Table 4.1: Aerial distances of different facilities from the proposed project location

Sl. No.	Facility Name	Distance (km)	Sl. No.	Facility Name	Distance (km)
1	Ghorasal Municipality	4.2	10	Ghorasal Power Station (GPS)	1.30
2	Polash Upazila HQ	4.73	11	Gazaria Union HQ	7.2
3	Jinardi Union HQ	6.6	12	Panchdona Union HQ	7.8
4	Bahadursadi Union HQ	2.7	13	Panchdona Road Morr	10.0
5	Jamalpur Union HQ	2.5	14	Railway line	5.80
6	Moktarpur Union HQ	3.1	15	Zero point at Dhaka	36.0
7	Char Sindur Union HQ	4.2	16	Shahjalal International Airport	28.0
8	Tongi Power Station	24.7	17	Aggreko Rental Power	0.90
9	Regent Power	1.88	18	Max Power Station	0.80

Source: Imagery and NWRD of WARPO archived in CEGIS using GIS tool

Table 4.2: Major point sources of pollution around the Project site

Sl. No.	Name/Type of Industry/Pollution Source	Within Aerial Distance from the Plant Location
1	Ghorasal Power Plant	1.20 km
2	Janata Jute mill	2.78 km
3	Ghorasal Power Station	1.30 km
4	PRAN Industrial Park	3.8 km
5	Amigo Bangladesh Limited	5.03 km
6	Omera Petroleum Limited LPG Satellite Plant	4.6 km
7	Shun shing Power plant	6.78 km
8	RFL Industries Park	7.85 km
9	Aggreko International Power Plant	0.90 km
10	Regent Energy and Power plant	1.88 km
11	Polash Upazila	4.73 km
12	Ghorasal Rail Station	5.80 km
13	Ghorasal Sub Power plant	6.25 km
14	Bangladesh Jute Mills Limited	6.73 km
15	Aqua Refinery Limited	7.74 km
16	Momtex Expo Limited	9.41 km
17	Hamid Fabrics Limited	10.27 km
18	Gazi Textile	7.50 km
19	Shibpur Upazila	11.25 km

Source: Development of GIS based industrialdatabase of the DoE, 2015

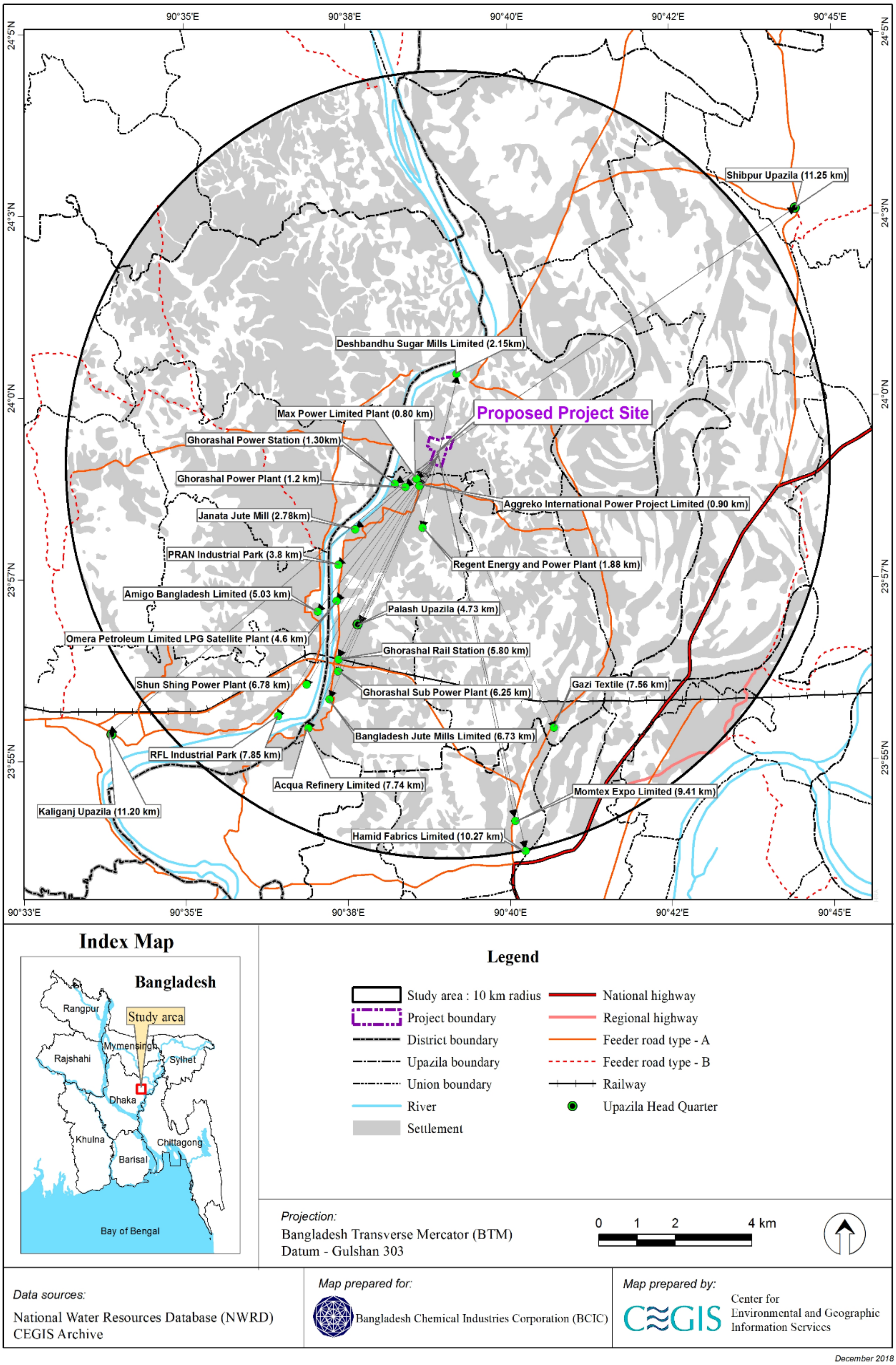


Figure 4.3: Distances of polluting industries from the Project site

217. Different types of infrastructures of a total area of about 6,37,263 sqft (59,204 sqm) located in the eastern side of the PUFFL will be dismantled and decommissioned. The area of such infrastructures will be replaced by the components of the proposed project.

218. The proposed utility boiler (60mX100m), central store (120mX48m), ammonia plant (230mX135m), cooling tower (210mX66m), central control room (60mX40m), urea unit (96mX135m), demi water unit (60mX51m), pumping station (80mX51m), ammonia storage tank (104mX74m), power plant (77mX81m), Waste Water Treatment System (WWTS)/Effluent Treatment Plant (ETP) (75mX50m), etc. will be installed at the eastern side of the PUFFL unit. The new equipment will be sited in the 110 acres of land designated for the construction work, which is now covered by grasses and bushes and occupied by some old office buildings, warehouses and other structures mentioned in Table 4.3. There are a number of other major point sources in the air shed and their distance from the GPUFP site is presented in Table 4.2.

219. Installation of major components of the proposed urea plant will require a land space of roughly 450 m width and 650 m length though the size of each facility will be finalized during detail engineering stage.

4.3 Project Impact Area

220. Siting of project components will require roughly 450 m width and 650 m length land within the PUFFL property boundary. The Department of Environment (DoE) requires a 10 km radius area as minimum, centering the stack location of the proposed urea fertilizer plant. This 10 km radius is used for environmental quality baseline and ecology and fisheries impact assessment (Figure 4.4). A two (02) km buffer area from the project boundary has been considered as Direct Impact Area (DIA) as the impact nature of the proposed project from different components support it (Figure 4.5). In the cumulative impact assessment, an air shed of 25 km x 25 km is considered centering the stack of GPUFP for air quality impact, water quality impact in the Shitalakhya, and water demand assessment.

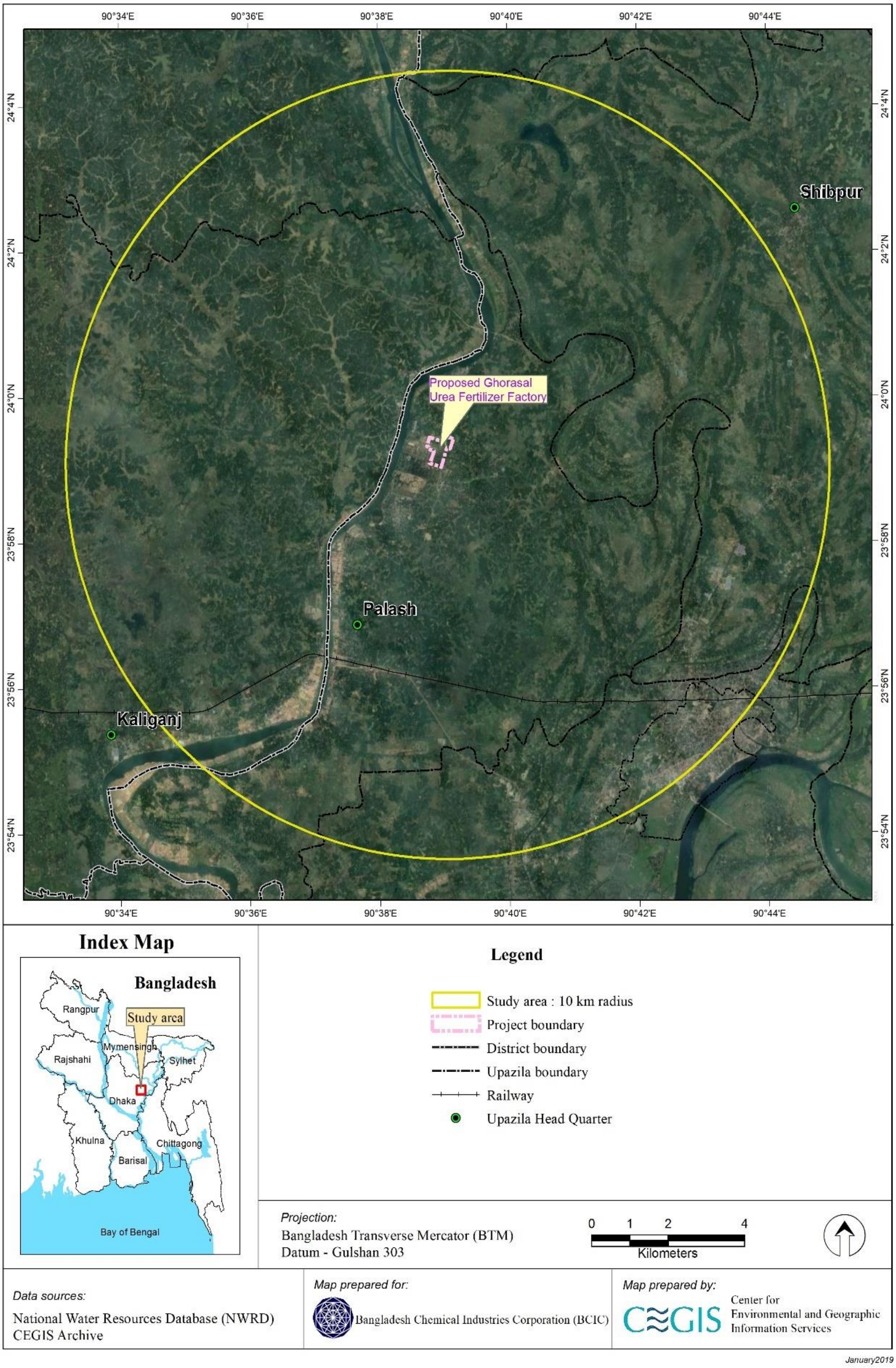


Figure 4.4: Study area (general impact area)

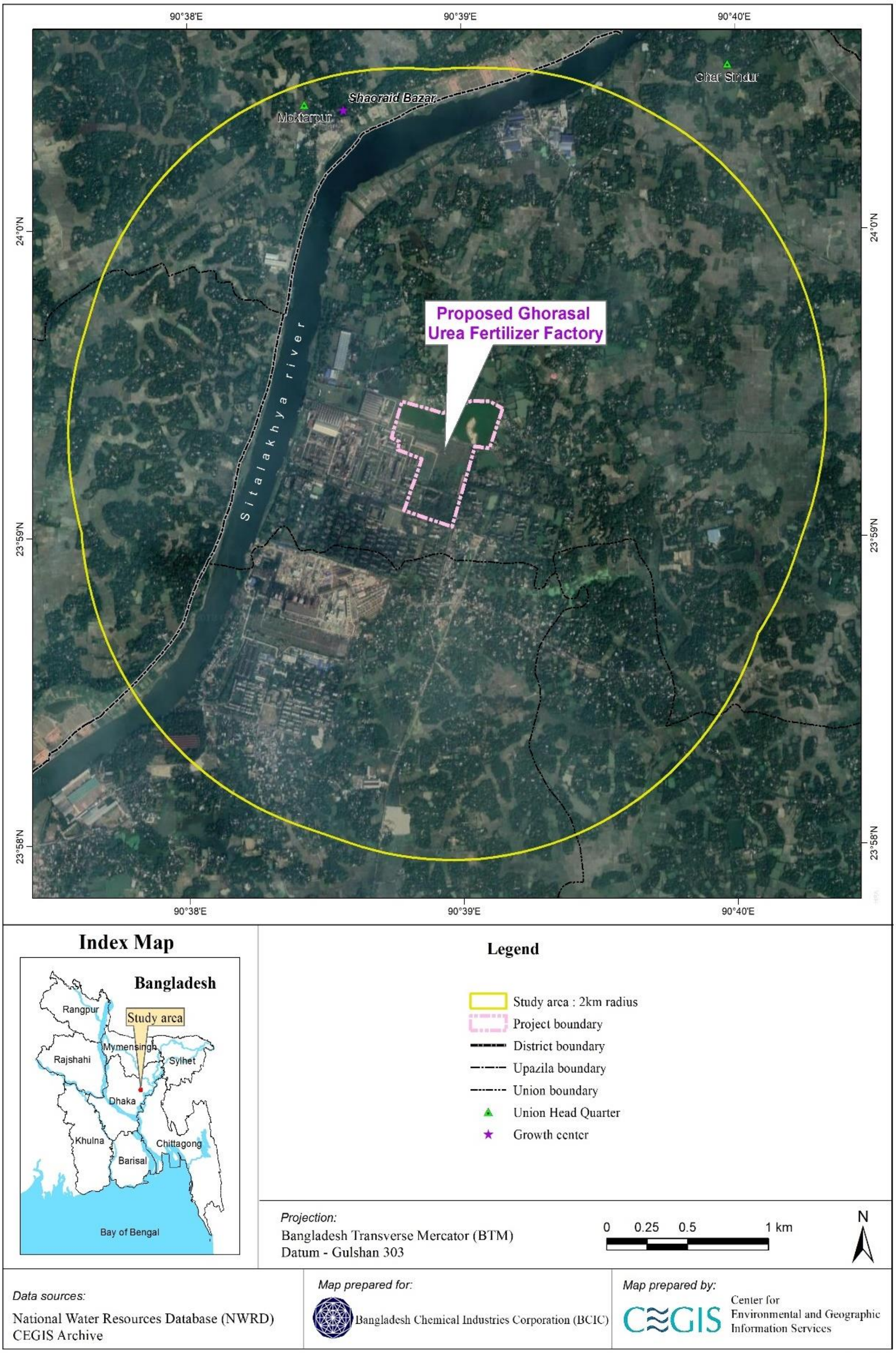


Figure 4.5: Direct impact area for the proposed Project

4.4 Nature and Size of the Project

221. The project involves dismantling of the existing infrastructures located inside the Project site. The nature of the proposed Project is a new construction of natural gas-based granulated urea plant. The urea production capacity of the proposed Project is 2,800 TPD and annual production capacity is based on 330 stream days in a year. For fulfilling the power requirements, the proposed project will have a 2x32 MW Steam Turbine Generator (STG) and one 09 MW GEG power plant as captive plant for its day to day use.

4.5 Project Concept

222. The proposed Project is a new construction of urea plant of about 0.924 million tons of urea at the rate of 2,800 TPD (based on 330 operating/stream days per year). Commissioning of the Urea Fertilizer Factory of above capacity will be done by installing utility boiler, central store, ammonia plant, cooling tower, central control room, urea unit, demi water unit, pumping station, ammonia storage tank, power plant, WWTS/ETP, etc. The proposed project will have a 2x32 MW ST and one 09 MW GEG Power Plant as captive plants for its day to day use. According to the agreement, Titas Gas Transmission and Distribution Company Ltd. (TGTDCL) used to supply about 64.7 MMCFD (UFFL- 48 and PUFFL- 16.7 MMCFD) natural gas at normal supply condition and ensured to supply to the UFFL and PUFFL about 70 MMCFD (UFFL- 52 and PUFFL- 18 MMCFD) natural gas at maximum supply conditions through the existing gas network and the proposed Regulating Metering Station (RMS).

223. Raw water withdrawal from the Shitalakhya River is about 2,040 t/h (0.5667 m^3/s), after storage tank it becomes about 1,159 t/h (0.3219 m^3/s) and the net water intake is about 1,020 t/h (0.2833 m^3/s) will be used for plant's cooling and all other purposes as stipulated below, such as open recirculation cooling (cooling water of 0.2325 m^3/s), other plant use (0.0508 m^3/s), etc.

224. Product urea in bags will be conveyed by a closed conveyor belt to the jetty to be constructed on the left bank of the Shitalakhya River. From the jetty, the urea will be transported by barges. The bagged urea will also be transported by trucks and rail wagons through road and railways respectively. A railway line from the site to nearby mainline will be constructed too.

4.6 Project Components

225. The project components are broadly categorized into two types, such as (i) dismantling component; and (ii) new construction component.

4.6.1 Dismantling Components

Demolition of Existing Infrastructures

226. The existing infrastructures which fall under the proposed project site will be dismantled. The type of infrastructures and the area these belonged to are as follows: buildings of an area of about 1,87,404 sqft (17,410 sqm), semi-pucca tin-shed building of an area of about 94,680 sqft (8,796 sqm), RCC (brick chips) road of an area of about 167,494 sqft (15,561 sqm), RCC (stone chips) road of an area of about 1,680 sqft (156 sqm), carpeting road of an area of about 86,550 sqft (8,040 sqm), boundary wall of an area of about 44,343 sqft (4,120 sqm), tin-shed/asbestos sheet/scrap yard/heavy vehicle of an area of about 10,525

sqft (977 sqm) and Titas infrastructure of an area of about 44,587 sqft (4,142 sqm) (Table 4.3). Approximately 27,400 tons of debris will be generated due to demolition of civil structures. For storing the debris generated from dismantling of infrastructure components will require an estimated area of about one (01) acre and spacious scrap site will be required temporarily or sold out to the relevant vendors. The existing stores/warehouses will be dismantled.

227. The project site is largely covered by grasses and having different species of trees, shrubs and climbers. Among the trees, the major ones are timber trees followed by fruit and other trees. The major timber trees are: Shegun, Mahogoni, Raindee Koroi, Kanthal, Sirish, Koroi, etc. The fruit trees are: bael, beetel nut, jackfruit, papaya, coconut, , lemon, mango, cashew nut, blackberry, embelic, etc. Trees fall in other category include Jhau, Kamini, Debdaru, Neem, Krishnochura, Bot, Daruchini, etc. A 'Demarcation Report' has been prepared and appended in *Annex 4-1*. Based on the report it is concluded that about 3,750 small to big trees (sapling mostly, juvenile and adult) will be cut down during site preparation. The trees found in the site were planted by PUFFL as a part of a greenery program from the date of commissioning of the Plant.

228. The hazardous waste generated from demolition of infrastructures will be treated as per the WBG's General EHS Guidelines, 2007 and WBG's Good Practice.

Table 4.3: List of infrastructures inside the proposed site of GPUFP

Sl. No.	Name of Infrastructures	Measurement (in sqft)
1	Administrative office building area (Two storied)	17,026
2	Technical office building area (Two storied)	13,596
3	Canteen building area	2,040
4	General store building area	30,450
5	General store semi-pucca asbestos sheet roof with M.S. tress	21,750
6	Security post (Two storied)	72
7	Factory out gate security office	364
8	Factory main gate security office	960
9	Receiving bay store office	1,200
10	Security office (Housing colony gate)	420
11	VIP Guset House building area	8,390
12	Medical Center (Three storied) and Porch	10,962
13	Officer's Club (Two storied), one storied and Porch	10,572
14	Officer's Hostel (Five storied), Porch, Passage (Three storied)	26,021
15	Employee's Hostel (Five storied), Passage, Porch	30,954
16	Union Office (One storied)	2,592
17	Employee's Club (Two storied) and Porch	9,285
18	UFFL Lagoon pump house	750
A	***Sub-total building area=***	***1,87,404***
B	***Sub-total semi-pucca tin-shed building area=***	***94,680***
C	***Sub-total RCC (Brick chips) road area=***	***1,67,494***
D	***Sub-total RCC (Stone chips) road area=***	***1,680***
E	***Sub-total carpeting road area=***	***86,550***
F	***Sub-total boundary wall area=***	***44,343***
G	***Sub-total tin-shed/asbestos/scrapyard/heavy vehicle area=***	***10,525***
H	***Sub-total Titas infrastructure area=***	***44,587***
I	**Grand Total Demolished Area=**	**6,37,263 sqft~59,204 sqm**

Source: Final Report from Demarcation Committee, BCIC, 2017

Composition of Spent Catalyst

229. Spent catalysts form the major part of the solid wastes generated in the fertilizer complex. Catalyst wastes include nickel, iron, iron oxide/chromium oxide, copper oxide/zinc oxide and aluminum oxide. The catalysts used in the existing Ammonia Plant of the PUFFL are listed in the Table 4.4.

Table 4.4: List of Catalysts used in existing Ammonia Plant of PUFFL

Sl. No.	Name of Vessels	Composition (wt%)
1.	DSV (Desulphurization Vessel)	ZnO=90; SiO_2=5-10; S=<1500ppm; Cl=<200ppm; As=<1ppm
2.	Primary Reformer	Ni=12-22; SiO2=0.1 ppm(max); S=500 ppm(max); Na=500 ppm(max); Al=Balance
3.	Secondary Reformer	Ni=19; SiO2=2000ppm(max); S=500 ppm(max); Na=500 ppm(max); Al=Balance
4.	HTS	Fe_2O_3=87-91; Cr_2O_3=6-10; CUO=1.5-2.1; C/Graphite=1.5-3.0; Al=<1.0
5.	LTS	CUO=52; ZnO=29; NiO=<0.03; Al_2O_3=<1.0; SiO_2= <0.01; S=<0.04; N=<0.06
6.	MTN	Ni=20$\pm$2; SiO2=2000 ppm(max); S=100 ppm(max) Cl=500 ppm(max)
7.	ACV	Fe_2O_3=65-68; FeO=30-37; Al=1.8-3.0; K_2O=.6-1.0 CaO=.2-.7

Source: BCIC, 2018

4.6.2 Newly Construction Components

230. The major components of the proposed GPUFP can be categorized in three systems/processes. These are: (a) Process Plants; (b) Utility; and (c) Off-sites.

(a) Process Plants: The process plants include the following components-

- Ammonia Plant;
- Urea Plant; and
- Urea Granulation Plant.

(b) Utility: The utility services are composed of following components-

Sl. No.	Components	Sl. No.	Components
1	River water intake Unit	7	Natural Gas Metering Station
2	Water Treatment Unit plus distribution system	8	Inert Gas Generation and Storage Facilities
3	Cooling water (Cooling Tower)	9	Waste Water Treatment System (WWTS)/ Effluent Treatment Plant (ETP)
4	Steam generation Facilities plus distribution system	10	Polyethylene Bag Making Plant
5	Electrical Generation Facilities and Power Distribution System	11	Central Control room, Substation, Switch room, etc.
6	Instrument Air and Plant Air Facilities	12	GEG, Emergency Generator & UPS

(c) Off-sites: There are some components of the proposed GPUFP which will function as forward linkages of the project. The components are as follows:

Sl. No.	Components	Sl. No.	Components
1	Ammonia Storage Unit	7	Road, Paving, Fencing, Lighting, Drainage Network
2	Urea Handling, Bulk Storage, Bagging Facilities and Bagged Urea Storage	8	Vehicle parking
3	Laboratory facilities	9	Buildings for different uses (Control Room, Administrative, Technical, Maintenance, Engineering, Security, Township etc.)
4	Warehouse for Spares, Catalysts, Resins, Chemicals, Consumable, etc.	10	Ammonia Bottling station
5	Maintenance shops (Mechanical, Electrical, Instrument)	11	Jetty
6	Fire Fighting System including First Aid Center	12	Water Intake

231. Building Infrastructures: The off-sites include the buildings for different uses of the GPUFP. The total number of new buildings and sheds to be constructed are 52. In these buildings, the number of Plant Buildings are 23 and Non-Plant Buildings are 29. The total number of floors of all 52 buildings are 71.

4.7 Resources and Utility Demand

232. Resources required to develop the project include soil, construction material, manpower etc. The site is a part of the existing urea fertilizer plant and of the same level, therefore will need only minor earth dressing except the lagoon. Filling up the lagoon will need soil which may be collected from nearby the Shitalakhya River through dredging. The estimated dredged materials will be about 2,26,700 m^3. The dredging activities may loosen contaminated bed materials (sediment) and entrain into the food chain of fish and other aquatic organisms. Local construction material will be used for the proposed project and the project will provide employment for unskilled, semi-skilled and skilled categories. Employment opportunities will be available with the start of construction activities and continue through the operation phase, mainly in service sector.

233. Electricity demand during the construction phase will be met by the existing sub-station and distribution facility. During the construction period, water can be fetched from the nearby Shitalakhya River and drinking water can be drawn from existing underground sources such as Deep Tube well. Natural gas as fuel will be available under the existing supply of the TGTDCL from nearby Regulating and Metering Station (RMS) for the proposed GPUFP. Waste will be disposed of in the approved designated site preferably apart from the Plant site.

234. A temporary sanitation facility for the workers during pre-construction and construction phases will be developed with septic pits or tanks with adequate capacity. The sewerage system will be connected to the existing facility.

235. A temporary road and drainage system will be developed in addition to the existing system until a final road and drainage system is constructed.

4.8 Source of Natural Gas and Quality

236. At present the gas is supplied to the PUFFL and UFFL by the Titas Gas Transmission and Distribution Co. Ltd (TGTDCL) of PetroBangla through a 8˝ diameter pipeline and a Regulating and Metering Station (Titas RMS) situated at the Northeast corner of the PUFFL and UFFL complex. The natural gas is supplied under a contract for maximum 70 MMCFD but currently being used 64.7 MMCFD of natural gas for operating UFFL and PUFFL. The contract needs to be maintained to meet the demand of gas for operating the proposed Project.

237. Natural gas will be supplied to the plant site through the existing pipeline system with minimum expected gas pressure at the plant boundary is 7-10 kg/cm^{2}G (6.9-9.8 bar). Considering distance from the location of existing RMS a new NG receiving system will be required to be installed in the space available at the Southwest side of the proposed site. A 8˝ diameter gas pipeline from inlet header of the Titas RMS up to the bus of the proposed gas station mentioned above is to be constructed. Existing and proposed gas supply arrangements are presented in Figure 4.6 and Figure 4.7 and the composition of gas used in the urea plant is presented in Table 4.5.

Table 4.5: Gas analysis report

Gas Composition	% Mole in Gas using PUFFL and UFFL	Expected as per Tender Document
Nitrogen	0.788	0.55
CO_2	0.008	0.43
Methane	97.644	96.6
Ethane	1.544	1.7
Propane	0.006	0.36
Normal Butane	0.002	Butane, i C_4H_{10}: 0.09 and Butane, n C_4H_{10}: 0.052
Hexane Plus	0.008	-
Air/O_2	-	0.10
Hydrogen Sulfide	-	2 ppm max
Calorific Value	>1,000 kcal/Nm^3	8691.98 kcal/Nm^3 (approx.) Lower Heating Value

Source: Bangladesh Gas Fields Company Ltd.

4.9 Pipelines for Natural Gas and new Gas Regulating and Metering System

238. At present the gas is supplied to PUFFL and UFFL from Titas Gas Transmission and Distribution Company Ltd. (TGTDCL). A Gas transmission line constituting 46.31 km distance from Titas field through one DN16 diameter pipeline with 1,000 psi pressure comes to Narsingdi (Figure 4.7). From Narsingdi VS#12, 2 nos. DN 14 of 22.31 km transmission line with the same pressure of 1,000 psi is connect to a Regulating and Metering Station (RMS) situated at the PUFFL and UFFL Complex (Figure 4.8). Gas inlet pressure of Titas RMS varies from 420 psi to 600 psi. A 8˝ diameter gas pipeline from inlet header of the Titas RMS up to the site will be constructed along with a new NG receiving system.

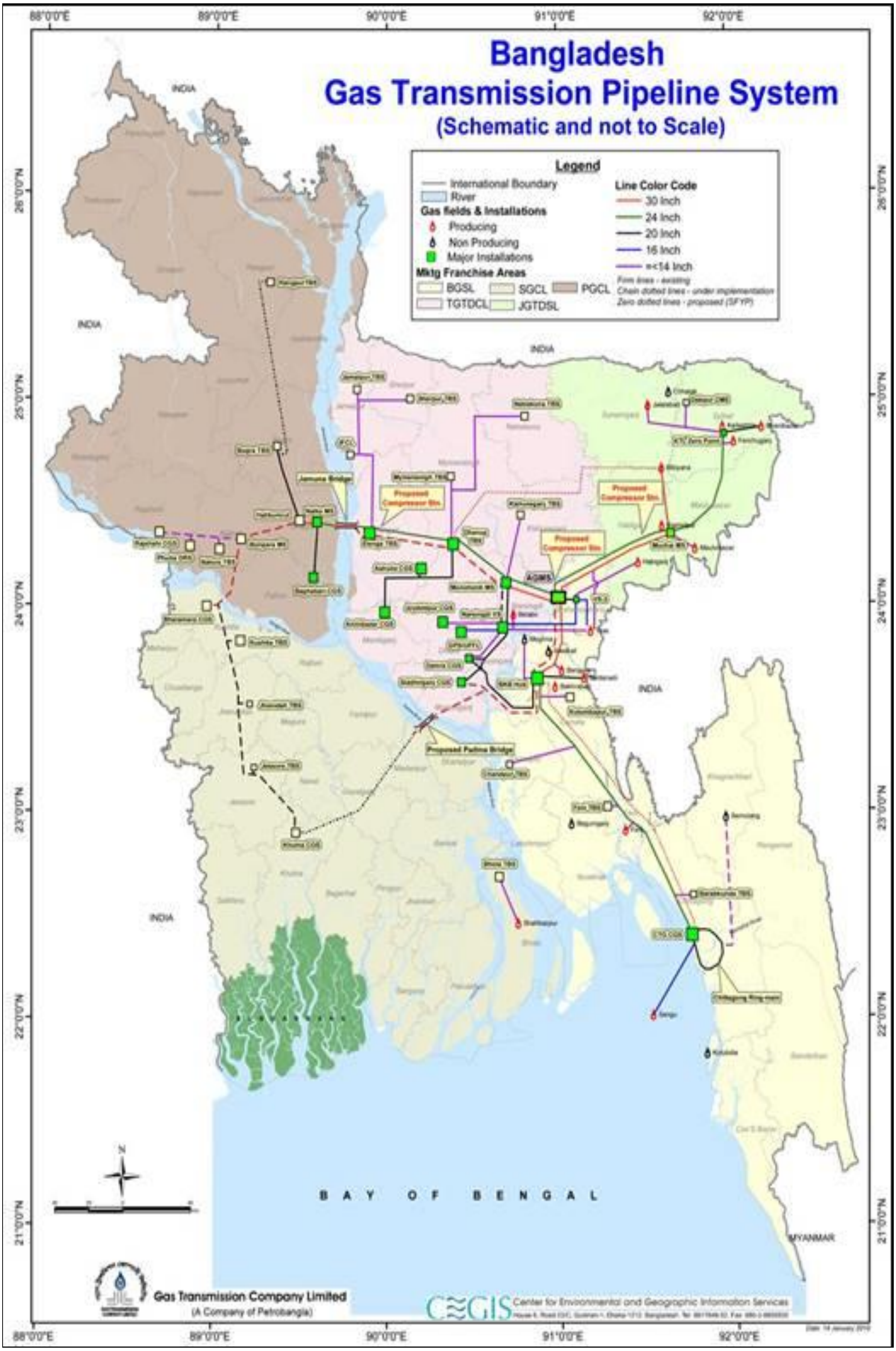


Figure 4.6: Gas transmission network

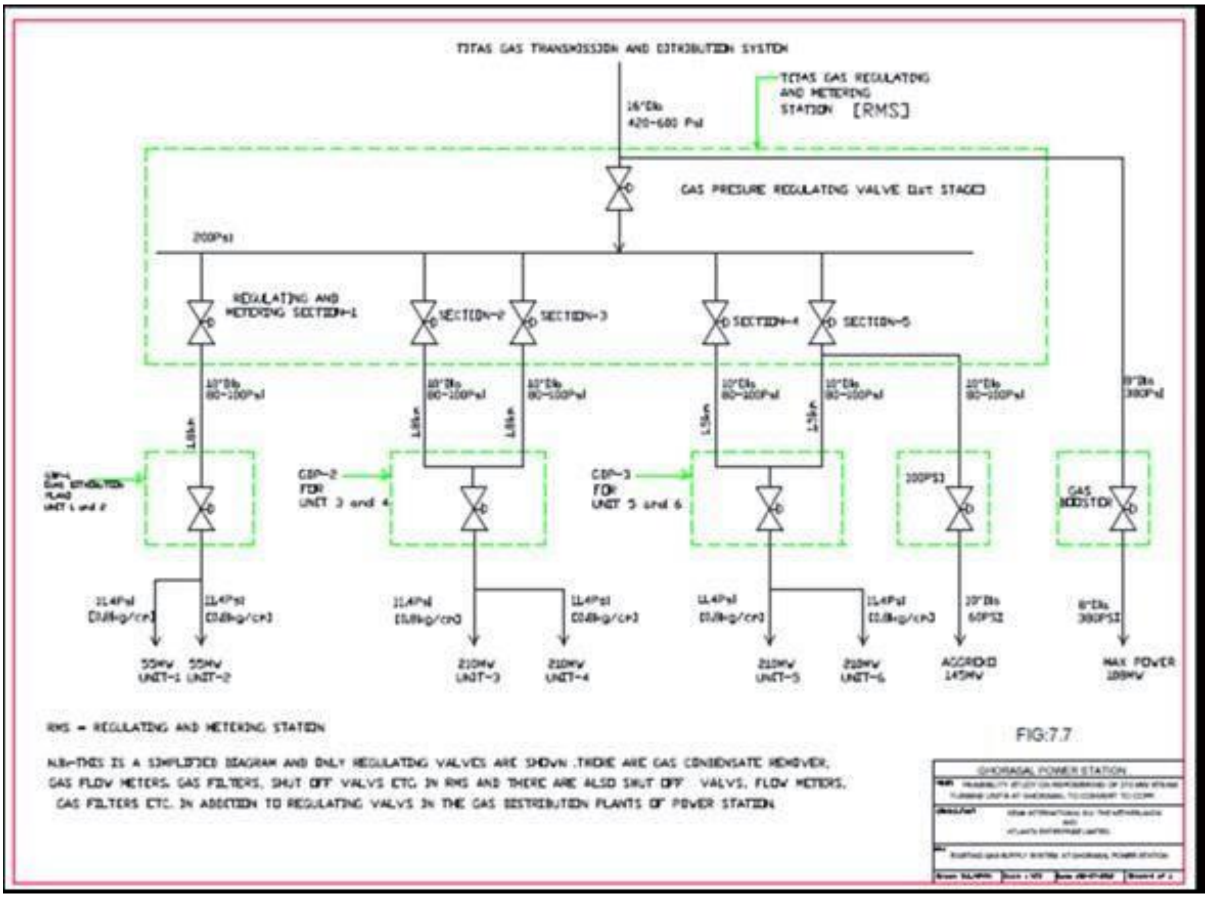


Figure 4.7: Existing Ghorasal gas connection system

4.10 Project Activities and Schedule

4.10.1 Project Activities

239. There are two main project activities, (a) Demolition of existing Infrastructures and (b) New Construction of Urea Fertilizer Factory. A list of project activities and associated concerns are given below in Table 4.6.

Table 4.6: List of activities and associated concerns

Sl. No.	Activities	Concerns
A.	**Pre-Construction Phase**	
A1.	Demolition of infrastructures and scraping	• Dismantling activities for the existing civil structures will result in loose soil within the complex. Wind flow is strong during dry months. Thus, the dust generated during the construction activities may spread to the nearby areas • Marginal exhaust emissions from dismantling equipment • Scrapping time dust emission • Noise generation • Management of spent catalysts • Associated risks
A2.	Site preparation	• Clearing of vegetation and removal of top soil • Labor mobilization

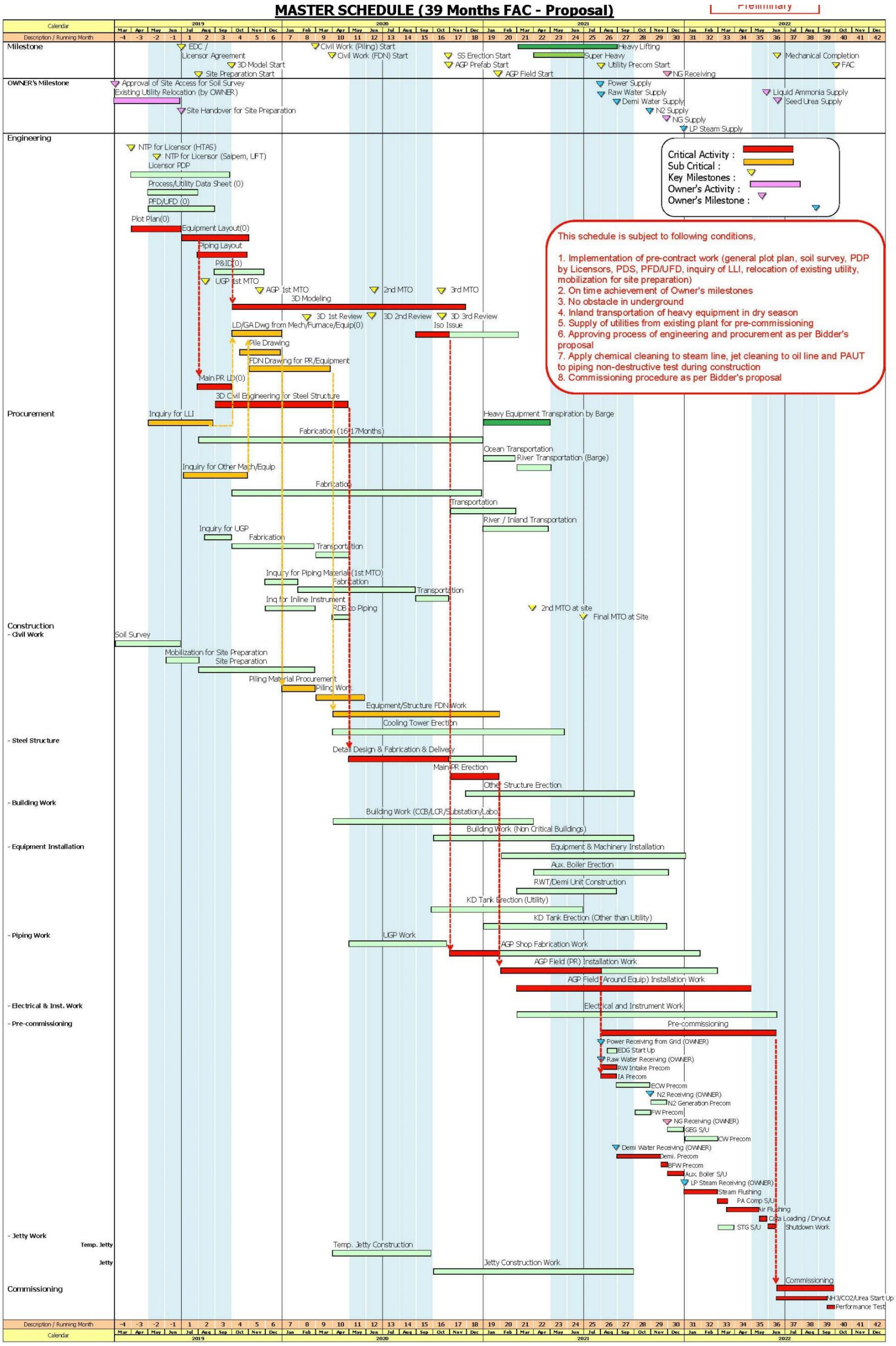
Sl. No.	Activities	Concerns
		• Lagoon to be filled up by dredged materials from the Shitalakhya River
A3.	Transportation with respect to equipment and materials procured and Site receiving, Handling and Warehousing which include:	
	A3.1 Unloading at the site	Vehicular movement; noise generation
	A3.2 Storing	
	A3.3 Receiving and issuing of equipment and materials	
A4	Temporary Works (needed by the contractor) include:	
	A4.1 Temporary warehouse	Vehicle movement; dust and solid waste generation; generation of sewage
	A4.2 Temporary office	Vehicle movement; dust and solid waste generation; generation of sewage
	A4.3 Water supply within the site	Drainage system
	A4.4 Electricity supply within the site	Pressure on grid and local allocation.
	A4.5 Temporary sewer and drainage system	Hygienic condition of labor shade, office and construction site; Drainage system would facilitate drainage of construction waste water.
	A4.6 Temporary firefighting equipment & first aid facilities.	Fire induced risk would be reduced.
	A4.7 Temporary site canteen	Solid wastage
	A4.8 Camp accommodation for contractor's and its subcontractor's personnel	Land requirement (estimate land area based on area requirement per person), solid waste, sewage, drainage, etc.; Social pressure in local market; Society may feel pressure in the following areas: mixing with local people, anarchy, diseases, house rent may increase, etc.
	A4.9 Other temporary facilities within the site as required such as scaffolding, fencing, guard house etc.	Construction of trenches, Construction waste, dust
B.	**Construction Phase (Construction and Erection work)**	
B1.	**Construction Work**	
	B1.1 Civil work (piling, foundation, structure, buildings, shades, roads, drains, pavements, etc.)	Vehicular movement and operation of construction equipment: Noise, dust, exhaust emissions (marginal increase in the levels of SO_2, NO_X, PM, CO and un-burnt hydrocarbons), construction liquid waste, solid waste, drainage, etc.
	B1.2 Shipment of Machinery to the site	Temporary load of barges increase; marginal exhaust emission; bilge and ballast water may affect water quality, etc.
B2.	**Erection Work: Installation Work (all equipment, package units if any etc.)**	

Sl. No.	Activities	Concerns
	B2.1 Piping Work B2.2 Electrical Work B2.3 Instrumentation Work B2.4 Insulation Work B2.5 Painting Work	Noise, dust, exhaust emissions (marginal increase in the levels of SO_2, NO_X, PM, CO and un-burnt hydrocarbons), construction liquid waste, solid waste, drainage, risk, health and safety, etc.
	B2.6 Flushing and Chemical Cleaning	Chemical contamination to ambient water environment
B3.	B3.1 Jetty construction	• Pile driving may affect aquatic biodiversity, vocalization behavior of the organisms may be affected. • Obstruction to water flow
C.	**Operation Phase**	
	C1. Water intake (2040 t/h) from the Shitalakhya River	Pressure on the river and environmental flow; Aquatic biodiversity; LLP-based agriculture
	C2. Drainage of rejected water C3. Sludge to Shitalakhya River	Contamination to water quality; Aquatic biodiversity, soil contamination, etc.
	C4. Effluent (chemical/fertilizer and oily)	Chemical/fertilizer mixed water pass through the ETP and oil-mixed water through oil separator.
	C5. Boiler (Aux.) and Gas Engine Generator	Flue gas (NOx, Particulate substances)
	C6. Ammonia plant	
	Ammonia Plant	Flue gas (negligible NOx); Noise
	CO_2 recovery plant	Exhaust CO_2
	C7. Urea Plant	
	Urea Granulation Plant	• Urea dust • NH3 (<150 mg/Nm^3-dry) • Noise
	C8. Officials (Administrative, Plant operation, Control Tower, etc.) C9. Labor requirements	Sewage, potable water requirements, solid waste, risk, etc.
	C10. Jetty operation	Solid and liquid waste
	C11. Dispatch of urea	Water, Rail and Road ways; Bilge and ballast water waterway vessel may contaminate water; Vehicle load will be increased; social mobilization may be hampered; exhaust emission (NOx, CO_2, dust, etc.)

4.10.2 Project Implementation Schedule

240. The duration of the Project is about 39 months, started from July, 2019 to September, 2022. The detail schedule of the Project implementation from Site Preparation to Commissioning is given in Table 4.7.

Table 4.7: Project implementation schedule



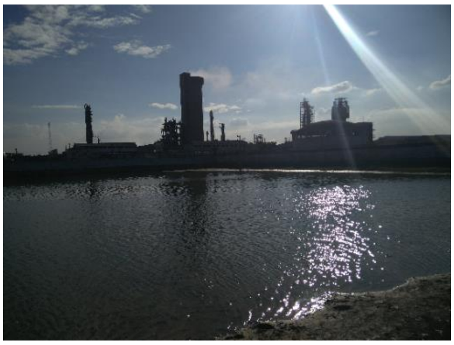
5. Project Design and Description

5.1 Overview of Existing Facility

241. At present, there are six urea fertilizer factories under BCIC. Out of these, the Ghorasal area has two Urea Plants: Urea Fertilizer Factory Ltd. (UFFL) and Polash Urea Fertilizer Factory Ltd. (PUFFL). The installed capacity of six urea fertilizer factories under BCIC is 2.80 million MT. However, due to aging some of these Plants cannot sustain the installed capacity and gradually the production is decreasing.

242. The UFFL is one of the old fertilizer plants in the country and was established in 1970. The installed production capacity of the plant was 340,000 tons of urea per year and the renovated capacity is 470,000 tons per year. At present production has come down to 600 TPD from 1,400 TPD.

243. The PUFFL having yearly production capacity of 95,000 tons of Prilled Urea was established in 1985. The economic life of the project was 15 years. The present production comes down to 250-300 TPD from 305 TPD. Figure 5.1 shows the existing major equipments of the PUFFL.



PUFFL

Compressor

Water Intake Point

Acid Tanks

Figure 5.1: Existing infrastructures of the PUFFL

5.2 Proposed Project Design

5.2.1 Design Life and Operating Time

244. The design life is 20 years for the process plant subject to appropriate maintenance and replacement for items such as catalysts, furnace tubes and mechanical seals which have

shorter life duration and will require replacement during the life of the Process Plant. The operating time/stream time of the proposed plant is 330 days per annum.

5.2.2 Technology Selection

245. The technologies or Process Licensors for Ammonia, Urea Melt, Granular Urea and CO_2 Recovery from Primary Reformer have been selected for this Project based on different aspects mentioned in Sections 3.8, 3.9, 3.10 and 3.11 respectively. The selected Process Licensors are attributed in Table 5.1 below.

Table 5.1: Process Licensors selected for the Project

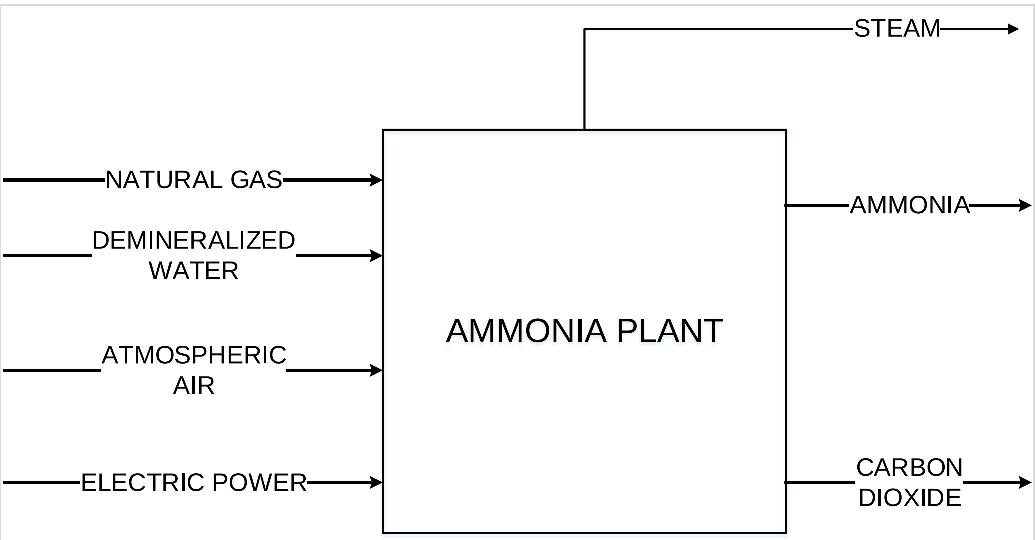
Sl. No.	Process Name	Name of Process Licensor
01.	Ammonia	Haldor Topsoe A/S (HTAS), Denmark
02.	Urea Melt	SAIPEM S. p. A., Italy
03.	Urea Granulation	thyssenkrupp Fertilizer Technology GmbH (TKFT), Germany
04.	CO_2 Recovery from Primary Reformer	Mitsubishi Heavy Industries, Ltd (MHI), Japan

5.2.3 Process Description

Ammonia Process

246. The proposed ammonia plant is designed with a capacity of 1,600 MT/day, based on steam reforming of natural gas. In the plant, ammonia is produced from synthesis gas containing hydrogen and nitrogen in the ratio of approximately 3:1. Furthermore, high purity CO_2 is produced from the CO and CO_2 contained in the reformed gas. Besides these components, the synthesis gas contains inert gases such as argon and methane to a limited extent.

247. The source of H_2 is demineralized water and the hydrocarbons in the natural gas. The source of N_2 is the atmospheric air. The source of CO_2 is the hydrocarbons in the natural gas feed. The main function of the plant is illustrated in the following sketch. The main function of the Ammonia Plant is illustrated in the following sketch and diagram in Figure 5.2.



Sketch of the Ammonia Plant

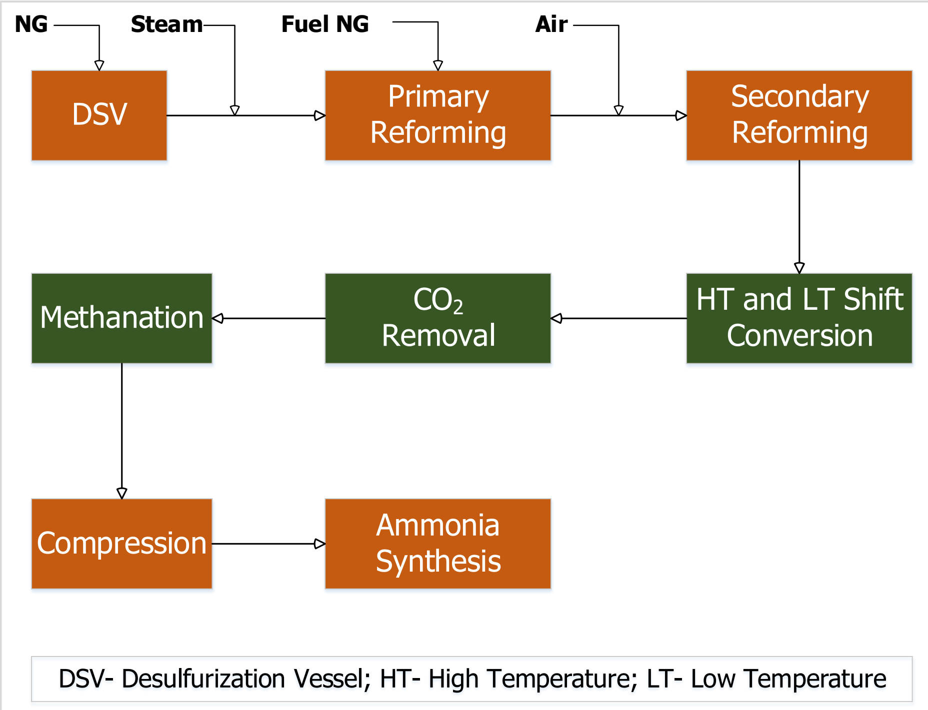


Figure 5.2: Sketch and flow diagram of ammonia synthesis

248. The process steps involved in production of Ammonia are:

- Desulphurization
- Reforming
- Carbon Monoxide Conversion
- Carbon Dioxide Removal
- Methanation
- Ammonia Synthesis
- Ammonia Refrigeration Circuit
- Ammonia Recovery
- Steam System
- Flare and Verit System

249. The descriptions of the various process steps are as follows:

Step-1: Desulfurization

250. The natural gas feedstock contains minor quantities of sulfur compounds which have to be removed in order to avoid poisoning of the reforming catalyst in the primary reformer and in the low temperature CO converter.

251. Natural gas from battery limit at 3.96 MPa g is mixed with recycle gas and heated to 370°C in the flue gas section of the primary reformer. Desulfurization is achieved by converting organic sulfur compounds to H2S. H2S is subsequently absorbed on a specially prepared zinc oxide catalyst, contained in sulfur absorbers. The sulfur contained in the natural gas will be reduced to less than 0.05 vol. ppm.

Step-2: Reforming

252. The reforming of the hydrocarbon feed takes place in two stages, a direct fired primary reformer and an autothermal catalytic secondary reformer.

253. The primary reformer is divided into two chambers having a common flue gas duct and a flue gas heat recovery section. In the primary reformer the hydrocarbon mixed with steam is decomposed into hydrogen, carbon monoxide, and carbon dioxide over a nickel catalyst. Flue gas flow is upwards with a temperature of about 1050°C.

254. In the secondary reformer methane is decomposed. The methane concentration in the outlet gas from the secondary reformer is 0.3 vol% (dry basis).

255. Thus, the reforming unit consists of a primary reformer with a waste heat section and a secondary reformer.

Flue Gas Heat Recovery Section

256. The flue gas then passes via the flue gas duct to the flue gas heat recovery section, where most of the heat of the flue gas is utilized for preheating purposes and then leaves through the stake at a temperature of about 190°C.

Secondary Reformer

257. The gas from the primary reformer is passed on to the secondary reformer where it is mixed with the compressed process air at about 3.38 MPa g and is preheated to 550°C.

258. The process gas leaves the reforming section at about 998°C. It is cooled to about 442°C in the RG waste heat boiler, where 12.26 MPa g saturated steam is produced, and further to 360°C in the RG steam superheater. After cooling, the gas flows to the high temperature CO Converter.

Step-3: Carbon Monoxide Conversion (CO)

259. The CO conversion takes place in two adiabatic stages- HT & LT converters. After reforming, about 13.47% CO is present in the gas (dry basis). In the high temperature CO converter the CO content is reduced to approximately 3.19 vol%, and the temperature increases from 360°C to 433°C. It is then cooled to 205°C and passed on to the low temperature CO converter, in which the CO content is reduced to approximately 0.3 vol%, while the temperature increases to 228°C.

Step-4: Carbondi Oxide (CO_2) Removal

260. The gas leaving the CO conversion unit contains a considerable amount of recoverable heat. The waste heat in process gas is recovered in a high pressure Boiler Feedwater (BFW) preheater, in the stripper reboiler and in the demineralized water preheater.

261. Carbon Dioxide (CO_2) is removed from the process gas by counter-current absorption in two stages using an activated Methyl Di-Ethanol Amine (aMDEA) solution. For removal of the CO_2, BASF's OASE process is used. Main equipment in the OASE process is the CO_2 absorber, and the CO_2 stripper. In the lower part of the CO2 absorber, flash-regenerated solution is used for bulk CO removal. In the upper part of the absorber, strip-regenerated Solution is used for scrubbing.

262. The extracted CO_2 will be delivered cooled to 43°C and at a pressure of 0.05 MPa g. In this way, a nearly complete removal of CO_2 with only 0.05 vol% CO_2 (on dry basis) left in the treated gas is obtained at the expense of very low heat consumption.

Step-5: Methanation

263. After the CO_2 removal, the gas contains 0.05% CO_2 and 0.36% CO (dry basis). These compounds are poisonous to the ammonia catalyst and must be removed before the. gas is taken to the synthesis section. This is done in the methanator where CO and CO_2 react with H_2 to form CH_4 , which is harmless to the ammonia catalyst. The reaction takes place over a nickel-based catalyst. The content of CO + $C0_2$ is reduced to less than 5 ppm. The outlet gas is cooled with the inlet gas and finally cooled to 42°C.

Step-6: Ammonia Synthesis

Compression

264. The synthesis gas is compressed from 2.55 to 18.73 MPa g by the centrifugal synthesis gas compressor.

Synthesis Loop

265. At this point a considerable part of the ammonia produced in the converter has been condensed. The mixture of synthesis gas and liquid ammonia passes from the 2nd chiller to the ammonia separator in which the liquid ammonia is separated. The outlet gas contains 4.05 vol% NH3 at a temperature of 0°C.

266. Ammonia condensation will absorb the traces of makeup gas impurities like H_2O and CO_2 and are removed with the liquid ammonia in the separator. The gas leaving the separator eventually will go to the hot exchanger and get heated to the converter inlet temperature.

267. The liquid ammonia is depressurized to 2.55 MPa g and taken to the let-down vessel in which the main part of the gases dissolved in the ammonia is liberated. The let-down gas contains a considerable amount of ammonia, which is recovered by water wash in the off-gas absorber. The off-gas is then sent to the fuel header.

Step-7: Ammonia Refrigeration Circuit

268. The refrigeration circuit consists of a compressor unit, a condenser, an accumulator and a number of chillers. Evaporated ammonia from the chillers and the flash vessel is compressed by the ammonia compressor. After compression, the ammonia is collected in the ammonia accumulator.

Step-8: Ammonia Recovery

269. Purge gas from the purge gas separator is sent to the purge gas absorber. Ammonia is washed out of the gas with water and the purified gas is sent to the hydrogen recovery system where 85% of the hydrogen is recovered and returned to the synthesis loop.

270. Inert gas and let down gas is introduced to the off-gas absorber and ammonia is washed out with water. The aqueous ammonia is sent to the ARU distillation column where the ammonia is distilled and returned as product to the let-down vessel. The off-gases from the hydrogen recovery system and the off-gas absorber are mixed and sent to the fuel header.

Step-9: Steam System

271. The major part of the waste heat available is utilized for production of high pressure steam. The produced HP steam is then superheated in the flue gas duct and sent to battery limit at 11.47 MPa g and 510°c.The superheated MP steam required for ammonia plant is imported from battery limit at 3.82 MPa g and 375°C for process and heating purpose.

272. Part of the HP boiler feed water is preheated in upstream and downstream of the low temperature CO converter and in the ammonia synthesis loop. The other part is preheated in the flue gas heat recovery section of the primary reformer.

Step-10: Flare and Verit System

273. Ammonia Plants are provided two (2) separate headers. One is flammable blow out gases without ammonia along with flammable natural gas from utility system is sent to the Vent Stack and discharged to atmosphere without burning. During the normal operation, quantity of blow-out gases is zero or very small. In case of upset conditions and/or during start-up and shut down operations of-the plant, large quantity of blow- out gases is released.

Urea Processing

274. This section contains a technical description of a Urea Melt Production train with a daily operating capacity to allow the production of 2800 MTPD of granulated urea by means of a Granulation Unit based upon "fluidized bed granulation technology". The process flow diagrams of urea fertilizer synthesis are presented in Figure 5.3.

275. Saipem ammonia stripping process is characterized by a urea synthesis loop operating at about 15.2-15.7 MPa(g) with an ammonia to carbon dioxide molar ratio at urea reactor inlet of 3.1-3.5.

276. Waste heat recovery from process streams in some parts of the process layout have been introduced as a part of recent modifications, thus allowing considerable savings in overall steam and fresh water consumption, viz.:

- HP ammonia to urea reactor preheating with off-gas from LP decomposition stage.
- Heat to vacuum preconcentrator with off-gas from MP decomposition stage.
- Total recovery of process condensate as boiler feed water.

277. This Saipem License Processor allows a CO_2 conversion into urea of 60-63 % in the reactor itself, featuring the perforated trays which prevent back-flow and favor gas absorption by the liquid. Urea Melt Sections are characterized by the following main process steps:

- Urea synthesis and NH3, CO2 recovery at high pressure;
- Urea purification and NH_3, CO2 recovery at medium and low pressures;
- Urea concentration;
- Process condensate treatment.

- Urea melt production unit is also provided with the following:
    - Steam networks;
    - Flushing networks;
    - Auxiliary installation.