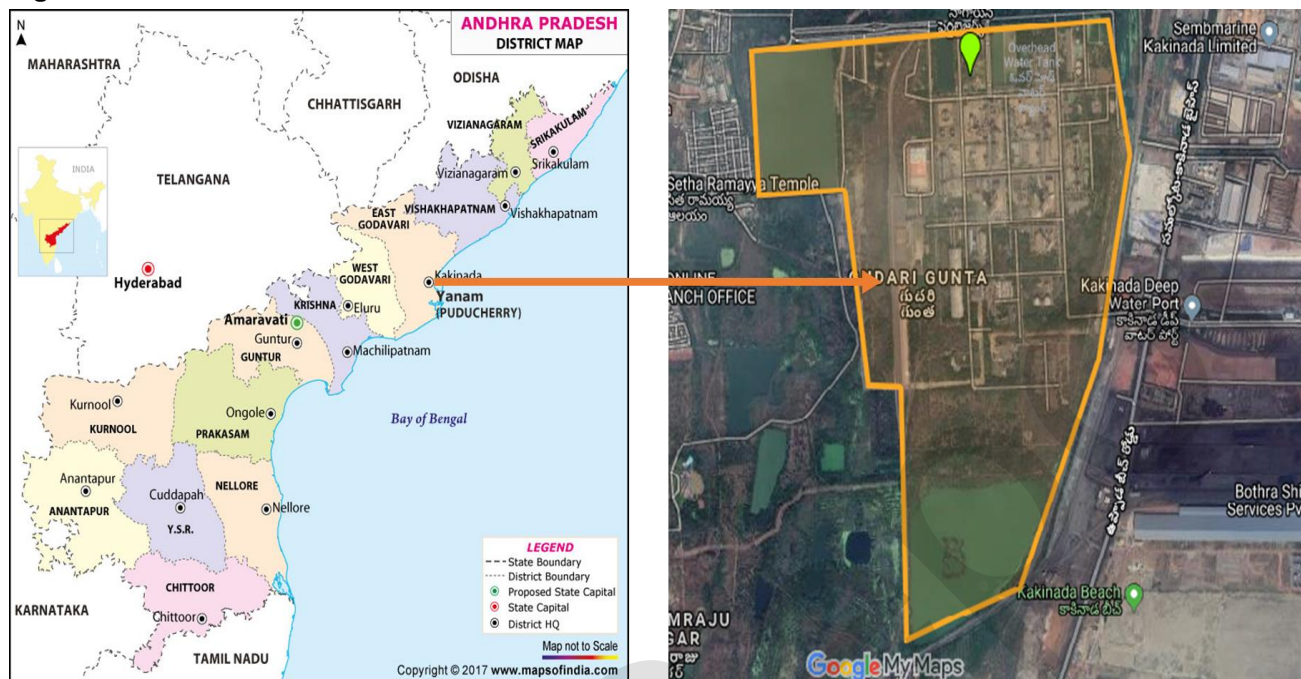
2.2 Plant History

NFCL started its urea fertilizer production in the year 1992 with 1500 TPD urea unit and 900 TPD ammonia unit with natural gas as the feedstock. In 1998, the capacity was enhanced by setting up another set of 900 TPD ammonia and 1500 TPD urea units but with an advantage of using both Naptha / natural gas as feedstock. Between 2007 to 2009, based on Government of India directive, the feed and fuel were switched over from Naphtha to Natural gas, along with installation of a 450 TPD carbon dioxide recovery unit. Along with this, failed and a few limiting equipment were replaced. After that, by operating the plant at more than 330 days per annum, after taking in account all engineering safety margins, NFCL was able to push maximum average production capacity to 2650 MTPD for Ammonia and 4606 MTPD for Urea till GAIL pipeline accident in 2014.

2.3 Location Assessment

The location of the plant is depicted in Figure 2.1.

Figure 2.1: Plant Location



Source: Google Maps

Table 2.2: Site Connectivity

S.no.	Particular	Description	Approx. Distance in km
1	Nearest Major City	Vishakhapatnam	159
2	Nearest Highway	NH 216	12
3	Nearest Railway Station	Kakinada Town Junction	5
4	Nearest Airport	Rajahmundry Airport	66
5	Nearest Port	Kakinada Port	5

Source: Google Maps

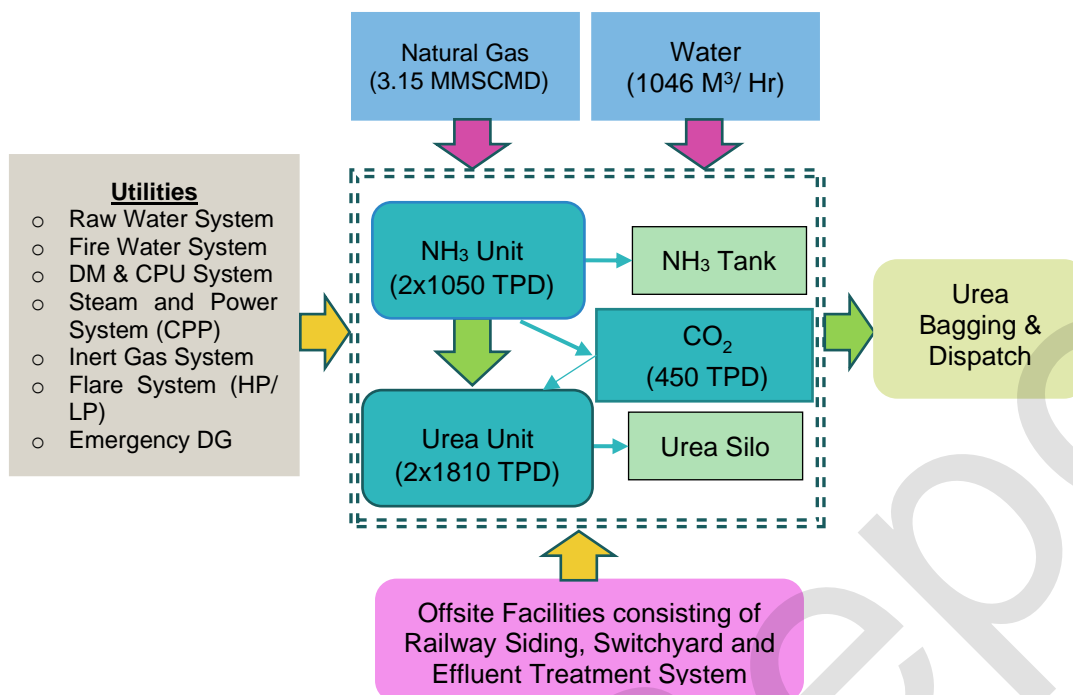
2.4 Plant Configuration

Plant consists of following units and facilities

- Ammonia unit – 1 & 2
- Urea unit – 1 & 2
- CDR unit
- GTG /HRSG Offsite units
- Utility units

The project configuration of NFCL is as depicted in Figure 2.2.

Figure 2.2: Project configuration



2.5 Raw Material

2.5.1 Gas

Source for ammonia as well as the gas turbine units is natural gas. Auxiliary boilers are designed for use of natural gas / low sulphur heavy stock (LSHS). Natural gas requirement at 100% utilisation of the revamp capacity is 3.15 MMSCMD and at 95% utilisation, it is 3 MMSCMD. The main supplier of natural gas for the Company is GAIL. The daily contract quantity from GAIL is 2.14 MMSCMD while the remaining requirement of the plant is met from GAIL's RLNG sources.

Table 2.3: GAIL Line I & Line II APM Gas Contract

Particular	Description
Contract	GAIL Line I APM Gas Contract & GAIL Line II APM Gas Contract
Date of Agreement	18th December 2015
Tenure	5th July 2021 Applied for Renewal
Delivery Point & Delivery Pressure	The gas 40 to 45 kg per cm pressure will be supplied at buyer's fertilizer plant premises
Gas Quantity	1.8 MSCMD Line I and 0.34 MSCMD Line II
Gas price	<ul style="list-style-type: none"> Gas price is as per directives of the Government of India In addition to the Gas price transmission charges will be levied which shall be the Provisional Initial Unit Natural Gas Pipeline Tariff for KG Basin Natural Gas Pipeline Network Marketing Margins will be charged as applicable from time to time

Particular	Description
Payment Terms	The seller shall raise the invoice fortnightly and the payment has to be made within 3 business days
Major Terms & Conditions	<ul style="list-style-type: none"> Take or Pay- Based on Article 5.2 of the agreement the buyer shall pay to the seller for actual quantity of the Gas supplied by the seller to the buyer subject to minimum payment for 90% of the annual quantities Planned Shutdown- Annual shutdown of gas supply from the seller's end shall be limited to 30 days in a financial year

Source: NFCL & MM Analysis

2.5.2 Water & Power

Water requirement is met through supplies from AP Public Health/Irrigation Department and Power requirement would be met through captive source i.e., NFCL is having 3 gas turbines, which caters required power for the complex. However, NFCL is having contract with AP Transco for supply of 6 MVA.

2.6 Major Facilities

Table 2.4 lists the major facilities along with their installed capacities.

Table 2.4: Major Facilities

S. No.	Facility	Capacity
1	Process Units	
1.1	Ammonia unit	2 x 1050 TPD
1.2	Urea unit	2 x 1810 TPD
1.3	CDR unit	450 TPD by MHI, Japan
2	Auxiliary & Utility System	
2.1	Raw water pipeline with pumping facilities from DVC Barrage to plant battery limit (BL)	Drawl Capacity – 8.5 MGD (1340 M ³ /Hr) Intake Pump – 3 x 1250 M ³ /Hr
2.2	Feed Gas Quantum	NG – 3.15 MMSCMD @ NCV of 8450 Kcal/SM ³
2.3	Captive power plant (CPP) for Steam and Power Generation	2 x 6.77 MW/60 MTPH by Turbotechnica, Italy 1 x 21.0 MW/100 MTPH by Thomassen, Netherlands
	Boilers	2 x 100 MTPH by Mitsui, Japan
2.4	Raw water system including storage, treatment and treated water storage with pumping unit	Treatment capacity 2 x 1175 m ³ /hr Water Storage Tank – 2 x 17940 M ³ (App. 20 hours)
2.5	DM water system including polished water storage and pumping	4 Nos. each of 60 M ³ /hr
2.6	Condensate polishing unit	3 Nos. each of 125 M ³ /hr 3 Nos. each of 200 M ³ /hr
2.7	Urea cooling towers	26,000 m ³ / hr
	Ammonia cooling towers	40,000m ³ / hr
2.8	Alternative fuel storage and handling system	
2.9	Plant air system	2 x 900 Nm ³ / hr
2.10	Instrument air system	2 x 2200 Nm ³ / hr

S. No.	Facility	Capacity
2.11	Inert gas (N ₂) system	600 Nm ³ /hr
2.12	Emergency DG set	2 x 1375 KVA
2.13	Ammonia storage system	2 x 5000 T
	Urea Silo capacity	30,000 T
2.14	Urea automatic bagging & loading system	240 TPH with 8 Nos. Fully Automatic Bagging Machine
2.15	Effluent treatment plant	300 m ³ / hr

Source: NFCL and MM Compilation

Major facilities are aligned with the project configuration.

2.7 Plant Performance

The following section discusses about the overall capacity utilisation for Ammonia and Urea in both plants. The utilisation is based on reassessed capacity for NFCL as mentioned in Table 2.1.

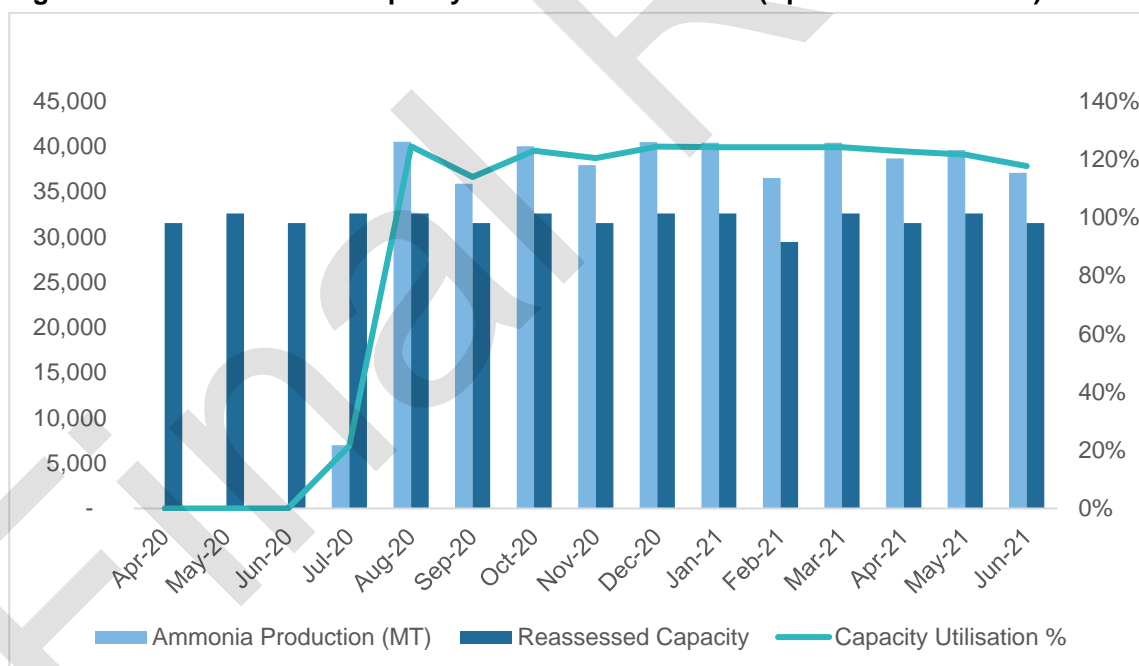
2.7.1 Unit 1

2.7.1.1 Ammonia 1

Capacity Utilization

Post-Covid-19 performance level of NFCL plant is depicted in the Figure 2.3.

Figure 2.3: Production and Capacity Utilization Ammonia 1 (Apr 2020 to Jun 2021)



Source: NFCL and MM Analysis

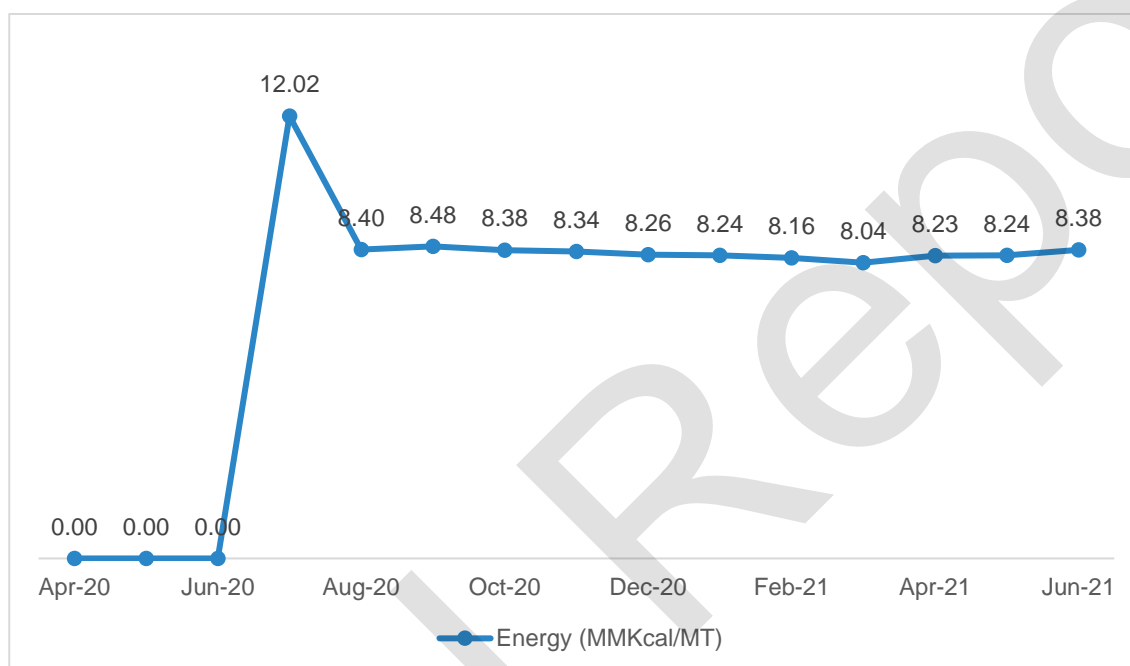
- Average capacity utilization is noted to be 91% for Apr-20 to Jun-21 period.
- During Apr-20 to Jun-20 the plant was under shutdown for annual maintenance activity. Production was noted to be zero for these months. For remaining period of Jul-20 to Jun-21 average plant utilization was 113%.

- By operating the plant at more than 330 days per annum, after taking in account all engineering safety margins, NFCL was able to produce more urea – exceeding the reassessed capacity. This is evident from Figure 2.3, where average utilisation of plant, during operational period, is more than 100%.
- Ammonia is produced to meet the urea requirement.

Energy Consumption

Specific Energy Consumption of the plant from Apr 2020 Jun 2021 is given in Figure 2.4.

Figure 2.4: Energy Consumption of Plant (Ammonia 1)



Source: NFCL & MM Analysis

- NFCL had replaced Combustion Air Pre-heater and Synthesis Loop Boiler in May 2020 during maintenance shutdown as indicated above to achieve optimum energy utilization.
- Accordingly, MM observes that the spike in the energy consumption for the month of July 20 was due to plant restart post maintenance shutdown.
- Aug-20 onwards, energy consumption is stable and noted to be at average of 8.2 MMKcal/MT which is higher than industry standard.

Downtime Hours

The downtime hours of the plant during April 2020 to Jul 2020 are listed in Table 2.5

Table 2.5: Downtime Hours – Apr 20 to Jul 20

Month	Period	Reason for Shutdown	DURATION (hrs)
April 20	05:00 Hrs of 01.04.2020 to 19:15 Hrs of 25.07.2020	Shutdown taken for Annual maintenance (Financial stress)	720.00
May 20			744.00
June 20			720.00
July 20			590.25

Source: NFCL

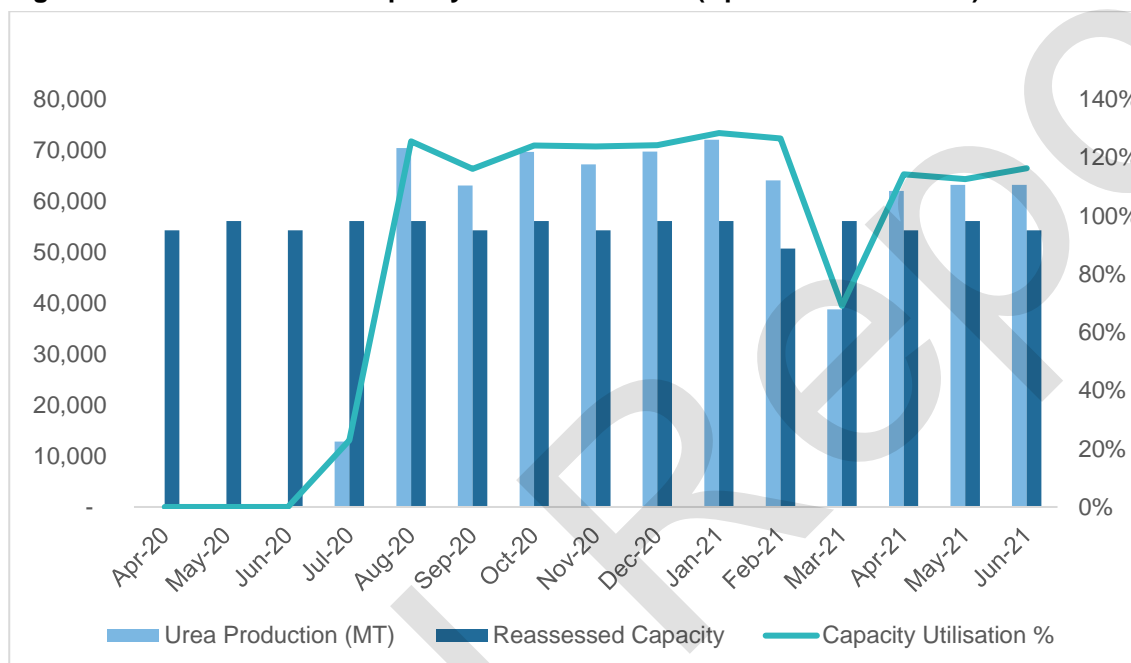
- MM notes that, cumulative shutdown hours were 2774.25 Hrs (115.59 Days) when annual maintenance activity was carried out. The timeframe for shutdown was between Apr 20 to Jun 20 when NFCL was experiencing financial stress.

2.7.1.2 Urea 1

Capacity Utilization

Post-Covid-19 performance level of NFCL plant is depicted in Figure 2.5.

Figure 2.5: Production and Capacity Utilization Urea 1 (Apr 2020 to Jun 2021)

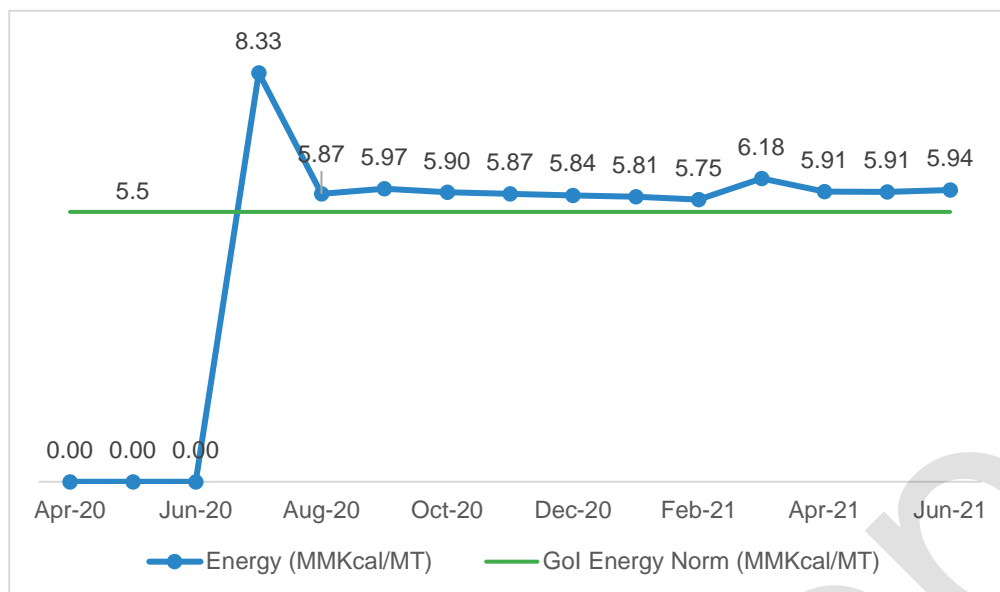


Source: NFCL and MM Analysis

- Average capacity utilization is noted to be 87% for Apr-20 to Jun-21 period.
- During Apr-20 to Jun-20 the plant was under shutdown for annual maintenance activity. Production was noted to be zero for these months.
- For remaining period from Jul 20 to Jun 21, average plant utilization was 109%.
- In the month of Mar 21, shutdown was taken to inspect vacuum section and in this month the ammonia generated from unit 1 was utilized to produce urea from unit 2, hence the dip in production.
- Taking cognisance of the engineering safety margins, NFCL were able to operate the plant beyond 330 days per annum – thereby producing urea in excess of the reassessed capacity. This can be observed in Figure 2.5, where average utilisation of plant, during operational period, is more than 100%.

Energy Consumption

Specific Energy Consumption of the plant from Apr 2020 Jun 2021 is given in Figure 2.6.

Figure 2.6: Energy Consumption of Plant (Urea 1)

Source: NFCL & MM Analysis

- MM observes that spike in the energy consumption for the month of July 20 was due to plant restart post maintenance shutdown. Aug-20 onwards, energy consumption was stable and noted to be at average of 5.9 MMKcal/MT which is on higher side vis-a-vis energy norms mentioned in Urea Policy (pricing and administration).
- To achieve the energy norms of 5.5 MMKcal/ MT of Urea as stipulated in the new Urea policy, energy conservation techniques and reliability schemes ought to be implemented. This has been discussed by MM in subsequent sections.

Downtime Hours

The downtime hours of the plant during April 2020 to Jun 2021 are listed in Table 2.6

Table 2.6: Downtime Hours – Apr 20 to Mar 21

Month	Period	Reason for Shutdown	DURATION (hrs)
Apr-20			720
May-20	05:00 Hrs of 01.04.2020 to 22:30 Hrs of 25.07.2020	Shutdown taken for Annual maintenance (Financial stress)	744
Jun-20			720
Jul-20			593.5
Aug-20		NIL	-
Sep-20	13:05 Hrs of 29.09.2020 to 18:25 Hrs of 29.09.2020	Plant tripped due to CO2 Compressor trip on low discharge pressure.	5.33
Oct-20	09:04 Hrs of 03.10.2020 to 19:00 Hrs of 03.10.2020	Plant trip taken due to surging of CO2 Compressor.	9.93
	14:10 Hrs of 17.10.2020 to 22:00 Hrs of 17.10.2020	Plant tripped due to CO2 Compressor trip owing to speed fluctuation. HP Governor Pilot valve serviced, and Plant restarted.	7.83
Nov-20	14:25 Hrs of 03.11.2020 to 17:50 Hrs of 03.11.2020	Plant tripped due to CO2 Compressor trip on low discharge pressure.	3.42

Month	Period	Reason for Shutdown	DURATION (hrs)
Dec-20	23:00 Hrs of 03.12.2020 to 02:30 Hrs of 04.12.2020	Plant tripped due to CO2 Compressor trip on low discharge pressure.	3.5
	07:20 hrs of 21.12.2020 to 20:48 hrs of 21.12.2020	Plant shutdown taken to attend CO2 compressor (LP pilot valve, Servomotor replacement & E/H converter replacement etc.) and E-127 (CO2 compressor 3rd stage cooler) & E-161 (Condenser) related jobs.	13.47
Jan-21	NIL		-
Feb-21			
Mar-21	08:15 hrs of 05.03.2021 to 14:20 hrs of 08.03.2021	Plant shutdown taken for inspection of vacuum section equipment.	78.08

Source: NFCL

- MM notes that, cumulative shutdown period was 2899.06 Hrs (120.79 Days) during which annual maintenance activity was carried out. The timeframe for shutdown was between Apr-20 to Jun-20 during which Company was experiencing financial stress.
- From Sep-20 to Dec-20 downtime of ~43 hrs are noted on account of issues faced in CO₂ Compressor. Necessary actions and activities were carried to keep the compressor running. As noted by MM, detailed study on the compressors by the OEM has been envisaged as a part of the revival plan.

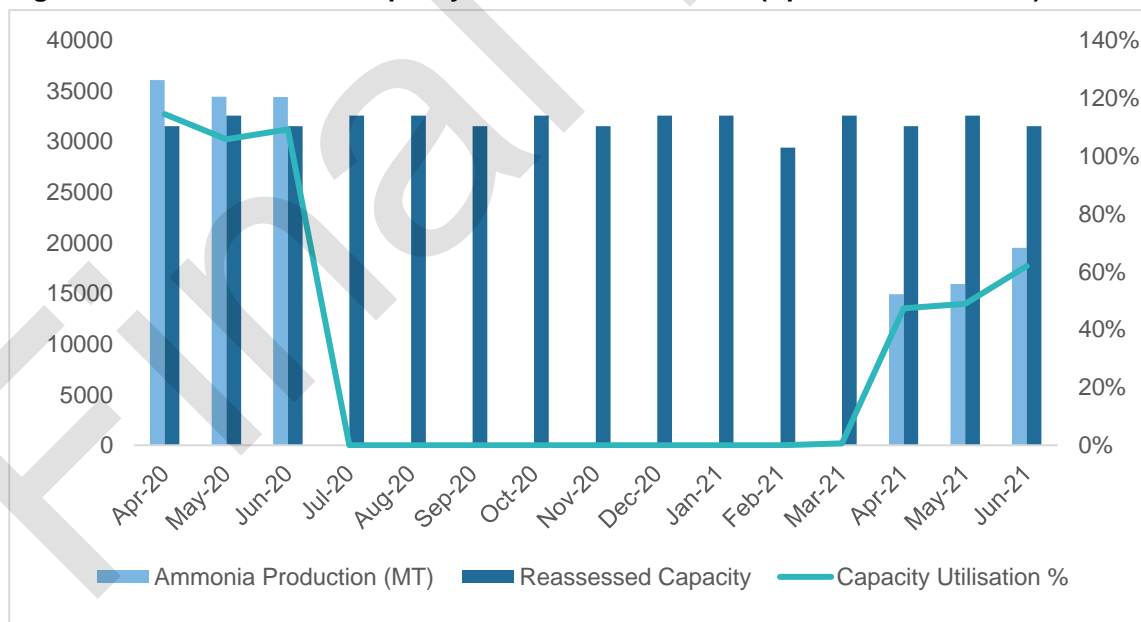
2.7.2 Unit 2

2.7.2.1 Ammonia 2

Capacity Utilization

Post-Covid-19 performance level of NFCL plant is depicted in Figure 2.7.

Figure 2.7: Production and Capacity Utilization Ammonia 2 (Apr 2020 to Jun 2021)



Source: NFCL and MM Analysis

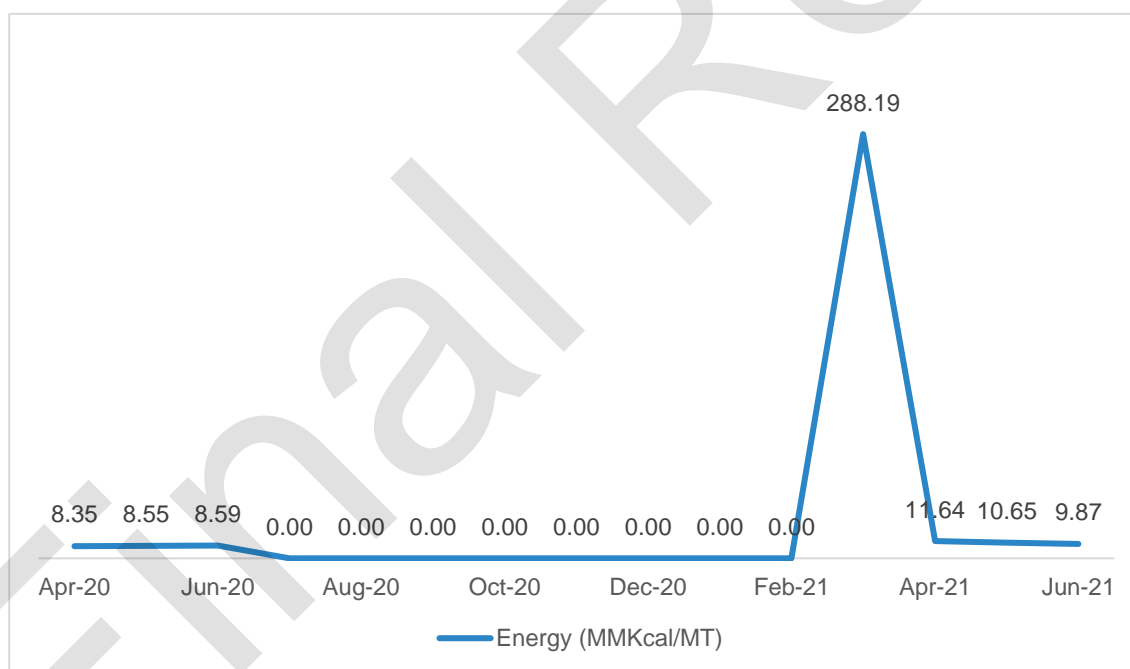
- Average capacity utilization is noted to be 31% for Apr-20 to Jun-21 period.

- During Jul-20 to Mar-21, operation at plant 2 ceased due to financial stress. Production was noted to be zero for these months. For the operational periods of Apr-20 to Jul-20 and Apr-21 to Jun-21, average plant utilization was 81%.
- It is observed that the average monthly utilization of the unit is at around 80% due to issues in Ammonia converter. It was understood that the main reactor, where Ammonia is produced had failed in Mar 2021 on account of catalyst slippage. This resulted in choking of downstream pipelines and equipment. High velocity gas entrained with catalyst particle damaged the equipment. Based on Process Licensors recommendation and industry expert's opinion the company has been attempting to repair and keep the plant in operation. It is noted that despite repeated ongoing attempts the plant operations could not be stabilized due to constant equipment failures. This has resulted in deterioration of performance of main ammonia reactor and downstream equipment, causing significant production and energy losses. This was validated by MM during their site visit.
- By operating the plant at more than 330 days per annum, considering all engineering safety margins, Company was able to produce urea in excess of the reassessed capacity. This is noted from Figure 2.7, where average utilisation of plant, during operational period, is more than 100%.

Energy Consumption

Specific Energy Consumption of the plant from Apr 2020 to Jun 2021 is given in Figure 2.8.

Figure 2.8: Energy Consumption of Plant (Ammonia 2)



Source: NFCL & MM Analysis

- MM notes that the apparent distortion in the energy consumption for the month of Mar-21 is on account of NFCL's repeated unsuccessful attempts to restart and stabilize ammonia operations resulting in significantly higher than normal energy consumption.
- From Apr-21 to Jun-21, energy consumption showed a declining trend and was noted to be at an average of 10.7 MMKcal/MT which is higher than industry standard.

Downtime Hours

The downtime hours of the plant during April 2020 to March 2021 are listed in Table 2.7.

Table 2.7: Downtime Hours – Apr 20 to Mar 21

Month	Period	Reason for Shutdown	Duration (hrs)
Apr-20	14:47 Hrs of 20.04.2020 to 23:55 Hrs of 20.04.2020	Process Air Compressor tripped due to Malfunctioning of mechanical over speed tripping system	9.13
May-20	08:30 Hrs of 29.05.2020 to 15:30 Hrs of 29.05.2020	Backend shutdown taken to attend Syn Gas Compressor Turbine LP valve broken spindle	7.00
Jun-20	12:40 Hrs of 08.06.2020 to 15:20 Hrs of 08.06.2020	Backend tripped on Ammonia Separator (EV-501) High level.	2.67
Jul-20	00:45 Hrs of 01.07.2020 to 23:20 Hrs of 24.03.2021	Shutdown taken for Annual maintenance (Financial stress)	4.25
Aug-20			744.00
Sep-20			744.00
Oct-20			720.00
Nov-20			744.00
Dec-20			744.00
Jan-21			744.00
Feb-21			672.00
			570.33
Mar-21	12:00 Hrs of 25.03.2021 to 03:25 Hrs of 01.04.2021	Backend Shutdown taken for removing the catalyst slipped from Ammonia Synthesis Converter to Synthesis Loop	159.42

Source: NFCL

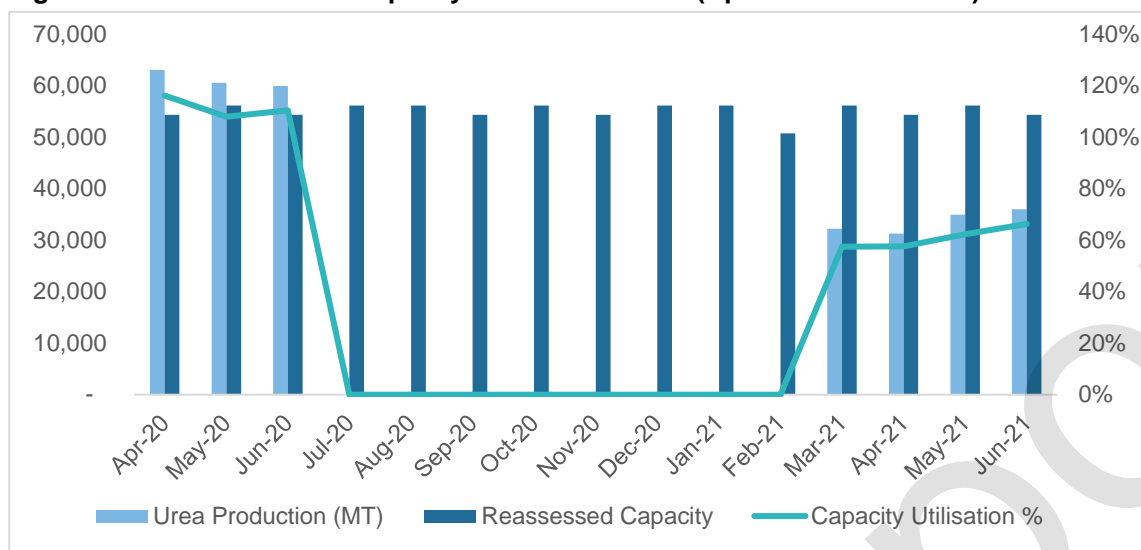
MM notes that, cumulative shutdown hours were 6584.80 Hrs (274.37 Days) when annual maintenance activity was carried out. The timeframe for shutdown was between Jul 20 to Mar 21 when NFCL was experiencing financial stress.

2.7.2.2 Urea 2

Capacity Utilization

Post-Covid-19 performance level of NFCL plant is depicted in the Figure 2.9.

Figure 2.9: Production and Capacity Utilization Urea 2 (Apr 2020 to Jun 2021)



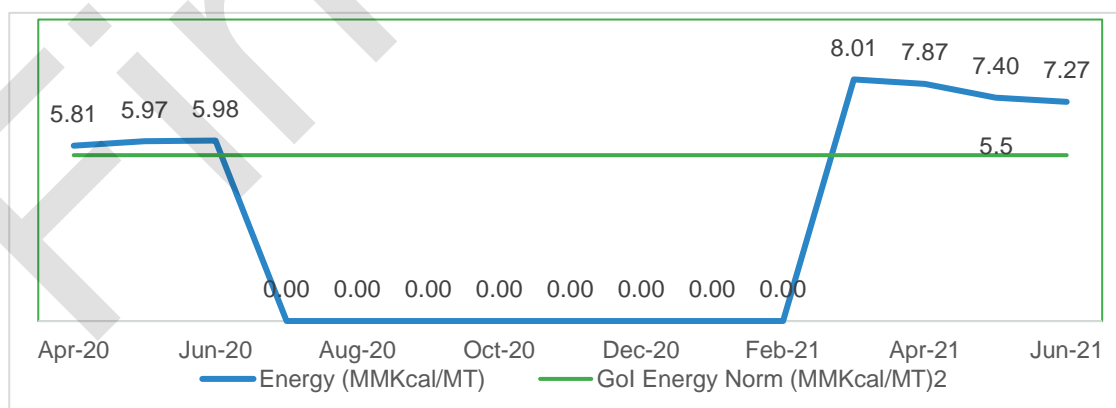
Source: NFCL and MM Analysis

- Average capacity utilization is noted to be 38% during Apr 20 to Jun 21 period.
- During Jul-20 to Feb-21 the plant was under shutdown due to shortage of ammonia from unit 2.
- Above period of forced shutdown was utilized for annual maintenance activity. Production was noted to be zero for these months.
- For remaining period from Mar 21 to Jun 21, average plant utilization was 61%.
- During the time when unit was available, the average utilization is hovering around 80%.
- By operating the plant at more than 330 days per annum, after taking in account all engineering safety margins, NFCL was able to produce urea more than reassessed capacity. This can be corroborated from Figure 2.9, where average utilisation of plant, during operational period, is more than 100%.

Energy Consumption

Specific Energy Consumption of the plant from Apr 2020 Jun 2021 is given in Figure 2.10.

Figure 2.10: Energy Consumption of Plant (Urea 2)



Source: NFCL & MM Analysis

- MM observes that spike in the energy consumption for the month of Mar-21 was due to plant restart post maintenance shutdown. Apr-21 onwards, energy consumption has a downward trend and was noted to be at average of 6.9 MMKcal/MT which is on higher side vis-a-vis energy norms mentioned in Urea Policy (pricing and administration).
- As explained earlier, to achieve the energy norms stipulated in new Urea policy, it is imperative that energy conservation techniques and reliability schemes are implemented. The Consultants have discussed this in subsequent sections.

Downtime Hours

The downtime hours of the plant during April 2020 to Jun 2021 are listed in Table 2.8

Table 2.8: Downtime Hours – Apr 20 to Mar 21

Month	Period	Reason for Shutdown	Duration (hrs)
Apr-20	14:48 Hrs of 20.04.2020 to 02:15 Hrs of 21.04.2020	Plant shutdown taken due to Ammonia-II trip	11.45
May-20	NIL		
Jun-20	01:15 Hrs of 08.06.2020 to 07:30 Hrs of 08.06.2020	Plant shutdown taken due to Auxiliary Boiler A trip.	6.25
	13:00 Hrs of 08.06.2020 to 16:05 Hrs of 08.06.2020	Consequent to Ammonia plant trip, due to drop in KS header pressure, plant shutdown taken.	3.08
			4.25
Jul-20			744.00
Aug-20			744.00
Sep-20			720.00
Oct-20	00:45 Hrs of 01.07.2020 to 17:15 Hrs of 04.03.2021	Shutdown taken for Annual maintenance (Financial stress)	744.00
Nov-20			720.00
Dec-20			744.00
Jan-21			744.00
Feb-21			672.00
			84.25
Mar-21	21:50 Hrs of 07.03.2021 to 01:40 Hrs of 08.03.2021	Plant tripped due to CO ₂ Compressor low discharge pressure owing to KS steam flow fluctuations.	3.83

Source: NFCL

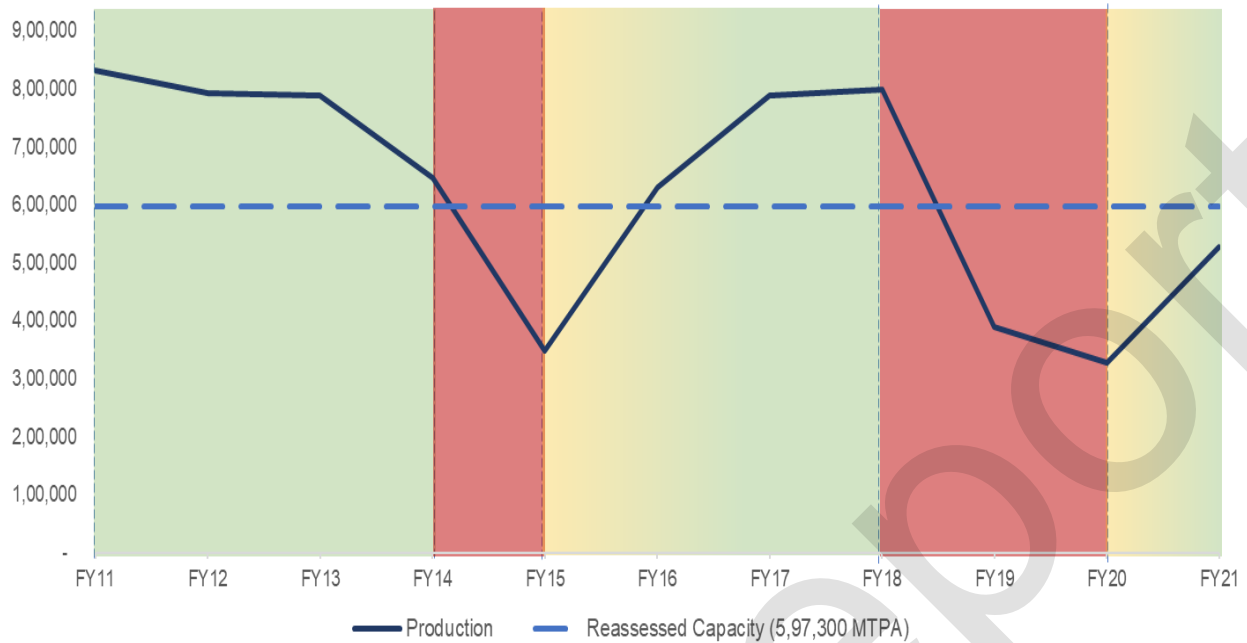
MM notes that, cumulative shutdown hours were 5945.11 Hrs (247.71 Days) when annual maintenance activity was carried out. The timeframe for shutdown was between Jul-20 to Mar-21 when NFCL was experiencing financial stress.

During Mar-21, downtime of ~4 hrs is noted on account of issues faced in CO₂ compressor. Necessary actions and activities were carried to keep the compressor running. Consultants believe that a detailed integrity study of the compressors have to be carried out by the OEM – which has been envisaged as part of the revival plan.

2.7.3 Performance Summary

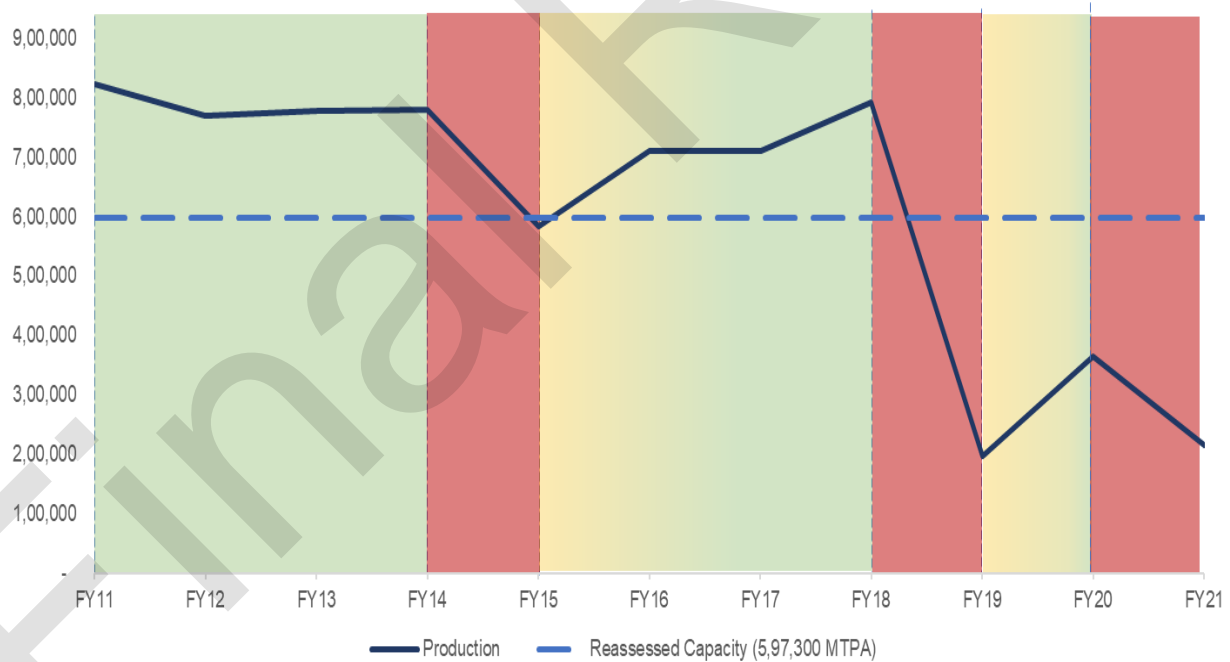
Figure 2.11 & Figure 2.12 depicts year-on-year Unit Wise Operational History for Unit-1 & Unit-2

Figure 2.11: Unit 1 – Operational overview



Source: MM Analysis

Figure 2.12: Unit 2 – Operational overview



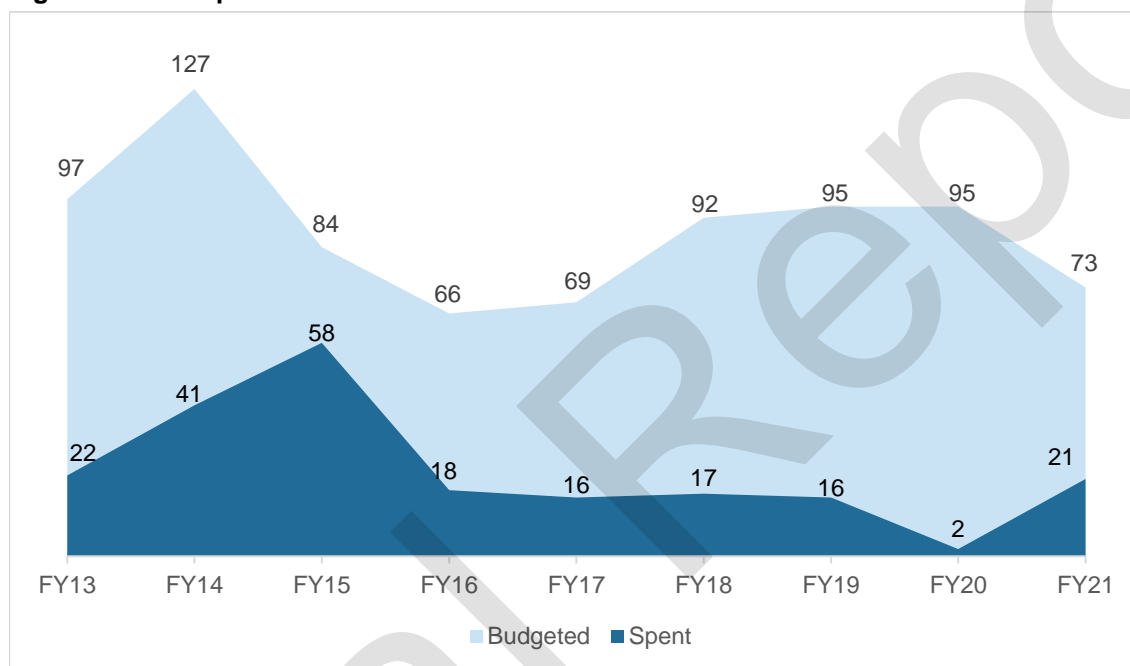
Source: MM Analysis

- During FY14, plant production was impacted due to the GAIL Nagaram incident. The decline in production continued into FY15 – due to slow ramp up of supply by GAIL.
- FY15 to FY18 saw a period of steady and unhindered recoveries in production from both the units.

- FY19 saw extensive dips in production in both the Units due to prolonged plant shutdowns on account of financial stress.
- It is noted that shutdowns for the two Units were taken between July 2018 and March 2021. Unit 1 and Unit 2 were under shutdown for 464 days and 709 days respectively.
- For the period from FY19 to FY21, the units were operated alternately which is evident from opposing production trends between the two units.

It is observed that the Company could not incur any major Capex during last few years, due to financial stress, resulting in accelerated plant deterioration and major break downs. The summary of unspent maintenance Capex since FY13 is shown in Figure 2.13.

Figure 2.13: Unspent Maintenance since FY13



Source: NFCL

Multiple major equipment failures have occurred throughout the years in both plants due to unspent maintenance budgets. The details of the same are mentioned below:

- In FY13 & FY14, equipment failures occurred in Reforming Section and synthesis Section of Ammonia and Urea plants.
- In FY16 & FY17, equipment failures occurred in Reforming section and CO₂ Removal section of Ammonia.
- In FY18 & FY19, equipment failures occurred in Synthesis sections of Ammonia and Urea plant along with issues in Reforming sections.
- In FY19, FY20 & FY21, shutdowns of 222, 183 and 181 days were taken due to issues/ failures in Urea synthesis, overall electrics and Ammonia synthesis sections respectively.

As plants are 29 and 24 years old, MM believes that the failures of the above nature could be largely due to unspent maintenance expenditures on equipment that are critical for plant operation. Timely maintenance could have prevented/ delayed the onset of deterioration of the plants thereby reducing the Capex requirement vis-à-vis major expense envisaged presently in the revival plan.

2.8 Buildings and Infrastructure

The details of building & other infrastructure are given in Table 2.9.

Table 2.9: List of Plant Buildings

S. No.	Building Name	Plinth Area, M ²
1	Technical Building & Lab Building	4,546
2	Plant - 1 control room	1,460
3	Operator Cabins	175
4	Substation - 2	2,400
5	Substation - 3	2,400
6	Plant - 2 control room	1,808
7	Ammonia substation building	1,966
8	Urea substation building	1,784
9	Steam & Power Generator Plant	3,940
10	GT-C control room building	1,820
11	SS-21	-
12	Urea silo	10,525
13	Bagging plant incl. loco shed	42,408
14	AMF-2	246
15	DM plant	4,134
16	DM MCC	96
17	Cooling tower	302
18	Clarifier water cum fire water pump house	764
19	Sludge sump & pump house	925
20	Filter water pump house	1,294
21	ETP	572
22	IG plant	2,153
23	MRSS	2,400
24	Substation – 4	1,445
25	Substation - 5	590
26	Chemical house WTP	1,214
27	Canteen building	1,310
28	Devi Canteen	180
29	H building	1,805
30	Project office	948
31	Fire & safety building	480
32	First Aid Centre	524
33	Workshop	4,836
34	Stores	3,342
35	Gate house	410
36	Weighbridge	33
37	Yard Toilet Near WS, MRSS, IGP, SP House	260
38	Akshara School	6,551
39	Club house	2,360
TOTAL		92,107

Source: NFCL

2.9 Utilities & Offsite facilities

2.9.1 Water

1046 m³/hr of water is required for the plant which is sourced from Dowlaiswaram barrage which is approx. 60 km away. The water is stored in tank of 2,044,122 m³ storage capacity near Samalkot, 13 km from the NFCL plant. Raw water from this tank is flown by gravity to plant raw water reservoir through two underground water pipes of 1 metre diameter each. Pre-treatment plant of 2x1175 m³/hr capacity is installed.

Filtered and treated raw water would be required for meeting the requirements of

1. DM water for process
2. Cooling water for make-up for Ammonia / Urea / CPP
3. Service water
4. Fire Water make-up
5. Drinking water

2.9.1.1 DM Water Plant

Demineralisation plant of 4x60 m³/hr capacity consists of –

1. Active Carbon Filters (ACF)
2. Strong Acid Cation Exchanger (SAC)
3. Degasser tower
4. Weak & Strong Base Anion Exchangers
5. Mixed Bed exchangers

Polishing unit of 325 m³/hr capacity containing ACF & mixed bed exchangers, housed within the DM plant shed is installed to clean the process & turbine condensate before reuse.

The exchanger resins are regenerated periodically as they lose their effectiveness after certain cycles.

2.9.1.2 Cooling water

Cooling water system is provided for exchanging heat with process streams, bearing cooling of pumps, compressors and other equipment. The system also includes control of chemical composition of circulating water to prevent corrosion, biological growth and solid deposit in piping by way of side stream filtration and ClO₂ dosing. Separate cooling towers are provided for unit – 1 & 2, both of which are supplied by Paharpur Cooling Towers. Details of cooling towers are given in Table 2.10, Table 2.11

Table 2.10: Unit – 1 Cooling Tower

S. No.	Particulars	Details
A	Ammonia CT	
1	Units catered	Ammonia plant, DM & Polishing plant, GT + HRSG (A & B)
2	Design capacity	25,200 m ³ /hr
3	No. of cells	7
4	Capacity per cell	3600 m ³ /hr
5	Other facilities	Chemical dosing, online analysers

S. No.	Particulars	Details
B	Urea + CDR CT	
1	Units catered	Urea plant, CDR plant
2	Design capacity	18,000 (10,800 + 7,200) m ³ /hr
3	No. of cells	3 + 2
4	Capacity per cell	3600 m ³ /hr
5	Other facilities	Chemical dosing, online analysers

Source: NFCL

Table 2.11: Unit – 2 Cooling Tower

S. No.	Particulars	Details
A	Ammonia CT	
1	Units catered	Ammonia plant, DM & Polishing plant, GT + HRSG (C)
2	Design capacity	25,200 m ³ /hr
3	No. of cells	7
4	Capacity per cell	3600 m ³ /hr
5	Other facilities	Chemical dosing, online analysers
B	Urea CT	
1	Units catered	Urea plant
2	Design capacity	14,400 m ³ /hr
3	No. of cells	4
4	Capacity per cell	3600 m ³ /hr
5	Other facilities	Chemical dosing, online analysers

Source: NFCL

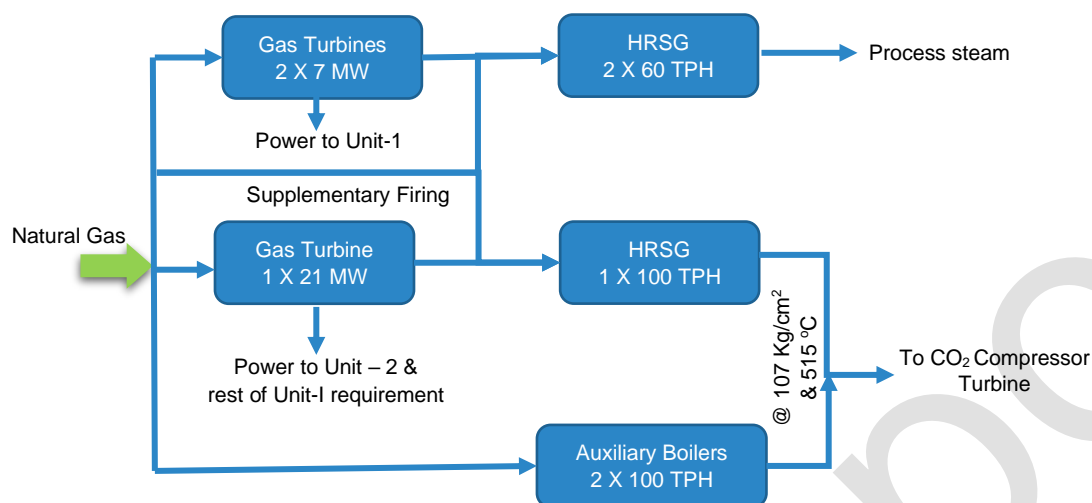
2.9.2 Power & Steam Generation Plant

Power requirement for the complex is 28.75 MW which is majorly met by captive generation and partly from APSEB. NFCL has two gas turbines (GT – A & B) of 7 MW capacity and one unit (GT – C) of 21 MW capacity running on natural gas.

Flue gases from these turbines leave at 540 °C, sensible heat of which is recovered in three heat recovery steam generators (HRSGs) of 60 TPH (2 nos.) and 100 TPH (1 no.) capacity. Two auxiliary boilers of 100 TPH capacity are also installed to meet the process steam requirements.

Flow chart indicating the power & steam generating units is presented in Figure 2.14.

Figure 2.14: CPP Flowchart



Source: NFCL & MM

2.9.3 Compressed Air

Ammonia plant caters to the compressed air needs of OSBL facilities and passivation air to Urea plant. It will also cater to the instrument air requirement of ammonia unit, urea unit and other utilities and offsite systems. The details of the compressed air system are given Table 2.12

Table 2.12: Compressed Air System

S. No.	Particulars	Details
1	Units catered	Ammonia plant, Urea plant, other utilities, and off sites systems
2	Capacity	600 Nm³ / hr

Source: NFCL

3 Review of Revival Plan

NFCL has drafted a revival plan in consultation with the Technology supplier Saipem, as its equipment which has outlived their life requires a replacement to avoid break down and to operate at 100% capacity. NFCL's revival plan also focus on how to meet the energy norm of 5.5 Gcal / MT of Urea, as per NUP 2015 effective from April 2018 onwards and stop cash losses due to high energy operation. Necessary steps are also envisaged to restore the reliability of units and stability in civil/structures. Plan also includes Operational and Capital expenditure required for maintaining the facilities.

Following table depicts the summary of revival plan envisaged for the NFCL facility.

Table 3.1: Revival Plan Summary

Plan	Description	Cost (INR Cr.)
1	Energy Conservation Scheme (Mandated by GoI)	250
2	Reliability Scheme	534
	• Reliability Measures identified pre-ammonia convertor failure ¹	139
	• Additional Measures identified post-ammonia convertor failure	395
Total – (Energy and Reliability)		784
3	Civil Repairs	87.5
4	Budgeted Maintenance for 24 months ² @ 75 Crs per annum (Rs 35 Crs + Rs 40 Crs)	150
Grand Total		1021.5

Source: NFCL

3.1 Energy Savings Project

As per the New Urea Policy of 2015 the specific energy norm for FY 2020-21 for both units of NFCL is 5.50 Gcal/MT of urea. The annual specific energy consumption of NFCL in 2017-18 when both the plants were operational was 5.65 Gcal/MT of urea. Therefore, the specific energy consumption has to be reduced minimum by 0.15 Gcal/ MT of urea in order to be eligible under the New Urea Policy of 2015.

NFCL has appointed Saipem for implementing the Energy saving project to achieve the pre-set energy norm of New Urea Policy 2015. Accordingly, Saipem has examined the various energy saving options available for the Ammonia, Urea and Utility plants, including the ones proposed by NFCL.

Saipem has highlighted the following schemes for energy savings:

Table 3.2: Energy Savings Schemes

Energy Saving Items	Urea Combination Scheme	14 MW GT Scheme	18 MW GT Scheme	24 MW GT Scheme
Turbine to motor small drive changes	✗	✓	✓	✓
Motor to Motor changes	✓	✓	✓	✓
Drive change for ARC in Ammonia-1	✗	✗	✓	✗
New PAC in Ammonia-2	✗	✗	✗	✗

¹ INR 15.73 Crores + 7.05 Crores already implemented

² Estimated expense during the period of implementation of energy saving and reliability schemes

Energy Saving Items	Urea Combination Scheme	14 MW GT Scheme	18 MW GT Scheme	24 MW GT Scheme
Turbine replacement of SGC, Ammonia-1	✓	✓	✓	✓
Turbine replacement of CO ₂ compressor, Urea-1 & Urea-2	✓	✓	✓	✓
Dehydrator package addition in Ammonia-1, Ammonia-2	✓	✓	✓	✓
Urea Plant (Urea-1 & Urea-2) modifications	✓	✗	✗	✗
Proposed offsite configuration	✓	✓	✓	✓
New GT and HRSG-D	✗	✓	✓	✓
Boiler 1 & Boiler 2 shut down	✓	✓	✓	✓
Existing GT/HRSG-A & B shutdown	✗	✓	✓	✓
Offgas burner modification in Ammonia Plant	✓	✓	✓	✓
Energy Saving, Gcal/ MT of Urea	0.19	0.23	0.26	0.30

Source: Saipem Energy Reduction Study

Basic schemes

- Turbine Up gradation / replacement of Urea 1 and Urea 2 CO₂ Compressor Steam Turbine
- Ammonia Plant-1 Synthesis Gas Compressor Steam Turbine drive replacement,
- Ammonia Plant 1 and Ammonia Plant 2 Synthesis Loop Dehydrator scheme
- HRSG-C study and coordination with OEM for modification for additional off gas firing.
- Off gas Firing- Burners Modification in Ammonia plants.

The above listed schemes are considered as Basic schemes due to high energy savings with lower CAPEX.

One of the below described scheme combination has to be implemented to realize the required energy savings.

Combination of Schemes

- Urea Combination Scheme
 - Basic Schemes
 - Urea Plant Modification's
 - New additional Carbamate Condenser in Urea-1 & Urea-2
 - New MP Decomposer (2 stacked Heat exchanger for MP steam saving) in both Urea plants
 - Operating Distillation Tower at higher pressure in Urea-1 & Urea-2
 - Addition of New Hydrolyser preheater in both Urea plants
 - Distillation Tower feed pumps including motors
 - Hydrolyser Feed pumps including motors
 - Purified wastewater pumps
 - Steam condensate pump including motors in Urea-2
 - HV-06 control valve modification in Urea-1
 - Evaluation of operating capacity limitation of the 1st vacuum concentrator with ILP steam usage in Urea-1
- New 14 MW GT (Gas Turbine) Scheme

- Basic schemes
- New 14 MW GT
- Two BFW pumps Turbine drive change to Motor
- New 18 MW GT Scheme
 - Basic schemes
 - New 18 MW GT
 - ARC Turbine drive change to Motor
 - One BFW pump Turbine drive change to Motor
- New 24 MW GT Scheme
 - New 24 MW GT
 - Basic schemes
 - PAC drive change
 - Two BFW pumps Turbine drive change to Motor

The overall energy savings and estimated capital expenditure as provided by Saipem for each of the above schemes are given in Table 3.3. It is to be noted that these schemes were identified during 2016 and may attract price / cost escalation for the time elapsed.

Table 3.3: Energy Savings

Description	Base case	Urea Combination scheme	14 MW GT scheme	18 MW GT scheme	24 MW GT scheme
Total Steam, TPH	218	171.70	168.20	152.40	136
Total power, MW	29	29.40	31	36.30	41.20
Energy saving, Gcal / MT	-	0.19	0.23	0.26	0.30
Production, MTPD	4,606	4,606	4,606	4,606	4,606
Capex for Energy Saving INR Cr	-	169	267	313	339

Source: Saipem Energy Reduction Study

Saipem has recommended Urea combination scheme due to the following reasons:

- Lowest Investment
- Shorter payback period
- Shorter schedule for the implementation
- Urea product quality improvement with respect to biuret
- Existing unhealthy pre-decomposer will be removed
- Better process condensate quality

The details of item wise capital expenditure with their respective lead times and estimated implementation date are given in Table 3.4.

Table 3.4: Capital Expenditure-Energy Savings Project

S. No		Item Description	Capex Estimation (In ₹ Cr.)		Remarks	Timeline (Months)
			2016 (Saipem)	2020		
1	Replacement of 3 Steam Turbines:	64.00	86.25	Purchase of 3 steam turbines from Siemens, Germany. Not forming part of the Saipem package and the cost has been taken as provided by NFCL	15	
	A. Synthesis Gas turbine of Ammonia Plant I					
	B. CO2 Turbines of Urea Plant I & II.					
2	Ammonia wash in both plants - estimated + Study of compressors by OEM	15.41	26.45	Plan to purchase ammonia dehydrator from outside supplier. Not forming a part of the Saipem package and the cost has been taken as provided by NFCL	-	
3	HRSG-C burners medication	2.50	5.75	The Company plans to purchase the HRSG burners from outside supplier and this will not be a part of Saipem package. Cost has been taken as provided by NFCL	15	
4	Urea Schemes					
4.1	Basic Equipment	25.02	25.02	Basic equipment (other than 3 steam turbines, Ammonia dehydrator and HRSG burner) will be provided by Saipem and the cost has been taken from Saipem Estimation.	15	
4.2	Bulk Material	12.75	10.20	80% of the Saipem Estimation has been considered		
4.3	Safety and Other Material	0.02	0.16			
4.4	Transportation Cost	2.54	2.03			
4.5	Construction, Pre-commissioning & Commissioning Cost	11.46	9.17			
4.6	Insurance and Other Miscellaneous	3.12	2.50	As per NFCL estimate		
4.7	Applicable Taxes	18.84	14.72			
Sub Total: Urea Scheme		73.93	63.80			
5	Saipem Total Consultancy cost	13.13	13.13	Consultancy Cost is as per Saipem Estimation	-	
Sub Total – 1+2+3+4+5		168.97	195.38			
6	Contingency @9% + IDC+FC	10.87	54.61			
Grand Total		179.84	249.99			
		~180	~250			

Source: Saipem Energy Reduction Study & NFCL

- The overall capital expenditure (hard cost) estimated by Saipem during 2016 was INR ~169 Cr. Considering forward escalation, the total estimated expenditure (hard cost) for implementing the energy saving scheme – recommended by Saipem – works out to ₹ 250 Cr.
- The Company has received quotations from KBR, USA for Ammonia wash scheme and from Siemens, Germany for replacement of the 3 turbines
- The overall escalation considered in capital expenditure is noted to be reasonable.



Table 3.5: Escalation Estimate of Capital Requirement for other schemes

Particulars	14 MW Scheme	18 MW Scheme	24 MW Scheme
Energy Reduction from Base (Gcal / MT)	0.23	0.265	0.3
Estimate as per Annexure 9-P. Cost Summary	267	313	339
Accuracy Factor	15%	15%	15%
Escalation per year (3 year old estimate)	4%	4%	4%
Estimate (Post above 2 factors)	345	405	439
Debt Funding	80%	80%	80%
Debt Amount	276	324	351
IDC (Rate of Interest)	10%	10%	10%
Interest (For 2 years)	40.41	47.37	51.31
Total project cost (Without Contingency)	386	452	490
Contingency	3%	3%	3%
Total project cost (With Contingency)	396	464	503

Source: Saipem

As the above is only an estimate, an accuracy factor of 15% has been considered to cover any exigencies during award/ implementation. The location of various modifications at the plant is depicted in Table 3.6.




Table 3.6: Location of Modifications

Particular	Location at Plant
Turbine replacement of SGC, Ammonia-1	
Turbine replacement of CO2 compressor, Urea-1	

Particular	Location at Plant
Turbine replacement of CO2 compressor, Urea-2	
HV-06 Control Valve Modification – Urea 1	
Hydrolyser Pre-heater – Urea 1	

Particular	Location at Plant
Hydrolyser Pre-heater – Urea 2	
New Carbamate Condenser – Urea 1	
New Carbamate Condenser – Urea 2	

Particular	Location at Plant
Replacement of Steam Condensate Pumps – Urea 2	
New Hydrolyser Feed Pumps – Urea 1	
New Hydrolyser Feed Pumps – Urea 2	

Particular	Location at Plant
Purified Waste Water Pumps – Urea 1	
Purified Waste Water Pumps – Urea 2	
Replacement of Distillation Tower Feed pumps – Urea 1	

Particular	Location at Plant
Replacement of Distillation Tower Feed pumps – Urea 2	
Replacement of MP Decomposer – Urea 1	
Replacement of MP Decomposer – Urea 2	

Source: Site Visit

- MM has reviewed the study undertaken by Saipem. The suggestion of Saipem in their energy reduction and life assessment study is noted to be reasonable given the fact that they are one of the market leaders and pioneers in Urea process technology. In addition, NFCLs Urea Plants operate on Saipem's Process License. As the schemes were developed in 2016, following prudent practises, a revalidation/ endorsement on the technical feasibility of the scheme – even now – ought to be obtained from Saipem before commencement of work.
- The timelines for undertaking such capex plan, falling under replacement & retrofit in an already operating plant, is in the range of 18-24 months.

- The overall implementation timeline is governed by manufacturing period for the key equipment since it would be custom built to meet specifications of the process.
- As already explained earlier, since the estimated costs in the Saipem Study is based on prevailing rates in 2016, cost escalation for the lapsed period has been factored accordingly in the revival plan.

3.2 Reliability Plan Improvement Measures

NFCL Unit-I is in operation since Aug 1992 and Unit-II is in operation since Mar 1998, completing 29 years & 23 years operation respectively. During September 2009, following a GoI mandate to switch from Naphtha to natural gas, CO₂ recovery plant was built in order to achieve conversion of all Ammonia to Urea. During the same period, replacement and revamping of other equipment were done. Most of the critical equipment are still in operation since inception and few major equipment are showing signs of ageing and technology obsolescence.

These equipment's are limiting the overall production capacity and the specific energy consumption of the plant. This particularly evident in Unit 1 as well as Unit 2. The average capacity utilization for Jul-20 to Jun-21 was ~49% for entire complex while average specific energy consumption during the same period was 9.51 MMKcal/MT. As the GoI energy consumption norm stands at 5.50 MMKcal/MT, higher energy consumption results in direct cash loss for the Company.

Hence, in order to have sustained production level with optimum energy performance and to improve the reliability of the plants, replacement of few critical equipment's have been envisaged. During the site visit, MM along with NFCL's team undertook a reconnaissance of the major facilities that requires implementation of measures to improve reliability. The following section attempts to discuss the details of the reliability measures envisaged to be implemented as part of the revival plan.

3.2.1 Reliability Measures – Pre-ammonia convertor failure

The following are the major items identified under reliability improvement prior to ammonia convertor failure.

- Replacement of Combustion Air Pre-heater for Ammonia-I
- New Synthesis Loop Boiler for Ammonia-1
- New RG Boiler for Ammonia-2
- Ammonia-2 Synthesis Converter Basket

In addition to the above critical jobs, Table 3.7 below details the consolidated improvement measures and the timeline





Table 3.7: Capital Expenditure-Reliability Improvement Measures

S. No	Item Description	Cost ₹ Cr	Timeline (Months)	Ordering & present Status	Justification
1	Combustion Air Pre-heater for Ammonia-I	15.73	-	Equipment arrived at Site	The existing Combustion Air Pre-heater is having carbon Steel plates which has got corroded due to cold-end corrosion, plate packs have got choked with corroded particles and offering limitation for Load. Hence, new Exchanger is required. Status – Implemented in May 2020
2	Synthesis Loop Boiler for Ammonia-I	7.05	-	Equipment arrived at Site	The existing Refurbished boiler is leaking and needs immediate replacement to avoid plant interruptions. Status – Implemented in May 2020
3	GT-B Major Inspection	12.00	6	To be ordered by 2020-21 Q4	As per OEM recommendation, Major Inspection has to be carried out for every 48,000 fired hours. Last Major inspection of GT-B was carried out during 2007
4	Up gradation of Unit-I and HRSG-C DCS/ESDS systems	12.00	8	To be ordered by 2020-21 Q3	Unit-I DCS was upgraded to the then DCS system of ABB make AC460 in the year 2003 and HRSG-C DCS System is in service from inception (1998). Unit-I ESD system is in line since 1992. The existing systems have become obsolete and has no support from OEM for spares and service.
5	Up gradation of GT-C Control System	8.00	8	To be ordered by 2020-21 Q3	OEM is not supporting critical spares supply because of obsolescence.
6	Up gradation of Vibration monitoring system	2.00	8	To be ordered by 2020-21 Q3	The existing Bentley-Nevada vibration monitoring system has become obsolete, and OEM is not supporting for spares and service.

S. No	Item Description	Cost ₹ Cr	Timeline (Months)	Ordering & present Status	Justification
7	Plant-I & Boiler UPS up gradation	5.00	6	To be ordered by 2020-21 Q4	The existing Plant-I & Boiler Control room UPS are in operation since 1992. Owing to the ageing the reliability of the UPS has come down and technology has become obsolete.
8	Re-conditioning of CT cells (5 cells)	5.20	4	To be ordered by 2019-20 Q3	In view of the aging, the existing CT cells require re-conditioning for sustained performance and integrity. The same will be taken up in phased manner
9	RG Boiler (EE-208) for Ammonia-II	18.85	16	Ordered & Equipment being fabricated	The existing RG Boiler of Ammonia-II (EE-208) has served its life of 20 years. Owing to high load operation of Ammonia plant post 2009 & vintage of the exchanger, the tubes of existing exchanger are failing and thereby the exchanger has become limitation for sustained high load operation of Ammonia Plant-II.
10	Ammonia-II Synthesis Converter Basket	35.00	14	To be ordered by 2020-21 Q1	The existing Synthesis Converter is in service since inception of the plant and basket has seen its life of 20 years. During the recent inspection of its downstream Boiler (EE-501), it was found that the synthesis catalyst from this basket is slipping. HTAS, the technology supplier has suggested NFCL to upgrade the existing basket with new basket and replacement of the catalyst.
11	Synthesis Catalyst	15.00	6	To be ordered by 2020-21 Q4	
12	Turbo log Phase-II	3.17	6	To be ordered by 2020-21 Q4	
Total Investment for Reliability Scheme					139 Cr.
Total Investment for Reliability Schemes (excluding Combustion Air Pre-heater for Ammonia-I & Synthesis Loop Boiler for Ammonia-I)					116.22 Cr.

Source: NFCL

- The above reliability measures can be implemented in parallel with the energy saving project.
- New Combustion Air Pre-heater and Synthesis Loop Boiler installed in Ammonia Plant 1 is depicted in table below

Equipment	Removed	Replaced
Combustion Air Pre-heater		
Synthesis Loop Boiler		

3.2.2 Reliability Measures – Post-Ammonia convertor failure

The following table depicts the details of the major activities identified by NFCL based on Saipem life assessment report after Ammonia converter failure under reliability improvement and also with a view to achieve 100% capacity utilisation. Delays due to unspent maintenance expenditures for past 8 years has aggravated the deterioration of the plant leading to frequent failures and non-operable condition of Plant 2.

Table 3.8: Capital Expenditure-Reliability Improvement Measures – Post Ammonia Convertor Failure

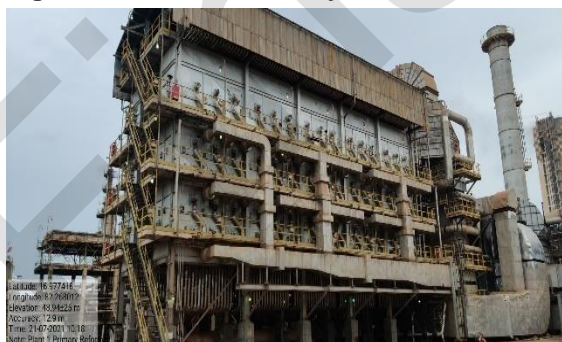
S. No	Item Description	Capex estimate (INR Cr.)
1	Plant-I & II Primary Reformer Tubes replacement, Plant-I Primary Reformer Pig tails & Hot Collector Replacement	42.50
2	Urea-I & II Reactor Re-lining	33.00
3	Replacement of BFW Exchangers, Ammonia Condensers & other exchangers in Ammonia Plants	30.95
4	Replacement of Urea-I Stripper and Upgradation of Exchangers in Urea Plants	30.90
5	Catalysts Replacement in both Ammonia Plants	28.25
6	SS-1 & 21 Up gradation (Switch Gear and Relay system up gradation), Electrical AVR, 3.3KV PCC, MCC & MRSS Upgradation & Electrical RLA Study & Safety Systems	20.95
7	Up gradation of Urea-I P-102B Pump & Motor	18.00
8	GT- A & B Control System Up gradation	17.00
9	Back-end Boiler for Ammonia-II	14.00
	Other items – Refer Appendix B	235.55
Total		395.00

Source: NFCL

- Detailed list of replacement equipment is available in Appendix B.

Below figures show some of the identified equipment planned under Reliability Improvement Measures

Figure 3.1: Plant 1 Primary Reformer



Source: Site Visit

Figure 3.2: Plant 2 Primary Reformer Leak



Source: Site Visit

Figure 3.3: Plant 1 Urea Reactor



Source: Site Visit

Figure 3.4: Plant 2 Urea Reactor



Source: Site Visit

Figure 3.5: Sub Station 1 Control Room



Source: Site Visit

Figure 3.6: Sub Station 21



Source: Site Visit

Figure 3.7: Plant 1 BFW



Source: Site Visit

Figure 3.8: Ammonia Condenser



Source: Site Visit

Figure 3.9: Plant 1 Urea Stripper



Source: Site Visit

Figure 3.10: Urea 1 P-102B Pump & Motor



Source: Site Visit

Figure 3.11: Equipment Choked with Catalyst



Source: NFCL

Figure 3.12: Removed Catalyst



Source: NFCL

- At site, Consultants had detailed discussions with NFCL team. This was followed by reconnaissance of various facilities for understanding the present condition and operation levels of the Plant. The equipment requiring replacement were validated during the visit by MM followed by verification of records.
- During the visit, MM observed extensive corrosion on critical equipment due to the saline environment and opines requirement of refurbishment and paint job.
- Based on the vintage of the plant, major equipment were noted to be due for replacement, this has been corroborated by MM with Company's records as well as Saipem life assessment report.

Due to the failure of Ammonia Plant 2 and non-spend of maintenance as indicated in life assessment study by Saipem and also based on the health of the plant, the reliability improvement measures post ammonia converter failure have increased substantially.

3.3 Civil & Infrastructure Repairs Plan

3.3.1 Current Condition – Civil Infrastructure

Figures below depicts damaged civil area which are due for repair and refurbishment

Figure 3.13: Cooling Tower Damages



Source: Site Visit

Figure 3.14: Cooling Tower damages



Source: Site Visit

Figure 3.15: Pipe Rack Damages



Source: Site Visit

Figure 3.16: Column damages



Source: Site Visit

Figure 3.17: Bagging Plant Damages



Source: Site Visit

Figure 3.18: Internal Damages – Bagging Plant



Source: Site Visit

Figure 3.19: Painting & Rust proofing Requirement



Source: Site Visit

Figure 3.20: Painting Requirement



Source: Site Visit

- During Site Visit, Consultants observed that the civil infrastructure were in dilapidated condition. This is noted to be on account of plant facilities being exposed to saline environment. The facilities in saline environment are to be regularly painted. In addition, the structures coming in contact/exposed to urea tend to corrode faster.
- Accordingly, major repairs and refurbishment are essential for process buildings, FG Silo, Bagging plant and common infrastructure like roads, drainage, etc. Areas identified for major civil work are as follows
 - Major buildings in complex – Roof treatment for water leakages & concrete spalling area
 - Cooling tower – Concrete repairs at basins and columns
 - Pipe racks – Re-concreting and strengthening the columns
 - Bagging plant – Re-concreting, replacement of corrosive reinforcement, reconstructing damaged brick work
 - All structures – Structural steel as well as RCC component require painting job
 - Internal factory roads – Bituminous coating and strengthening damage road area (especially at material handling area)
 - Prilling tower – inside coating and painting
- Activities and corresponding capex envisaged to strengthen and improve the overall condition of the civil infrastructure of the plant is given in tables below

Table 3.9: Civil & Infrastructure Estimate

S. No	Details of Requirement	Estimated Cost (INR Cr)
1	Cost of roof treatment required for all buildings and structures.	9.50
2	Cost of concrete repairs of Cooling Towers 1 and 2	1.80
3	Cost of Cooling Tower 1 and 2 damaged wooden structure repair/recondition	20.00
4	Cost of damaged concrete repairs in pipe racks and building in all plants	11.00
5	Cost of treatment of Bagging plant floors, which are damaged due to chemical attack	1.60
6	Total area (300000 sq meters) of Painting done for Plant 1, Plant 2 and off-sites during project stage	20.00
7	Cost of renewal bituminous coat on all roads in plant area	15.00
8	Cost of Railway Track maintenance to be taken-up to improve reliability	4.90
9	Prilling towers inside protective coating	2.50
10	Bagging plant building & RCC structures strengthening	1.20
Total		87.50

Source: NFCL

Following table depicts activities to be carried with respect to civil improvements at NFCL plant.

Table 3.10: Civil Improvement Activities – Appendix

S. No.	Activity	Repair Area	UoM	Area
1	Roof treatment	Silo	Sqmt	16960
		Stores	Sqmt	4500
		workshop	Sqmt	760
		MRSS (switch gear area)	Sqmt	550
		SS23	Sqmt	950
		SS3 (Balance area)	Sqmt	730
		Ammonia compressor hss	Sqmt	3470
		News club	Sqmt	1580
		Conveyor Gallery	Sqmt	4200
		Tech bldg & Lab	Sqmt	4800
		Gate hues, canteens, H bldg ,weigh bridge etc	Sqmt	2100
		Process plant1 &2	Sqmt	12900
		DM plant, PTP & ETP bldgs	Sqmt	9300
		Steam power generating plant & GTC bldg	Sqmt	5900
		Bagging plant	Sqmt	44400
2	Concrete repairs of Cooling Tower-1 and 2	ACT1 internal	Sqmt	1200
		ACT1 external	Sqmt	1800
		UCT1 internal	Sqmt	525
		UCT1 external	Sqmt	787.5
		ACT2 internal	Sqmt	1200
		ACT2 external	Sqmt	1800
		UCT2 internal	Sqmt	750
		UCT2 external	Sqmt	1125
3	Cooling Tower-1 and 2 reconditioning.	No of timber cells balance for re-conditioning	No.	11

S. No.	Activity	Repair Area	UoM	Area
4	Concrete repairs in pipe racks and building in all plants.	Scaffolding	CuMt	4000
		Repair	Sqmt	15600
		CFG Low bay roof Slant Area - strengthening	Sqmt	5940
		Side cladding area - strengthening	Sqmt	1920
5	Treatment of Bagging plant floors.	Floor area	Sqmt	20000
6	Painting of structures & buildings	Painting - Structural area	Sqmt	306000
		Painting - Building area	Sqmt	106000
7	Renewal of black topping on roads	Roads	Sqmt	165000
8	Railway track strengthening	5 points & crossings t be replaced	-	-
		CST 9 sleepers t be replaced with RCC sleepers	KM	6
9	Prilling towers inside protective coating	Prill tower Inside area - 2 tower	Sqmt	16465
10	Bagging plant structure strengthening	To connect the existing retaining walls which are not rested on the pile caps to the permanent columns	-	L.S
		Dismantling and re-building of office rooms		L.S
		Modification of conveyors structures resting and shallow foundations.		L.S
		Connecting of staircases to the main building columns and beams.		L.S
		To replace the hollow block masonry walls with brick masonry walls		L.S

Source: NFCL

- MM has relied on the area computed by NFCL for repair work.
- Though the rates estimated by the company is reasonable, variations could be in the range of 10-12% during actual execution.
- Given the extent of the damage/ dilapidation noted by MM during the site visit, urgent repair of these areas (refer photographs above) has to be undertaken on priority as part of the revival plan envisaged.

3.4 Maintenance Plan – Capital & Operational Expenditure by Saipem

3.4.1 Capital Expenditure

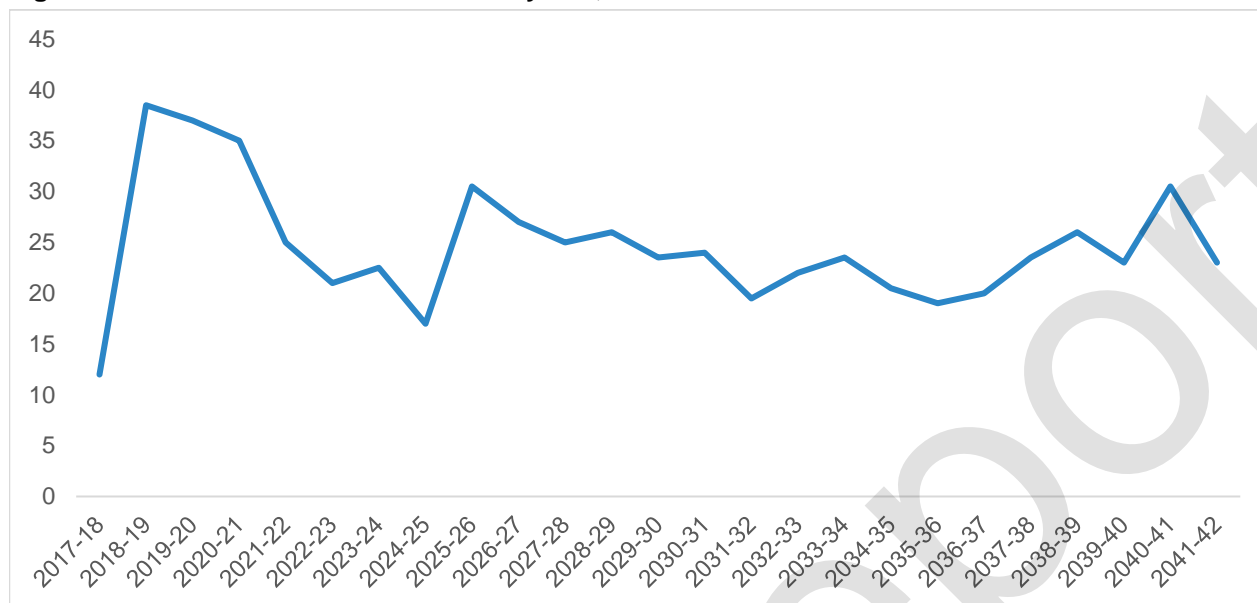
Capex projected for the next 25 years is shown in Table 3.11.

Table 3.11: Capex Plan

CAPEX	For 25 years (in ₹ Cr.)	Yearly Avg. (in ₹ Cr.)
Instrumentation	82.40	3.30
Static	296.00	11.84
Electrical	32.80	13.10
Rotating & Package	117.18	46.90
Piping	3.00	0.12
Bagging & CT	9.15	0.37
Grand Total	540.53	21.63

Source: Saipem

Figure 3.21: CAPEX Forecast for next 25 years, Rs. Crores



Source: Saipem

Table 3.12: CAPEX Plan – Plant Wise

CAPEX	For 25 years (in ₹ Cr.)	Yearly Avg. (in ₹ Cr.)
Ammonia-I	135.79	5.43
Urea-I	50.37	2.01
Ammonia-II	170.60	6.82
Urea-II	31.80	1.27
Offsite	115.86	4.63
Complex bulk	36.10	1.44
Grand Total	540.53	21.60

Source: Saipem

- Capital expenditures are the amounts that companies use to purchase major physical goods or services that will be used for more than one year.
- Average Capex requirement in next 25 years will be around 25 Cr. In 2018-19 the requirement will be around 40 Cr. The net total requirement of Rs 540.53 Cr will be required over the period of 25 years. The yearly average of Rs 21 Cr will be required for next 25 years. Static & packaging department will be having maximum requirement of Rs 296 Cr & 117.18 Cr respectively followed by Instrumentation department with requirement of Rs 82 Cr approximately.
- The CAPEX requirement for Ammonia – I is 25 % of the total requirement amounting to Rs 135 Cr approximately and Ammonia – II is 31% of the total requirement amounting to Rs 170 Cr approximately.

3.4.2 Operating Expenditure

Table 3.13: Operating expenditure. Plan

CAPEX	For 25 years (in ₹ Cr.)	Yearly Avg. (In ₹ Cr.)
Repairs & Maintenance	425.00	17.00
Chemicals & Consumables	175.00	11.00
Plant Roads & Building	20.25	0.81
Catalyst Replacement	139.85	5.59
Total OPEX	860.10	34.40

Source: Saipem & MM Analysis

- Operating expenses are the costs for a company to run its business operations on daily basis. The net total requirement of ₹ 860 Cr approximately will be required for the next 25 years. Repairs & maintenance along with chemicals sections form major portion of the Operating expenditure.
- Operating expenditure. expected for next 25 years with major requirement in repairs & maintenance of ₹ 425 Cr & ₹ 272 Cr in Chemicals & Consumables Section of the plant. Operating expenditure requirement of ₹140 Cr approximately in catalyst replacement section of the plant.

Taking cognisance of yearly average capex and opex indicated in table 3.1 and 3.3, the cost to be parked during the 2-year implementation period of energy scheme and reliability measure project works out to approximately ₹120 Cr.

While operating Unit-2, there was a breakdown in ammonia convertor on account of catalyst leaking out of the basket and subsequently damaging the downstream equipment. Company approached the ammonia process licensor – HTAS for possible remedial action. Being a proprietary made-to-order item – the basket manufacturing, shipping and installation takes about 24 months' timeframe and costs about ₹ 35 Cr. HTAS has suggested following options.

- Option-1 (Short Term): Temporary repair of the inside structure of the convertor where leaks have been identified followed by replacement of catalyst completely. The cost of replacement of catalyst is around ₹ 15 Cr which will be incurred twice in the refurbishment process. Apart from cost towards repair, the timeframe would be around 45-50 days with the plant shutdown of about 1 month.
- Option-2 (Long Term): Since energy reduction and reliability scheme have been planned by Company, during the 24-month implementation window of the above Project, order can be placed for manufacture of basket. The new basket can be installed along with the replacement of catalyst.

In case welding of metal during repair is not feasible due to operating constraints like exposure to high concentrations of Hydrogen, very high temperatures and operation cycles, Plant 2 cannot be operated until basket replacement.

Accordingly, NFCL has budgeted the costs towards additional catalyst procurement as well as temporary repair for operating the plant during the 24-month window. This works out to Rs. 30 Crores tentatively.

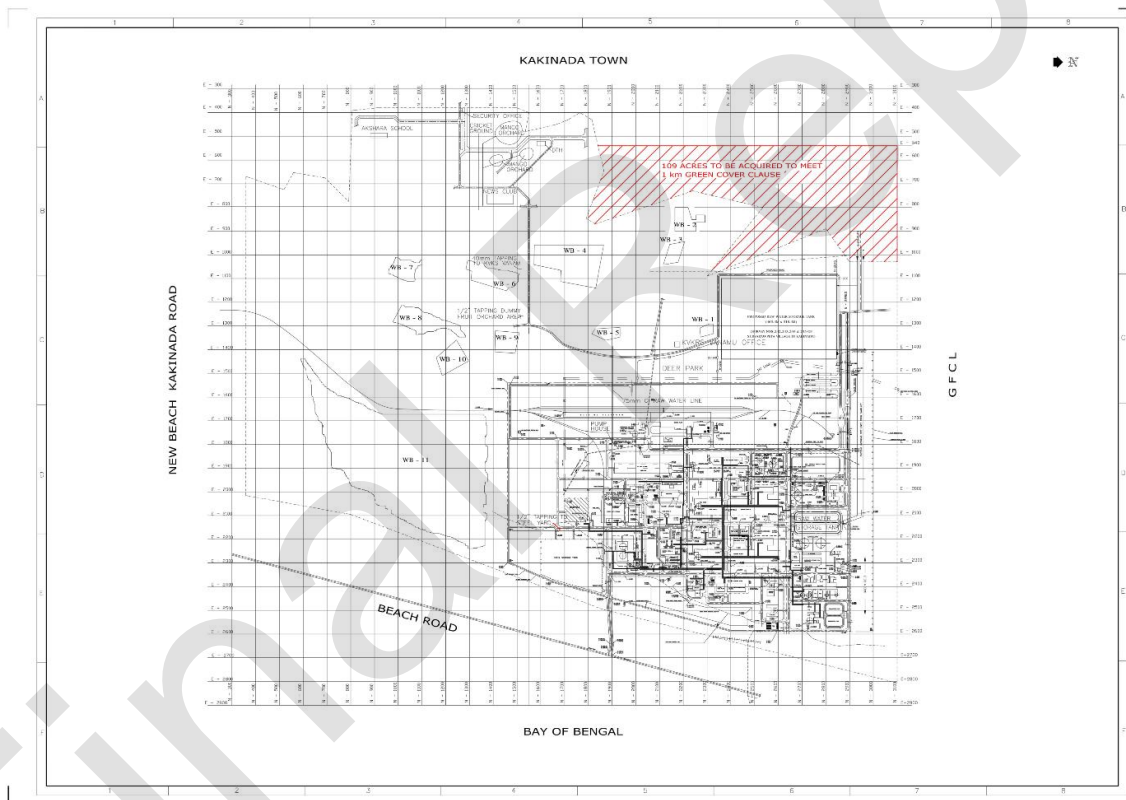
4 Environment & Compliance

The plant is maintaining a green belt of about 863 acres around the plant. The plant built up area is around 122 acres with roads, plant and non-plant buildings about 56 acres.

4.1 Additional Green Belt (GB) requirement

According to Hon'ble Supreme court order and based on expert committee report and 14.10.1985 first plant NOC (equivalent to current CFE), the company must maintain 1 KM wide green belt towards the west side of boundary. During recent due diligence it was found that the company does not have 1 km wide green belt on the west boundary at some portions. Figure 4.1 depicts the additional area identified to comply the requirement,

Figure 4.1: Plant Map & Additional area to meet Green Belt Clause



Source: NFCL

4.2 Statutory Documents Review

MM has reviewed following documents shared by NFCL with respect to Green Belt development as follows,

1. Consent for Establish (CFE) awarded by APPCB vide order no. 301/PCB/CFE/RO-KKD/HO/2008-939 Dtd. 01/07/2008.
2. Consent for Operate (CFO) awarded by APPCB vide order no. APPCB/VSP/KKD/10300/HO/CFO/2014-602 Dtd. 28/11/2014.

3. Auto renewal of Consent, Hazardous waste authorisation order for operations by APPCB Dtd. 28/02/2017.
4. Copy of Environmental Clearance (EC) awarded by MoEF, New Delhi for expansion of the plant vide file no. J-11011/17/94. IA-II (I) Dtd. 14/09/1994
5. Copy of Environmental Clearance (EC) awarded by MoEF, New Delhi for expansion of the plant for installing carbon dioxide recovery (CDR) plant at KAKINADA vide file no. J-11011/272/2007. IA-II (I) Dtd. 15/02/2008
6. Six monthly compliance reports submitted by the facility against the stipulated conditions mentioned in the CFO.
7. Green belt development plan, compliance part of EMP

4.3 Observation & Remarks

Following table depicts MM observations and remarks on development of greenbelt

Table 4.1: Observations and Remarks

S. No.	Document Referred	Observations/ Remarks
1	CFE awarded by APPCB vide order no. 301/PCB/ CFE/ RO-KKD/ HO/ 2008-939 Dtd. 01/07/2008.	Point no.14 of other conditions mentioned "Thick green belt shall be developed along the boundary of the industry". Point no. 16 indicate that the industry shall comply with all the conditions stipulated in the Environmental Clearance vide order Dtd. 15/02/2008.
2	CFO awarded by APPCB vide order no. APPCB/ VSP/ KKD/ 10300/ HO/ CFO/ 2014-602 Dtd. 28/11/2014.	<ol style="list-style-type: none"> 1. Point no.21 and 22 in Schedule B of the order mentioned that "Industry shall maintain the greenbelt in 789 acres and Industry shall comply with Hon'ble Supreme Court directions in WP no. 5357/1985". 2. The consents issued by the APPCB from time to time re-iterated that "the existing green belt of 789 acres shall be augmented and shall not be disturbed."
3	Auto renewal of Consent, Hazardous waste authorisation order for operations by APPCB, Dtd. 28/02/2017.	<p>The consent APPCB/VSP/KKD/ 10300/HO/CFO/2014-602 which was valid till 31/03/2017 was further renewed for a period of 5 years i.e., till 31/03/2022 on the following conditions.</p> <ol style="list-style-type: none"> 1. All the conditions mentioned in the Schedule A, B and C of the combined order of the CFO&HWA order issued by the board vide order Dtd. 28/11/2014 will remain same. 2. The industry shall comply with the standards issued by MoEFCC/CPCB from time to time.
4	Copy of Environmental Clearance (EC) awarded by MoEF, New Delhi for expansion of the plant vide file no. J-11011/ 17/ 94. IA-II (I) Dtd. 14/09/1994	<ol style="list-style-type: none"> 1. During expansion proposal of NFCL, The Hon'ble Supreme Court of India while passing the order WP no. 5357/1985 on 07/01/1995 stated that application is allowed granting permission to NFCL to carry out the expansion of the project subject to the conditions imposed by MoEF & SPCB from time to time and NFCL would abide by all the conditions so imposed. 2. APPCB while issuing NOC to NFCL vide letter Dtd. 14/10/1985 stipulated that "Provision of the green belt is the primary requirement for the approval of the site. Otherwise, this location is not acceptable", further it was mentioned that "the green belt will be so protected that nobody is allowed to remove the trees or shrubbery for use as firewood or to be cut off for any other purpose".

S. No.	Document Referred	Observations/ Remarks
5	Copy of Environmental Clearance (EC) awarded by MoEF, New Delhi for expansion of the plant for installing carbon dioxide recovery (CDR) plant at KAKINADA vide file no. J-11011/272/2007. IA-II (I) Dtd. 15/02/2008	<ol style="list-style-type: none"> 1. During expansion proposal of NFCL, MoEF while according the Environmental Clearance (EC) Dtd. 15/02/2008 stipulated a specific condition at Sl. No. IX "That green belt shall be developed in 789 acres (70%) out of total 1127 acres and existing plantation shall be properly maintained to mitigate the effects of fugitive emissions all around the plant as per the CPCB guidelines". 2. During this proposal for expansion by NFCL, the raw material and the fuel was changed to natural gas from naphtha, As per APPCB consent order the effluent discharge from NFCL is 3958 KLD say 4000 KLD for which 400 acres of land (1 acre = 10 KL discharge) is required for the discharge of treated effluents.
6	Six monthly compliance reports submitted by NFCL vide NFCL/ENV/APPCB/CFO/01/2021 Dtd. 28/01/2021 and NFCL/ENV/APPCB/CFO/02/2021 Dtd. 20/07/2021 to APPCB against the stipulated conditions mentioned in the CFO.	<p>NFCL had mentioned in their compliance reports</p> <ol style="list-style-type: none"> 1. NFCL is maintaining the green belt in 789 acres (Sr.No.20). 2. All the directives of Hon'ble Supreme Court in WP No. 5357/1985 have been complied to, at NFCL (Sr. No.21)

4.4 Conclusion and Recommendations

4.4.1 Conclusions

- Orders issued by Hon'ble Supreme Court of India while passing the order WP no. 5357/1985 cannot be overruled by NFCL and therefore green belt of 1 km by planting trees with different heights to provide a continuous integrated green leave wall shall be developed and maintained.
- Guidelines issued by MoEF & CPCB for Red category of MAH (Major accident hazards) units will be applicable to NFCL.
- With reference to condition no. 5 and 6 of (Environmental Clearance (EC) awarded by MoEF, New Delhi for expansion of the plant for installing carbon dioxide recovery (CDR) plant at KAKINADA vide file no. J-11011/272/2007. IA-II (I) Dtd. 15/02/2008) it is clearly mentioned that:
 - The Ministry may revoke or suspend the clearance, if implementation of the any of the conditions mentioned in EC is not satisfactory.
 - The Ministry reserves the right to stipulate additional conditions, if found necessary, the company in a time bound manner shall implement these conditions.

4.4.2 Recommendations

- NFCL should adhere with the guidelines of Hon'ble Supreme Court of India and Statutory conditions. Accordingly, NFCL has to either acquire the additional land of 109 acres as identified by Company and shown in Figure 4.1 to maintain 1km green belt or get a fresh approval from APPCB/ Hon'ble Supreme court regarding the same.
- NFCL is further advised to look for alternative options for safe storage of Ammonia as the industry is having 2 nos. of ammonia storage tanks of 5000 tones capacity, these tanks should either be shifted from industrial premises to bulk storage facilities, which are away from the habitations.
- Also, it was observed that habitation has come close to industry boundary and a school is existing near plant with a strength of approx. 2000 nos. Therefore, adequate mitigation measures should be adopted by NFCL in manufacturing, storage and handling of ammonia to the nearby habitation.
- QRA-DMP (Quantitative risk assessment and Disaster management plan) studies should be done for the plant and reports should be submitted to District authorities and APPCB.

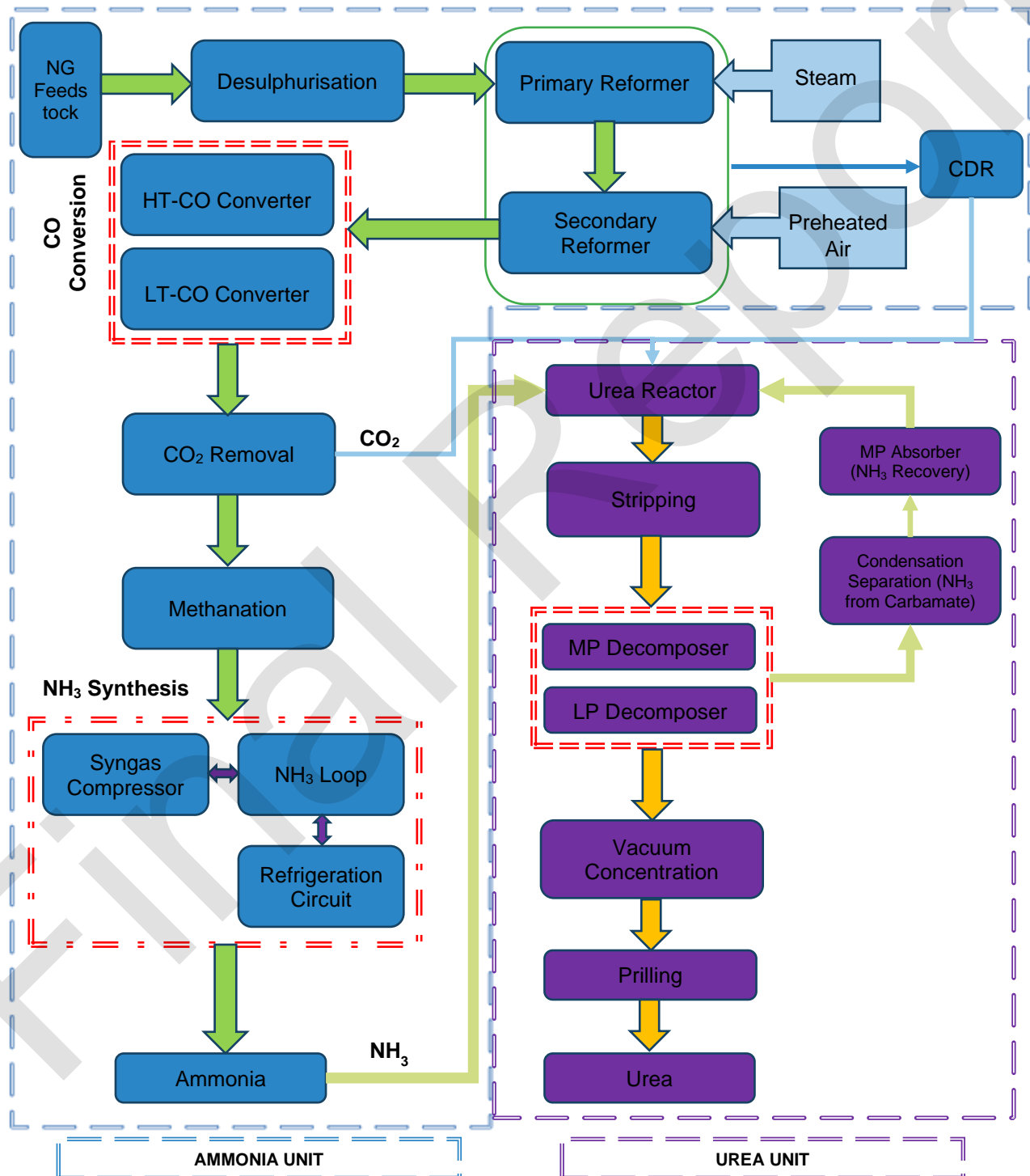
Appendices

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A. Process Description

Figure below illustrates the broad process flow.

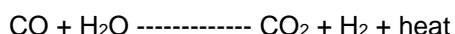
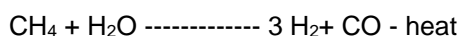
Figure A.1: Broad Process Flow Diagram



Source: MM, NFCL

A.1 Ammonia Unit

The feed stock natural gas is desulphurised by conversion of stable organic sulphur compounds into Hydrogen Sulphide in presence of Nickel Molybdenum catalyst followed by absorption of Hydrogen Sulphide on Zinc Oxide bed. The desulphurised natural gas is mixed with super-heated steam to give steam to Carbon ratio of 3.3:1, preheated and fed to the catalyst tubes in Primary Reformer. The Primary Reformer is a side-fired furnace with radiant burners. The natural gas, which is predominantly methane, undergoes following reactions producing Hydrogen and Carbon Oxides:

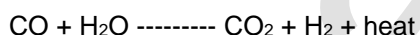


The process gas from the tubes is gathered by a collector system and sent to the Secondary Reformer.

The Secondary Reformer is a refractory lined vessel containing Nickel catalyst. Air from atmosphere comes in contact with the process gas from Primary Reformer. Combustion of some part of Hydrogen and Methane occurs consuming the total oxygen in the air and the temperature rises to about 1300 deg. C. This supplies the heat needed for completion of the endothermic reaction in the catalyst bed. Nitrogen needed for ammonia synthesis gets introduced in to the system in the Secondary Reformer through the process air. The gas leaving Secondary Reformer contains residual Methane of 0.6%. The exit gas from Secondary Reformer is cooled to about 380 deg. C in the Waste Heat Boiler where high-pressure steam is generated.

The carbon monoxide formed in the reforming step is converted to CO₂ by water gas shift reaction in two stages, namely, high temperature shift conversion and low temperature shift conversion. The HT shift reaction takes place in presence of iron oxide chromium oxide catalyst and LT shift reaction takes place in presence of copper oxide zinc oxide catalyst. The shift conversion reaction being exothermic, steam is produced by heat recovery.

The reaction-taking place in the shift conversion can be represented as:



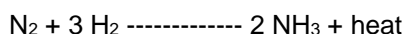
The process gas leaving the CO conversion step contains in addition to Hydrogen and Nitrogen, large quantity of CO₂ and small quantities of CO, Argon and Methane. The CO₂ present in the process gas is removed in the CO₂ removal section using Giammarco Vetrocoke process. Here, CO₂ absorbed in potassium Carbonate solution is regenerated by reducing the pressure and addition of heat in two stage regenerators. The regenerated solution is pumped back to the absorber. Thus, the system operates in closed circulation. The CO₂ gas stripped from the solution in the regenerators is cooled and sent to Urea plant.

The process gas exit absorber now contains only traces of CO and CO₂. Since carbon oxides act as poison to the ammonia synthesis catalyst, the residual carbon oxides present in the process gas are converted into methane in a methanator reactor containing nickel catalyst. This step is the reverse of reforming reaction and consumes a small amount of hydrogen.

The methanator exit gas after cooling and removal of condensate is the synthesis gas with some interests. This gas is compressed from 24 Kg/Cm²g to 134 Kg/Cm²g in a centrifugal syn gas compressor. Also, there is a recirculation stage in the compressor where the recycle of

unconverted gas along with the compressed make up gas are further compressed to about 142 Kg/Cm²g. This gas after pre-heating is admitted to ammonia synthesis converter containing promoted iron catalyst, where Hydrogen and Nitrogen combine to form ammonia with evolution of heat.

The ammonia synthesis reaction is:



The gas from the converter is cooled in a series of heat exchangers including a Waste Heat Boiler. The condensed ammonia is separated, and the uncondensed gases are recirculated back to the converter via the recirculator compressor. The product ammonia is cooled to a temperature of -33 deg. C by means of ammonia refrigeration system. The inerts level in the synthesis loop is kept low by taking an inerts purge and sending the same to the purge gas recovery unit where ammonia and Hydrogen are recovered, and the remaining off gas is used as fuel. The product ammonia is pumped to the ammonia storage tanks or directly to Urea Plant.

As the Natural Gas is lean, CO₂ available will be lower than that required for converting available ammonia to urea. This will result in surplus ammonia. Excess gas firing will be required to avoid the ammonia accumulation. Table A.1 summarizes the ammonia block key steps / reactions.

Table A.1: Key Steps / Reactions in NH₃ Block

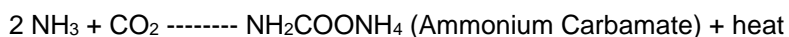
Section / Step	Unit process/operation	Description
Desulphurization	Hydrogenation and Absorption	Sulphur is reacted with hydrogen to form hydrogen sulphide and then stripped in the absorber $\text{ZnO} + \text{H}_2\text{S} \rightarrow \text{ZnS} + \text{H}_2\text{O}$
Primary reformer	Catalytic reforming	Methane converted to CO, H ₂ , CO ₂ $\text{CH}_4 + \text{H}_2\text{O} \leftrightarrow 3\text{H}_2 + \text{CO}$ (Endothermic) $\text{CH}_4 + 2\text{H}_2\text{O} \leftrightarrow 4\text{H}_2 + \text{CO}_2$ (Endothermic)
Secondary reformer	Catalytic auto-thermal oxidation	Residual methane conversion to CO ₂ and H ₂ $2\text{O}_2 + \text{CH}_4 \leftrightarrow 2\text{H}_2\text{O} + \text{CO}_2$
High temperature shift conversion	Water-gas shift reaction at high temperature	CO converted to CO ₂ at high temperature $\text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2$ (Exothermic)
Low temperature shift conversion	Water-gas shift reaction at low temperature	Residual CO converted to CO ₂ at low temperature $\text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2$ (Exothermic)
Carbon dioxide absorption	Chemical Absorption	CO ₂ absorbed through OASE process
Carbon dioxide stripping	Stripping	CO ₂ stripped through OASE process
Methanator	Methanation	CO ₂ and CO traces in process gas are converted to methane $\text{CO} + 3\text{H}_2 \leftrightarrow \text{CH}_4 + \text{H}_2\text{O}$ (Exothermic) $\text{CO}_2 + 4\text{H}_2 \leftrightarrow \text{CH}_4 + 2\text{H}_2\text{O}$ (Exothermic)
Synthesis gas compressor	Centrifugal compression	To develop operating pressure for synthesis reactor
Ammonia synthesis reactor	Formation of ammonia	Ammonia formation and liberation of dissolved gases $\text{N}_2 + 3\text{H}_2 \leftrightarrow 2\text{NH}_3$ (Exothermic)
Chilling	Heat exchange	Ammonia vapour cooling
Refrigeration and compression	Screw compression	To liquefy ammonia for storage
Purge gas and recovery	Absorption, separation	To separate traces of nitrogen, argon, methane and hydrogen in the process

Source: MM Analysis

A.2 Urea Unit

The production of Urea requires ammonia and CO₂ as the inputs, both of which are available from Ammonia plant. The CO₂ from ammonia plant is compressed to about 160 Kg/Cm² and sent to the Urea Reactor. Liquid Ammonia is pumped using high-pressure reactor feed pump and along with recycle carbamate enters into Urea Reactor. Urea Reactor operates at about 156 Kg/Cm² and 188 deg. C.

Following reactions take place in the Urea Reactor:



The product stream from the Urea Reactor contains in addition to Urea, large quantity of unconverted ammonia, CO₂ and water. The ammonium carbamate in the product stream is recovered in three stages viz., high pressure stage, medium pressure stage and low-pressure stage by decomposing the carbamate into ammonia and CO₂, separating the gases from the liquid product stream and recondensing the gases back to carbamate solution which is recycled back to the Urea Synthesis Reactor. In this process, the product stream becomes richer and richer in the urea content. In the high-pressure section, separation of Ammonia and CO₂ in the falling film of liquid in the tubes is stripped by ammonia vapour. Medium pressure steam supplies the required heat.

As the Urea Reactor operates with excess ammonia, the excess ammonia is recovered in ammonia condenser. The product stream leaving the low-pressure section contains 70% Urea. This is further concentrated in the vacuum concentrators to get 99.8% Urea melt. This molten Urea is pumped to the top of urea prilling tower and fed into a prilling bucket. The prilling tower of 22-M diameter and 75 M free fall height operates under natural draft. The Urea prills from the bottom of the prilling tower are transported through mechanised belt conveyor system into urea storage silo or directly to urea bagging plant. The bagged urea is dispatched by rail wagons/road trucks. Table A.2 summarizes the key steps / reactions of urea block.

Table A.2: Key Steps / Reactions in Urea Block

Section / Step	Unit process/operation	Description
CO ₂ compression	Compressor/turbine	Compressed to 160 kg/cm ² (g)
Urea synthesis and high-pressure recovery	Formation of ammonium carbamate and its dehydration into urea. Recovery and recycling of excess / unreacted NH ₃ , CO ₂ and ammonium carbamate	Urea production at 190 - 210 °C, 160 kg/cm ² (g) $2\text{NH}_3 + \text{CO}_2 \leftrightarrow \text{NH}_2\text{COONH}_4$ (ammonium carbamate) $\text{NH}_2\text{COONH}_4 \leftrightarrow \text{NH}_2\text{CONH}_2 + \text{H}_2\text{O}$ The above reactions are exothermic
Medium pressure purification and recovery	Stripping	Purify urea stream by stripping NH ₃ and CO ₂ at 17.5 kg/cm ² (g)
Low pressure purification and recovery	Stripping	Purify urea stream by stripping NH ₃ and CO ₂ at 3.8 kg/cm ² (g)
Vacuum concentration	Vacuum evaporation	Concentration of urea by removing water under vacuum.
Prilling tower	Prilling	Formation of urea granules from urea melt

Source: MM Analysis

A.3 CDR Unit

The Flue Gas from Primary Reformer enters the Flue Gas Quencher, where it is cooled to 40°C. The Flue Gas is compressed to a pressure of 1.113 Kg/cm² (a) and enters the CO₂ Absorber. The CO₂ in Flue Gas is absorbed by KS-1 Solvent, which is distributed from top through packed bed system. Subsequent to contact with KS-1 Solution the Flue Gas is further washed with DM Water in the top section of CO₂ Absorber. The Flue Gas after removal of CO₂ is sent out to atmosphere through a stack provided at CO₂ Absorber top. The CO₂ rich solution at 55°C is pumped to the Lean / Rich Heat Exchanger. The Lean Solution is recycled back to CO₂ Absorber. The rich solution stream is heated up to 114 °C and sent to CO₂ Regenerator, wherein CO₂ is stripped off from rich solution by providing necessary heat to Reboiler using Low Pressure Steam. The CO₂ thus liberated is washed with DM water at the top of CO₂ Regenerator, cooled to ambient temperature in an overhead condenser and sent to Urea Plants

B. Replacement Equipment

Section below gives details of replacement equipment identified by NFCL post ammonia convertor failure

B.1 Replacement based on Saipem's Life Assessment Study

Table B.3: Equipment Replacement – As per Saipem's Life Assessment Study

S. No	Equipment / Item	Cost of Equipment - INR Cr
1	Plant-I Primary Reformer Tubes replacement	20.00
2	Plant-II Primary Reformer Tubes replacement	20.00
3	Urea-I reactor Relining	15.00
4	Urea-II Reactor Relining	18.00
5	GT-A & B Mark-IV Control System Up gradation (for both GTs)	17.00
6	Urea-I Stripper Replacement	16.20
7	Back-end Boiler for Ammonia-II	14.00
8	U-I & II CO2 compressor Inter-stage Coolers & Separators replacement	12.50
9	Additional stream in Bagging plant	12.50
10	SS-1 & 21 Up gradation (Switch Gear and Relay system up gradation)	12.00
11	Compressor rotor for GT-C & stator blades	12.00
12	Replacement of E/EE-510 (3 Nos)	10.00
13	BFW Exchangers	10.00
14	Ammonia-I Primary Reformer Catalyst Replacement	9.00
15	Ammonia-II Primary Reformer Catalyst Replacement	9.00
16	Plant-I & II CW Header, Lines & Raisers Replacement	6.00
17	4 CT Cells Re-construction	6.00
18	Ammonia-II Secondary Reformer Catalyst Replacement	5.85
19	GT-C Overhauling including Electrical Generator	5.00
20	Electrical AVR Up gradation	4.00
21	1 PRDS station Up gradation in each Ammonia plant	4.00
22	EE-504 for Ammonia-II	4.00
23	Urea HP loop Valves and Piping	3.60
24	Replacing & Keeping Ready Spare Critical Motors	3.50
25	E-421 First inter stage cooler for Process air compressor in Ammonia-1	2.80
26	Ammonia-I Primary Reformer Pig tails & Hot Collector Replacement	2.50
27	Urea-I CO2 Compressor Vibration Monitoring System up gradation from existing 7200 Series to 3500 Series	2.50
28	HT Shift Catalyst for Ammonia-II	2.40
29	WBA & SBA for DM Plant (for 5th DM Chain)	2.40
30	Up gradation of Unit-II vibration monitoring system	2.20
31	3.3KV PCC, MCC at Plant-1 and bagging repairs and retrofits	2.00
32	Electrical RLA & Safety Systems	1.95

S. No	Equipment / Item	Cost of Equipment - INR Cr
33	Methanator Feed-Effluent Exchanger EE-311B replacement	1.65
34	AMF-I Up gradation including Alternator, AVR & Protection relays up gradation	1.56
35	Restoration of Civil structures in the Complex	1.35
36	Urea-II Ammonia Pre-heater (EE-122) retubing	1.20
37	MRSS Up gradation	1.00
38	A-II HDS Catalyst Replacement	1.00
39	A-II ZnO Catalyst Replacement	1.00
40	Replacement of HP Ammonia Feed Pump VFD in U-II (for one pump among EP-101 A/B/C)	0.90
Sub Total – A		277.56

Source: NFCL

B.2 Additional Equipment to be replaced for Reliability based on Present Health of Units

Table B.4: Equipment Replacement – As per Present Health of Plants

S. No	Equipment / Item	Cost of Equipment - INR Cr
1	Up gradation of Urea-I P-102B Pump & Motor	18.00
2	Suction Chilling for Urea-I CO2 Compressor	12.00
3	Implementation of Energy Saving Schemes suggested by Energy Audit	7.50
4	Installation of NG filters at B/L of each Ammonia Plant	6.25
5	A-I Cold Box Exchanger replacement	6.25
6	Common Railway track doubling	4.85
7	HRSG-C Screen Tube Header replacement	2.50
8	A-I PAC Inter-stage Cooler (E-422/423) Replacement	2.50
9	LP & MP NG Knockout Drums at B/L Area	2.50
10	HRSG-C CPH replacement	2.40
11	Analyzers of Ambient Air Monitoring Stations	2.10
12	Boiler-I RGAH replacement	2.20
13	AST 1 Tank decommissioning and Inspection	2.00
14	Up gradation of existing IACs in IG plant	2.00
15	To install Neem Oil manufacturing facility	2.00
16	Complete Cold collector for A-II	2.00
17	Strengthening the SS tank filling system.	1.50
18	Existing Common Railway track strengthening (NFCL Share)	1.50
19	Critical & Limiting Control Valves Upgradation	1.50
20	Ammonia-I PGRU Up gradation with the study outcome of Linde / Costain	1.40
21	Modifications at NG Skid Area - changing HP & MP Letdown valves to Control Valves etc.	1.40
22	New Instrument Air Compressor	1.27
23	ICC Consumables & minimum essential spares	1.20

S. No	Equipment / Item	Cost of Equipment - INR Cr
24	ID and FD fan Clutch for Ammonia-II	1.20
25	P-101 manifold block in SS material	1.10
26	CC TV Control Room server with CC's.	1.05
27	E-119 higher capacity exchangers	1.00
28	Ammonia Refrigeration Compressor in Ammonia Storage (K-1401)	1.00
29	GT-C Load gearbox high speed shaft	1.00
30	Installation of Online Analyzers for measuring Emissions as per PCB Statutory requirement	1.00
31	Replacement of Prill Tower lift rope and suspending mechanism with wedge type for Plant-I & II	1.00
32	GT-B Generator-B overhauling as per running hours and mechanical schedule (Electrical Scope)	1.00
33	Additional Battery Stack for GT-C UPS for redundancy.	1.00
34	GTC & GT-B Spare AVR Panel	1.00
35	Upgradation of compressor vibration monitoring system (Balance)	1.00
36	DSTK-431 Electronic Governing System & Hardware.	1.00
37	Submersible Pumps for ETP Effluent transfer	1.00
38	Ammonia Condensers in AST	1.00
39	One Ammonia Transfer Pump (P/EP-501) Replacement with Higher Capacity in each Ammonia Plant	1.00
40	Pressurisation fans for all Electrical Substations	1.00
41	MAC Elements Replacement in IG Plant	0.80
42	New Motor for BFW Pump in A-I	0.75
43	IAC Inter stage Coolers replacement in IG Plant	0.60
44	Oxygen Analyzers (4 Nos) - Ammonia Plants	0.50
45	Resins and Activated Carbon for DM Plant	0.50
46	Cationic Conductivity Meters	0.50
47	Items Below Rs.50 lakhs each (104 Items)	8.98
Sub Total - B		116.80

Source: NFCL

