PRE- FEASIBILITY REPORT
FOR
TECHNICAL AMMONIUM NITRATE PRODUCTION UNIT

AT
VILLAGE BAGDIA, CHAUKIMATHA, RANGIAGARH
TEHSIL PARADEEP, DISTRICT JAGATSINGHPUR,
DISTRICT ODISHA

Project Proponent
M/s DEEPAK FERTILISERS &
PETROCHEMICAL CORP. LTD

Submitted to
Ministry of Environment, Forest & Climate Change
New Delhi

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EXECUTIVE SUMMARY

1.1. Project Outline
The project will consist of 900 MTPD Weak Nitric Acid plant, 1,140 MTPD Ammonium Nitrate Solution plant and a Technical Ammonium Nitrate Prilling plant out of which both LDAN and HDAN can be produced. The plant will be located at Paradeep, Orissa. The plant will utilize nearly 83.26 acres of land. Ammonia plant of 380 TPD will be relocated from Taloja to this site also.

The main raw material Ammonia will be imported through Paradeep port. Existing Ammonia storage tanks / terminals of one of the industries, which is near of project site, will be used on hired basis through a long-term contract for importing and storing Ammonia. Additionally NG from Dharma pipeline Adani will be sourced from cross country pipeline.

Water is available from Taladanda canal and will be sourced from the same for which required applications are already submitted to concerned departments. A dedicated power line will be installed from nearby substation of CESCO/GIRDCO.

Nitric Acid will be produced from Ammonia and will serve as an Intermediate for manufacturing TAN

The Ammonium Nitrate will be trucked from the site to the customer. The Ammonium Nitrate plant is expected to be on stream for 330 days per year.

2. INTRODUCTION
2.1. Background
Deepak Fertilizers & Petrochemicals Corporation Limited (DFPCL) is a 35-year-old company engaged in manufacture and marketing of Ammonia/ Nitric Acid/Sulphur based fertilizers, Formulated Nutrients based fertilizers, Technical Ammonium Nitrate (TAN), Nitrogenous and Phosphatic Fertilizers, Methanol, Iso-Propyl Alcohol (IPA) & other Industrial & Petrochemical products.

DFPCL’s Fertilizers/Petrochemicals Complex is located at Taloja industrial Area, about 50 Kms from Mumbai, the financial capital of India.
Some of the notable attributes of the company are:

- A 600 plus million US$ company having over three decades of experience of manufacturing Ammonia, Ammonia down-streams, Petrochemical & fertilizer products.
- A company listed on the National & Bombay Stock Exchanges having majority of the board members with eminent/professional background as independent board of directors.
- Ranked Fourth among chemicals manufacturers in India by Dun &Bradstreet.
- Credit rating of AA for long term borrowing, byICRA.
- Consistently paying dividend for 18 years.
- The only IPA and TAN manufacturer in India and the largest Nitric Acid and AN producer in South East Asia.
The process plants are controlled through most modern DCS based control systems.

DFPCL has prominent position in manufacture and distribution of both specialty fertilizers and technical Ammonium Nitrate (which forms the backbone of mining industry).

DFPCL currently manufactures 410,000 MTPA of high density and low density Ammonia Nitrate products at its Taloja complex in addition to 40,000 MTPY TAN at Smartchem, Srikakulum which is 100 % subsidiary company of DFPCL.

The company has worked with all major technologies for Nitric Acid and Ammonium Nitrate (M/s Uhde Germany, GPN France, Chematur Sweden, Plinke Germany, Weatherly, Spain etc) and over years improvised the same to achieve higher productivity, better efficiencies and lesser effluents.

DFPCL intends to enhance its Ammonium Nitrate manufacturing capacity by setting up a 1140 MTPD \{3,76,200 (MTPY)\} Ammonium Nitrate Solution manufacturing complex at Paradeep situated in state of Odisha on eastern coast of India to meet the growing demand of the mining explosives emerging out of the spurt in coal and iron mining activities.

The set-up will support, manufacturing of Ammonium Nitrate solution and the end products shall be

- **LDAN-Upto** 1,000 MTPD (330,000 MTPA)
- **HDANUpto** 1000 MTPD(330,000 MTPA)
- **AN Meltup to** 47000MTPA (140TPD)

and various combinations of above products based on the market requirements. The major raw materials for making Ammonium Nitrate are

- Ammonia and
- Nitric Acid
Ammonia shall be manufactured in house having capacity of 380 TPD & balance will be outsourced as mentioned.

Nitric Acid will be made within complex by setting up

- Nitric Acid unit of 900 MTPD {297,000 MTPA} capacity.

The company already has the basic & detailed engineering packages ready and key equipment are readily available from reputed manufacturers. The project is based on the feasibility study carried out internally by the company.

2.2. **Promoter Highlights:**

DFPCL was incorporated in the year 1979 and commenced commercial production of Ammonia in 1983. DFPCL went in for forward integration projects for adding various downstream products to their portfolio. These projects, which commenced production in 1992, include Diluted & Concentrated Nitric Acid, Ammonium Nitrate, ANP fertilizer and Methanol as a diversification initiative. Thereafter, DFPCL implemented expansion projects for various products like Dilute Nitric Acid, Concentrated Nitric Acid and Ammonium Nitrate. The company also implemented projects for diversification to produce Liquid Carbon dioxide, Isopropyl Alcohol and Sulphur Bentonite Fertilizer. In 2011 DFPCL commissioned 300 KTPA plant to produce both High Density (HDAN) and Low Density (LDAN) grade Technical Ammonium Nitrates at its Taloja site at a cost of around Rs 600crores.

This state of the art complex with fixed assets of more than 1,700 crores is located at MIDC, Taloja near Mumbai. The company has impeccable record of over 30 years in the industry with excellent reputation and relationship with its Bankers, Customers, Suppliers and Shareholders. The company’s shares are listed and traded on BSE and NSE.

DFPCL follows the best safety practices and has won British Safety Awards multiple times. It has maintained excellent environment records.
The World class facilities to manufacture Nitric acid / Technical Ammonium Nitrate along with related off-sites and utilities facilities proposed to be set up at Paradeep, Also Ammonia Plant will be relocated from Taloja Odisha requires apart from financial strength, project execution skills, experience in operating large scale continuous process plants and the ability to maintain high safety and environmental standards.

DFPCL has demonstrable experience and track record in all these areas.

2.3. **Location & Infrastructure**

The proposed project will be coming up at Village Bagadia, Chuakimatha, Rangiagarh Tehsil Paradeep, District Jagatsinghpur, Odisha. The location map of the proposed unit shown below.

![Figure 1: Project Location with Surrounding vicinity](image)
The project location, in addition to proximity to major markets (Coal and Iron Ore mining) is selected based on the following criterion.

1. TAN Plant will be in the eastern part of India at “Kujang (Tehsil), Jagatsinghpur (Dist.), Paradeep”.

   The site is located along the Cuttack-Paradeep railway line and adjacent to IOC Refinery township.

2. The distance from the Paradeep sea port to Plant site is a @ 10-12Km.

3. Location of plant is close to the major Mining hub especially coal i.e. Chhattisgarh, Jharkhand, Odisha.

4. DFPCL already have possession of 340,000 Sq. Meter of prime land suitable for industrial activities. The IOCL refinery, Paradeep Phosphates Limited (PPL), IFFCO etc refinery/petrochemicals/Fertilizer complexes are within the radius of 10 Kms of DFPCL land.

5. DFPCL Plan to capture both domestic market (eastern & central India) as well as
export market (Australia, SEA etc) from the aforesaid plant.

6. Proximity to major port to facilitate export of finished product.
7. Location is well connected with rest of the country for movement of finished product by land.

The project is proposed to be set up in a part of a total 83.26 Acre plot of land. This area has good infrastructure of roads and good connectivity with the port.

The process plants area will be around 20 acres. The area required for supporting facilities shall be about 20 acres more. Hence land acquired is sufficient to accommodate the main process plants, other offsite facilities, road, drains, green belt required for the project and most importantly to meet the revised AN regulation related to storage and transportation of AN products.

2.4. Project Implementation

The implementation of the project will be carried out with the Deepak Project team and the reputed engineering company under engineering, procurement & construction management (EPCM) Contract working in parallel and interfacing where appropriate. The EPCM team will consist of the Technology Provider and Engineering Contractors.

The basic process engineering for the Ammonia, Nitric Acid plant and the Ammonium Nitrate plant will be carried out in the office of the technology provider.

The detailed engineering and procurement of the non-proprietary equipment will be carried out by the EPCM Contractor. Based on the data from the technology suppliers, EPCM Contractor will carry out utility and infrastructure requirements. Project construction will be carried out by construction contractors operating under the management of Deepak and the local EPCM contractor’s site team.
2.5. **Capital Cost**

The estimated total cost for TECHNICAL AMMONIUM NITRATE (TAN) PROJECT is approx. 1,750 /-Crores.

3. **PROJECT DESCRIPTION**

Deepak intend to produce Ammonium Nitrate Melt and TAN Prills at Paradeep, Odisha utilizing Imported/domestic anhydrous Ammonia and NG as feedstock.

The project will consist of Ammonia 380 TPD and 900 MTPD Nitric Acid plant and a total capacity of 1140 MTPD Technical Ammonium Nitrate plant. These facilities will comprise of the following:

- Nitric acid storage tank for minimum 3 days’ capacity;
- Bagged Ammonium nitrate storage, including fully automatic bagging and handling facilities of up to 1500 MTPD capacity for filling of 25 Kgs, 50 Kgs bags in the initial stage and 1000 Kgs and 1200 Kgs jumbo bags (later if required).
- Loading of bagged AN prill in trucks for transportation;
- All the required utilities including cooling systems, instrument air system, and demineralized water to the extent required;
- Ammonium nitrate Melt storage (2000 tonnes) and dispatch facilities for 400 MTPD;
- Diesel/ Thermal emergency power generation or Dynamic Un-Interrupted Power Supply (UPS) systems;
- Boilers for start-up and normal plant operation;
- General facilities such as site development, boundary fencing, security system, offices, stores & maintenance buildings, administration building,
laboratory, canteen, control room, gatehouse, weigh-bridge, internal roadways, plant lighting, housing colony for employees;

- Storm water handling;
- Effluent treatment and handling;
- Fire water systems to meet statutory requirements;

The TAN prills will be transported from the site in enclosed trucks or by containers using 25 Kgs, 50 Kgs bags or 1000 Kgs, 1200 Kgs Jumbo bags. The Ammonium Nitrate Solution will be transported in Road tankers.

For the power supply to the plant, a dedicated power line from the nearest Power substation of CESCO / GRIDCO will be erected.

Raw water will be available from Taladanda Canal via dedicated pipeline to the site. Catalysts and chemicals will be delivered to the plant by truck via the public roads.
### 3.1. General Requirements – Codes & Standards

<table>
<thead>
<tr>
<th></th>
<th>Codes &amp; Standards</th>
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<td>1.0</td>
<td>Codes &amp; Standards</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Engineering standard</td>
<td>Contractor’s Standard</td>
</tr>
<tr>
<td>1.2</td>
<td>National standard</td>
<td>DIN, BIS</td>
</tr>
<tr>
<td>1.3</td>
<td>Material specification</td>
<td>DIN</td>
</tr>
<tr>
<td>1.4</td>
<td>Petroleum industry code</td>
<td>API</td>
</tr>
<tr>
<td>1.5</td>
<td>Pressure vessels and boiler</td>
<td>AD</td>
</tr>
<tr>
<td>1.6</td>
<td>Heat Exchanger</td>
<td>ASME, IBR, SMPV</td>
</tr>
<tr>
<td>1.7</td>
<td>Pumps and compressors</td>
<td>DIN</td>
</tr>
<tr>
<td>1.8</td>
<td>Machines</td>
<td>Manufacturer Standard</td>
</tr>
<tr>
<td>1.9</td>
<td>Piping</td>
<td>Manufacturer Standards</td>
</tr>
<tr>
<td>1.10</td>
<td>Electrical code</td>
<td>IEC</td>
</tr>
<tr>
<td>1.11</td>
<td>Instrumentation</td>
<td>IEC</td>
</tr>
<tr>
<td>1.12</td>
<td>Civil code</td>
<td>DIN</td>
</tr>
<tr>
<td>1.13</td>
<td>Hazardous area classification</td>
<td>Ex-RL</td>
</tr>
<tr>
<td>1.14</td>
<td>Tanks</td>
<td>DIN</td>
</tr>
<tr>
<td>1.15</td>
<td>Pressure relieving devices</td>
<td>API</td>
</tr>
</tbody>
</table>

### 3.2. General Requirements – Laws & Regulations

<table>
<thead>
<tr>
<th></th>
<th>Laws &amp; Regulations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Laws &amp; Regulations</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Pressure Vessels</td>
<td>ASME SEC VIII, SMPV, IBR</td>
</tr>
<tr>
<td>1.2</td>
<td>Boilers</td>
<td>ASME SEC VIII, IBR</td>
</tr>
<tr>
<td>1.3</td>
<td>Buildings and Structures</td>
<td>IS 875, IS 1893, IS 4326</td>
</tr>
<tr>
<td>1.4</td>
<td>Electrical</td>
<td>IER, BIS</td>
</tr>
<tr>
<td>1.5</td>
<td>Fire Fighting</td>
<td>Fire insurance regulation</td>
</tr>
<tr>
<td>1.6</td>
<td>Water Pollution</td>
<td>OPCB</td>
</tr>
<tr>
<td>1.7</td>
<td>Air Pollution</td>
<td>OPCB</td>
</tr>
<tr>
<td>1.8</td>
<td>Safety</td>
<td>NSC, NFPA, Factory Act</td>
</tr>
<tr>
<td>1.9</td>
<td>Sanitation</td>
<td>Local Authorities,</td>
</tr>
<tr>
<td>1.10</td>
<td>Aircraft Warning</td>
<td>DGCA norms</td>
</tr>
<tr>
<td>1.11</td>
<td>Noise</td>
<td>Statutory laws</td>
</tr>
<tr>
<td>1.12</td>
<td>Storage Tanks</td>
<td>API 620/API 650 / API 653</td>
</tr>
</tbody>
</table>
3.3 **General Requirements – Measuring Units**

Following measuring units are to be used.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Deg C</td>
</tr>
<tr>
<td>Pressure, gauge</td>
<td>Bar</td>
</tr>
<tr>
<td>Pressure, absolute</td>
<td>Bar abs</td>
</tr>
<tr>
<td>Vacuum</td>
<td>mBar</td>
</tr>
<tr>
<td>Weight</td>
<td>Kg</td>
</tr>
<tr>
<td>Volume, liquids</td>
<td>m3</td>
</tr>
<tr>
<td>Volume, gases (or at flow condition)</td>
<td>Nm3</td>
</tr>
<tr>
<td>Flow rate – liquid</td>
<td>m3 / hr</td>
</tr>
<tr>
<td>Flow rate gases</td>
<td>Nm3/h</td>
</tr>
<tr>
<td>Flow rate steam</td>
<td>Kg/h</td>
</tr>
<tr>
<td>Heat</td>
<td>kJ</td>
</tr>
<tr>
<td>Power</td>
<td>kW</td>
</tr>
<tr>
<td>Heat transfer coefficient</td>
<td>W/m² K</td>
</tr>
<tr>
<td>Viscosity</td>
<td>cP</td>
</tr>
<tr>
<td>Liquid density</td>
<td>Kg / m³</td>
</tr>
<tr>
<td>Vapor density</td>
<td>Kg / m³</td>
</tr>
<tr>
<td>Equipment dimension</td>
<td>mm</td>
</tr>
<tr>
<td>Piping length</td>
<td>mm, m</td>
</tr>
<tr>
<td>Pipe diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Area</td>
<td>m²</td>
</tr>
<tr>
<td>Tube sizes (ND)</td>
<td>mm</td>
</tr>
<tr>
<td>Velocity</td>
<td>m / sec</td>
</tr>
<tr>
<td>Vessel / Nozzle sizes (ND)</td>
<td>mm</td>
</tr>
<tr>
<td>Sound pressure</td>
<td>dB</td>
</tr>
<tr>
<td>Stresses</td>
<td>N / mm²</td>
</tr>
<tr>
<td>Force</td>
<td>N</td>
</tr>
<tr>
<td>Flange Rating</td>
<td>lbs</td>
</tr>
</tbody>
</table>

3.4. **General Requirements – Pollution Control Measures**

<table>
<thead>
<tr>
<th>1.0</th>
<th><strong>Water Disposal</strong></th>
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</thead>
<tbody>
<tr>
<td>Disposal</td>
<td>Allowable treated mg/l</td>
</tr>
<tr>
<td>Treated Effluent</td>
<td>COD, BOD, Ammoniacal Nitrogen, suspended solids, TDS, Nitrate Nitrogen, Phosphates</td>
</tr>
</tbody>
</table>

Treated effluent water from the plant shall meet the local regulatory (OPCB) requirements.

<table>
<thead>
<tr>
<th>2.0</th>
<th><strong>Solid Waste Disposal</strong></th>
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</thead>
<tbody>
<tr>
<td>Incinerable wastes</td>
<td></td>
</tr>
<tr>
<td>Non incinerable wastes</td>
<td></td>
</tr>
<tr>
<td>Solid waste collected from the chemical store, offices, control room and</td>
<td></td>
</tr>
</tbody>
</table>
areas will be segregated and disposed safely.

<table>
<thead>
<tr>
<th>3.0</th>
<th>Gaseous Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid plant: Stack Gas vented to atmosphere after going through a NOx Abatement Unit which brings the emission levels within norm)</td>
<td></td>
</tr>
<tr>
<td>Ammonium Nitrate Plant: Air is vented to atmosphere after passing through scrubbers to remove any dust</td>
<td></td>
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<table>
<thead>
<tr>
<th>4.0</th>
<th>Additional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise: All rotating equipment and noise generating equipment shall follow the Company’s own guidelines for noise attenuation. The noise level shall be &lt; 85 dBA at 1 meter from the source</td>
<td></td>
</tr>
</tbody>
</table>
4. **PROCESSDESCRIPTION**

4.1 **AmmoniaPlant**

Existing Ammonia plant at Taloja will be relocated to Paradeep which was based on license provided Fish International Engineering Ltd, USA.

Original capacity of 272 MTPD has been enhanced to 380 TPD step by step.

4.1.1. Overall conversion

The process conversions are based on NG/methane feedstock, are given in the following overall chemical reaction:

\[ 0.88\text{CH}_4 + 1.26\text{Air} + 1.24\text{H}_2\text{O} \rightarrow 0.88\text{CO}_2 + \text{N}_2 + 3\text{H}_2 \]

\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

For more detailed refer Annexure-1 as block diagram.

4.1.2. Gas receiving, Treatment & metering station

Gas received from battery limit is first passed through knockout drum to remove condensate, slugs/droplets and then through a filter separator D8-0119 to eliminate dirt, dust scales and condensate mist. The pressure of the gas to the battery limit is regulated at 27 Bar g before metering. The total gas to the plant is metered.

4.1.3. Feedstock desulphurization

Most of the catalysts used in the process are sensitive to sulphur and sulphur compounds. The feedstock normally contains up to 5mg S/Nm³ as sulphur compounds. The feed-gas is preheated to 350-400°C, usually in the primary reformer convection section, and then treated in a desulphurization vessel/reactor D8-0101, where the sulphur compounds are hydrogenated to H₂S, typically using a cobalt molybdenum catalyst, and then adsorbed on pelletized zinc oxide desulphuriser D8-0102:

\[ \text{R-SH} + \text{H}_2 \rightarrow \text{R}_2\text{S} + \text{RH} \]

\[ \text{H}_2\text{S} + \text{ZnO} \rightarrow \text{ZnS} + \text{H}_2\text{O} \]

In this way, the sulphur is removed to less than 0.1 ppm S in the gas feed. The zinc sulphide remains in the adsorption bed. The hydrogen for the reaction is usually recycled from the synthesis section.

4.1.4. Primary reforming

The gas from the desulphuriser is mixed with process steam, usually coming from an extraction turbine, and the steam/gas mixture is then heated further to 500-600°C in the convection section before entering the primary reformer. Preheated steam/gas mixture is passed through an adiabatic pre-reformer and reheated in the convection section, before
entering the primary reformer). Part of the process steam is supplied by feed-gas saturation. The amount of process steam is given by the process steam to carbon molar ratio (S/Cratio), which should be around 3.57 for the. The optimum ratio depends on several factors, such as feedstock quality, purge gas recovery, primary reformer capacity, shift operation, and the plant steam balance. The primary reformer consists of many high–nickel chromium alloy tubes filled with nickel-containing reforming catalyst. The overall reaction is highly endothermic and additional heat is required to raise the temperature to 780-830°C at the reformer outlet. The composition of the gas leaving the primary reformer is given by close approach to the following chemical equilibria:

\[
\begin{align*}
\text{CH}_4 + \text{H}_2\text{O} & \rightleftharpoons \text{CO} + 3\text{H}_2 \\
\text{CO} + \text{H}_2\text{O} & \rightleftharpoons \text{CO}_2 + \text{H}_2
\end{align*}
\]

The heat for the primary reforming process is supplied by burning natural gas or other gaseous fuel, in the burners of a radiant box containing the tubes. The flue-gas leaving the radiant box has temperatures more than 900°C, after supplying the necessary high level heat to the reforming process. Thus, only about 50-60% of the fuel's heat value is directly used in the process itself. The heat content (waste heat) of the flue-gas is used in the reformer convection section, for various process and steam system duties. The fuel energy requirement in the conventional reforming process is 40-50% of the process feed gas energy. The flue-gas leaving the convection section at 100-200°C is one of the main sources of emissions from the plant. These emissions are mainly CO2, NOx, with small amounts of SO2 and CO.

4.1.5. Secondary reforming

Only 30-40% of the hydrocarbon feed is reformed in the primary reformer because of the chemical equilibria at the actual operating conditions. The temperature must be raised to increase the conversion. This is done in the secondary reformer by internal combustion of part of the gas with the process air, which also provides the nitrogen for the final synthesis gas. In the reforming process the degree of primary reforming is adjusted so that the air supplied to the secondary reformer meets both the heat balance and the stoichiometric synthesis gas requirement. The process air is compressed to the reforming pressure and heated further in the primary reformer convection section to around 600°C. The process gas is mixed with the air in a burner and then passed over a nickel-containing secondary reformer catalyst. The reformer outlet temperature is around 1,200°C, and up to 99% of the hydrocarbon feed (to the primary reformer) is converted, giving a residual methane content of 0.6% (dry gas base) in the process gas leaving the secondary reformer. The process gas is cooled to 350-400°C in a waste heat steam boiler or boiler/superheated downstream from the secondary reformer.

4.1.6. Shift conversion
The process gas from the secondary reformer contains 9.54 % CO (dry gas base) and most of the CO is converted in the shift section per the reaction: 

\[ \text{CO} + \text{H}_2\text{O} \leftrightarrow \text{CO}_2 + \text{H}_2 \]

In the High Temperature Shift (HTS) conversion, the gas is passed through a bed of iron oxide/chromium oxide catalyst at around 360°C, where the CO content is reduced to about 1.8 % (dry gas base), limited by the shift equilibrium at the actual operating temperature. There is a tendency to use copper containing catalyst for increased conversion. The gas from the HTS is cooled and passed through the Low Temperature Shift (LTS) converter. This LTS converter is filled with a copper oxide/zinc oxide-based catalyst and operates at about 260 °C. The residual CO content in the converted gas is about 0.1 % (dry gas base). A low residual CO content is important for the efficiency of the process.

4.1.7. CO2 removal

The process gas from the low temperature shift converter at 220 °C contains mainly H2, N2, CO2 and the excess process steam. The gas is cooled and most of the excess steam is condensed before it enters the CO2 removal system. This condensate normally contains 1,500-2,000ppm of ammonia 800-1,200ppm of methanol. Minor amounts of amines, formic acid and acetic acid could be present in the condensate. All these components should be stripped from the condensate and/or recycled in processes. The heat released during cooling/condensation is used for: 

– The regeneration of the CO2 scrubbing solution
– Driving an absorption refrigeration unit
– Boiler feed water preheat

The amount of heat released depends on the process steam to carbon ratio. If all this low-level heat is used for CO2 removal or absorption refrigeration, high-level heat must be used for the feed water system. An energy-efficient process should therefore have a CO2 removal system with a low heat demand.

The CO2 is removed in a chemical or a physical absorption process. The solvents used in chemical absorption processes are aqueous amine solutions Methyl Diethanolamine (aMDEA.) Residual CO2 contents are usually in the range 100-1,000ppmv, dependent on the type and design of the removal unit. Contents down to about 100ppmv are achievable.

4.1.8. Methanation

The small amounts of CO and CO2, remaining in the synthesis gas, are poisonous for the ammonia synthesis catalyst and must be removed by conversion to CH4 in the methanator by following reactions: 

\[ \text{CO} + 3\text{H}_2 \rightarrow \text{CH}_4 + \text{H}_2\text{O} \]
\[ \text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O} \]
The reactions take place at around 355°C in a reactor filled with a nickel containing catalyst. Methane is an inert gas in the synthesis reaction, but the water must be removed before entering the converter. This is done firstly by cooling and condensation downstream of the methanation and finally by condensation/absorption in the product ammonia in the loop or in a make-up gas drying unit.

4.1.9. Synthesis gas compression and ammonia synthesis

Centrifugal compressors for synthesis gas compression, driven by steam turbines, with the steam being produced in the ammonia plant. The refrigeration compressor, for condensation of product ammonia, is driven by steam turbine. The synthesis of ammonia takes place on an iron catalyst at pressures usually in the range 310 bar g and temperatures in the range 40 °C:

\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

Only 16.5% is reacted per pass in the converter due to the unfavorable equilibrium conditions. The ammonia that is formed is separated from the recycle gas by cooling/condensation, and the reacted gas is substituted by the fresh make-up synthesis gas, thus maintaining the loop pressure. Synthesis loop arrangements differ with respect to the points in the loop at which the make-up gas is delivered and the ammonia and purge gas are taken out. The best arrangement is to add the make-up gas after ammonia condensation and ahead of the converter. The loop purge should be taken out after ammonia separation and before make-up gas addition. This configuration is dependent on the make-up gas being treated in a drying step before entering the loop. A make-up gas containing traces of water or carbon dioxide must be added before ammonia condensation, with negative effects both to ammonia condensation and energy. The size of this purge stream controls the level of inert in the loop to about 10-15%. The purge gas is scrubbed with water to remove ammonia before being used as fuel or before being sent for hydrogen recovery.

4.2. Nitric Acid Plant

The technology for the Nitric Acid plant is already decided based on performance evaluation of different Licensors technology by our internal core team who hold professional operating experience of operating such plants.

Basically, there are three types of process involved for manufacturing of Nitric Acid.

4.2.1 Mono Medium Pressure

4.2.2 Mono High-pressure

4.2.3 Dual Pressure
Each process is not substantially different from the others and hence there is little difference in overall cost due to process adopted. The outline of the process flow description and process flow diagram are given below:

The process steps involved in production of Nitric Acid plant can be divided into (8) eight main sections described as follows:
- Air Compression
- Ammonia Evaporation
- Ammonia Oxidation
- Heat Recovery of low pressure nitrous gas
- Nitrous gas compression
- Absorption
- Acid Bleaching
- Tail gas treatment and NOx abatement
- Steam and Condensates

4.2.4 Air Compression
At this section, air is compressed in air compressor and mixed with ammonia. A small part of air, called secondary air, is used during the bleaching process.

4.2.5 Ammonia Evaporation
Liquid ammonia coming from battery limit is filtered to eliminate any unwanted particles present and evaporates in evaporator. Ammonia Gas coming from evaporator is superheated and mixed with them.

4.2.6 Ammonia Oxidation
The ammonia combustion in the Oxidation Reactor produces nitric oxide, following this equation:

\[ 4 \text{NH}_3 + 5 \text{O}_2 \rightarrow 4 \text{NO} + 6 \text{H}_2\text{O} \]

Other secondary and undesired reactions in the reactor are: 
\[ 4 \text{NH}_3 + 3 \text{O}_2 \rightarrow 2 \text{N}_2 + 6 \text{H}_2\text{O} \]
NH₃ + 2 O₂ → N₂O + 3 H₂O
The ammonia oxidation takes place over a set of Platinum-Rhodium gauzes at a temperature around 890 ºC. The efficiency of this reaction varies between 96.7% (with new gauzes, beginning of campaign) to 94-95% (end of campaign, just before changing the gauzes).

4.2.7 Heat Recovery of LP Nitrous Gases
From the reactor, the gases are sent to a train of heat exchangers, where its temperature is reduced. While cooling of the Nitrous gases, two reactions are taking place inside the exchangers in the gas phase:

\[ 2 \text{NO} + \text{O}_2 + \text{NO}_2 \]
\[ 2 \text{NO}_2 + \text{N}_2\text{O}_4 \]
Both reactions, nitric oxide oxidation and nitric dioxide dimerization, are exothermic, producing an additional heat, also recovered in the exchangers.

4.2.8 Absorption
The absorption of the nitrous dioxide and nitrous tetra oxide in water to produce nitric acid at 60- 62 %w/w takes places in the upper trays of the Absorption Tower. These are perforated trays with refrigeration coils to reduce the temperature of the gases, improving the absorption process.

The nitric acid production is achieved through the following reactions:

\[ 2 \text{NO}_2 \text{ or N}_2\text{O}_4 + \text{H}_2\text{O} + \text{HNO}_3 + \text{HNO}_2 \]
\[ 3 \text{HNO}_2 + \text{HNO}_3 + 2 \text{NO} + \text{H}_2\text{O} \]
This could be merged in a single reaction:

\[ 3 \text{NO}_2 + \text{H}_2\text{O} + 2 \text{HNO}_3 + \text{NO} \]

The nitric oxide (NO) produced in the reaction is oxidized inside the column, to nitric dioxide (NO₂), which is absorbed in the column.

The process water needed for the absorption can be added as demineralized water or as clean condensate from Ammonium Nitrate Solution Plant.

4.2.9 Acid Bleaching
Nitric acid coming from the bottom of the absorption tower flows to the bleaching tower where NOx gases dissolved in the acid are removed. To do this operation, secondary air is flow counter current, removing the dissolved gases. Bleached Nitric Acid goes to the Battery Limit.

4.2.10 Tail Gas Treatment and NOx Abatement
Tail gas comes out from the absorption tower having a residual content of nitrogen oxides of 500 ppm v. It is heated in heat exchanger to recover its energy. The heated tail gas from the absorption tower with NOx content about 500 ppmv, are mixed with a stoichiometric amount of ammonia in the Ammonia/Tail Gas Mixer and sent to the DE NOx Abator, where a Selective Catalyst Reduction takes place decreasing the nitrogen oxides concentration in the tail gas below 50 ppm v.
Gas coming out from the DE NOx unit is superheated in normal operation in Tail Gas Super heater and is sent to the expander that supplies around 57% of the required energy to compress the air. The additional energy required in the process is supplied by the steam turbine. Once tail gas is cleaned and expanded it is sent to the atmosphere through stack. The entire steam produced in the Nitric Acid Plant is sent to the steam turbine coupled to an electric generator, to generate power for the Nitric Acid plant and/or to export.

4.2.11 Steam and Condensate
High pressure steam is required for Air compressor steam turbine. In normal operation HP steam is produced in the nitric acid plant during the cooling of nitrous gases from converter. But during start-up it is necessary to import steam to move the turbine.
Steam condensate is generated in the surface condenser of turbine and transported by means of turbine condensate pumps to the de-aerator.

4.3 Technical Ammonium Nitrate (TAN) Plant
The process description for the preparation of Technical Ammonium Nitrate can be divided in two parts:
• Ammonium nitrate solution preparation (wet zone)
• Prilling, drying and cooling the product (solid zone)

The ammonium nitrate is obtained by the reaction between the gaseous ammonia and the nitric acid per the following reaction:

\[ \text{NH}_3 + \text{HNO}_3 = \text{NO}_3\text{NH}_4 + \text{Heat} \]

This reaction is exothermic. When the temperature is above 200°C the ammonium nitrate decomposes violently per the below shown reactions:

\[ \text{NO}_3\text{NH}_4 = \text{N}_2\text{O} + 2 \text{H}_2\text{O} + \text{Heat} \]

\[ 2 \text{NO}_3\text{NH}_4 = 2 \text{N}_2 + \text{O}_2 + 4 \text{H}_2\text{O} + \text{Heat} \]

4.3.1. Solution Section (Wet Zone) – AN Solution Plant

The wet zone consists of the preparation of an ammonium nitrate concentrated solution from Ammonia and Nitric Acid as raw materials. We can divide this zone in three sections:

• Reaction of reactants in pipe reactor.
• Concentration of the diluted AN solution

a) Reaction of reactants in pipe reactor

Liquid ammonia is evaporated / superheated and fed to Pipe Reactor where it reacts with the nitric acid, to form ammonium nitrate liquor. The pH of the ammonium nitrate solution obtained in the reactor controls the feed of ammonia gas to the Reactor. This flash produces process steam and concentrated solution. Ammonium Nitrate solution of (ANS) of about 85 - 92% concentrations from the bottom of separator flows to a Tank. Mist of ammonium Nitrate is removed from Process steam in a scrubber. The clean steam is used to evaporate and heat the ammonia gas.

b) AN Liquor Concentration

85 – 92 % Ammonium nitrate solution is pumped to the tube side of Falling Film Evaporator. Steam is fed to the shell of evaporator to supply necessary heat to concentrate the solution. The concentrated AN solution (96-99.8% AN) leaves the bottom of the Falling Film Evaporator and either collected in the intermediate
tank or goes for prilling depending on the grade of Technical Ammonium Nitrate. In case of former, the tank has internal coils, which are fed with LP steam to increase the solution temperature. The concentrated AN solution/melt is pumped to the upper part of the prilling tower.

4.4. Dry Section – LDAN & HDAN Plant

The Ammonia Nitrate Dry zone is generally divided in three sections:

- Prilling of ammonium nitrate solution
- Drying
- Screening, Cooling and Coating of the product

a) Ammonium Nitrate Solution Prilling

The hot concentrated melt is either granulated (fluidize bed granulation, drum granulation etc) or prilled. Ammonium nitrate is formed into droplets by a prilling bucket or spray nozzles which then fallen by gravity within a tall tower (prill tower) where they get cooled and solidified against a counter-current air stream. Technical Ammonium Nitrate (TAN) prills are collected on the belt conveyors located at the bottom of the prilling tower. The temperature of solid ammonium nitrate at the bottom of the prilling tower is around 80 °C – 110 °C depending upon the product cycle (start-up and stable operation respectively).

The air stream leaving the top of the prilling tower is scrubbed and cooled in the prilling scrubber by means of an AN solution, which is recycled by the prilling scrubber pumps and recovers most of the AN contained in the air.

The washing AN solution is cooled in exchanger with cooling water. In the scrubber, the washing AN solution cools the air which is partially recycled the prilling tower, by means of the air blowers while the rest of the air is sent to the stack.

Ammonium nitrate prills collected at the bottom of prilling tower are sent by belt conveyors to the drying section.

b) Drying of the Prills

The drying of the prills involves slow vaporization of most of the water of the prills
allowing a progressive drying which does not damage the prills and gives hardness required to the product.

The exhausted hot air loaded with dust leaving the dryer drums is sucked into the scrubbers by means of blower. The washing of the air is done in the Ventures and scrubber with an AN washing solution. Clean air is then sent to the stack by means of the air blower. From the dryer, the prills are sent to the screens through belt conveyors.

c) Screening, Cooling and Coating of the product
Oversized and fines prills from screen are recycled, to the Wet Zone to be re-melt with the ammonium nitrate solution. The on-size product is cooled in the fluidized bed cooler against air conditioned air or in the bulk flow cooler against chilled water.
Depending upon the product application, prills are sent to coating drum after cooling and sprayed on the outer surface with a coating agent to attain the anti-caking characteristics. Subsequently the coated/un-coated product is sent to storage/ Bagging Plant through belt conveyor for storage or Bagging.

d) Product Handling & Bagging
The coated/un-coated prills are sent to the bin/hopper in the Bagging plant, where they are packed in HDPE bags for selling. Two automatic bagging machine of sufficient capacity shall be installed to bag entire production in different packing size as per the Customer need.

f) Bagged Storage and Dispatch:
To load these bags on trucks, two portable type truck loaders with provision of one more truck loader in future shall be provided to load bags directly on trucks. During the non-availability of trucks, the same truck loader can be moved to other side for loading the bags on pellet with same work force. On the availability of trucks, truck loader shall be diverted to truck end again. Bags from pellets also
to be put on truck loader manually for dispatch.

Bagged storage area equivalent to 5 days’ final production capacity shall be created to store bagged product during the non-availability of trucks.

g) AN Melt dispatch
Facilities shall be provided to load 85-87% concentrated AN melt by installing loading bays for tanker. Facilities to include blast proof wall

5. TECHNOLOGIES AVAILABLE
There are number of process licensors offering the technologies to manufacture Nitric Acid and Technical Ammonium Nitrate. A list of some of the reputed Process Licensor is given below:

- Udhe/TKIS, Germany
- Espindesa, Spain
- Grande Paroisse, France (now owned by Casale, Switzerland)
- Weatherly Inc, USA (now owned by KBR, USA)
- Orica Australia

Basically, each of the technologies is not substantially different from the others and hence there is little difference in cost due to technology adopted.

DFPCL over the years has not only absorbed but improvised these technologies and is in position to carve out best possible process configuration towards most cost-effective manufacture of AN-products.

For the Paradeep Project DFPCL has selected the technologies from one of the above, and with whom DFPCL has the experience of installation, commissioning
6. PLOT & SITE DIAGRAMS – EMPHASIZING TOTAL AREAS

6.1 Site information

The plant is to be located at the site OFF IOCL ROAD, NEAR IOCL OVERBRIDGE, BAGADIA- RANGIAGARH, DIST: JAGATSINGHPUR, PARADEEP – 754141, ODISHA.

The preliminary layout of the plot is shown on end of Section 12 of this report.

The site is located along the Cuttack-Paradip railway line and adjacent to IOCL Refinery Township.

The existing ground level of the site is approximately 2.5 M to 3.0 M above the Mean Sea Level. It is planned to have the Finished ground level as 5.5 M from the Mean Sea level as per the available site conditions. Hence, filling of app. 3.00 M depth is envisaged.

6.2 Power and Water

Power requirement for the plant will be met through CESCO/ GRIDCO. Depending on the voltage at which power is available, suitable step down transformers will be provided. The app. length of power supply line will be 4 – 5 KM.

The water requirement for the Plant will be met through a water reservoir having a storage capacity of 10 days. The source of water supply will be from Taladanda canal. A Pump house and water supply line from Taladanda canal will be laid up-to reservoir. The length of water supply line is estimated at 10 - 12 KM from Distributary point16.

7. RAW MATERIAL AND UTILITIES

7.1 Plant Capacities

The plant design is based on the following production capacities:
### Product

<table>
<thead>
<tr>
<th>Product</th>
<th>Production Capacity Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid (capacity as 100 %)</td>
<td>900 MTPD / 297 KTA</td>
</tr>
<tr>
<td>Ammonium Nitrate Solution (100%)</td>
<td>1140 MTPD / 376.2 KTA</td>
</tr>
<tr>
<td>Technical AN (TAN) Prill</td>
<td>1,000 MTPD / 330 KTA</td>
</tr>
<tr>
<td>(as LDANHDAN or combination)</td>
<td></td>
</tr>
<tr>
<td>AN Melt</td>
<td>390 MTPD / 140.0/46 KTA max</td>
</tr>
<tr>
<td>Ammonia</td>
<td>380 MTPD/126 KTA</td>
</tr>
</tbody>
</table>

Note: Nitric Acid produced will be used by Ammonium Nitrate plant.

### Consumption Norms

The requirement of raw materials, Chemicals and utilities for the proposed project has been worked out based on rated capacity operation of the plants.

The requirement of various inputs is summarized in table below

#### Raw Material & Utility Requirement

<table>
<thead>
<tr>
<th>S.</th>
<th>Raw Material / Utilities</th>
<th>Unit</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Raw Material</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ammonia</td>
<td>MT/day</td>
<td>380</td>
</tr>
<tr>
<td></td>
<td>NG Gas</td>
<td>Sm³/day</td>
<td>830</td>
</tr>
<tr>
<td>B</td>
<td>Utilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power</td>
<td>MWh</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td>Raw Water</td>
<td>M³/day</td>
<td>15000</td>
</tr>
<tr>
<td></td>
<td>Steam</td>
<td>MT/hr</td>
<td>55</td>
</tr>
</tbody>
</table>

### Ammonia

Currently DFPCL sources Ammonia from Middle East. The additional requirement of Ammonia for the Project shall be met through relocated Ammonia plant of 380 TPD which will also cater requirement of nitric acid plant to fill additional requirement..

DFPCL is in advance stage of entering long term contract with one of the industries in Paradeep for utilizing their Ammonia receiving, storage and transfer facility. Existing Ammonia storage tanks of this company shall be used on hired
basis thru a long-term contract for receiving, storage and pipe line delivery of imported Ammonia. The Ammonia pipeline length between the nearby factory and DFPCL plot will be around 6 Kms.

7.4 **Raw Water**

The raw water requirement is 15000KLD which shall be supplied from the local irrigation canal located at approx.10 - 12 Kms away from the plant site. The water availability from this canal is restricted to 310 days in a year; hence the average lifting/day capacity of water shall be kept with 20% margin of normal requirement.

Suitable water intake facilities shall be created at canal site to lift the required volume of water through two number of pumps (one operating and one stand by) and discharge to the raw water storage reservoir located inside the plant premises. Water from canal intake station to plant site reservoir shall be supplied through pipeline. Decision of underground or above ground pipeline shall be taken during the further development stage of the project.

The requirement of water is mainly for cooling water make up. Other requirement of process water is as make up to DM plant, utility water, etc. Water requirement indicated above has been worked out based on recycle of majority of steam condensate to DM plant.

**Raw Water Treating**

The overall water users are listed below

- Dematerialized water production
- Portable water and safety showers
- Fire water and make-up
- Chemical mixing (Intermittent)
- Other users in the plant
- Cooling water (circulating water) make-up
Raw water shall be sourced from Taldanda Canal and will be stored in a reservoir before feeding to the treatment unit.

**Raw Water Reservoir**

Water reservoir shall be designed to store the water for 10 days’ continuous operation of the plant considering non-availability of canal water for maximum 10 days in one stretch. A Raw Water reservoir of capacity 60000 M3 shall be provided, considered with 24 hrs pumping basis at a rate of 250 m³/h flow to the plant.

**Raw Water Consumption Basis**

<table>
<thead>
<tr>
<th>Water Demand</th>
<th>Normal, m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable Water</td>
<td>4</td>
</tr>
<tr>
<td>Dematerialized Water make-up</td>
<td>10</td>
</tr>
<tr>
<td>Other users</td>
<td>4</td>
</tr>
<tr>
<td>Cooling Tower make up</td>
<td>232</td>
</tr>
<tr>
<td>Ammonia plant</td>
<td>150</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
</tr>
</tbody>
</table>
7.5. **Potable Water**

Potable water is to be sourced from Taldanda canal. The total requirement of whole plant is likely to be 96 M3/day, which is further used for various applications within the plant premises.

**Basis of Design**

- 10 nos of 500 letters capacity Sintex tanks will be installed at different locations of the plant for storage of potable water.
- These tanks will be fed by filtered water pumps.
- UVR unit will be provided wherever potable water shall be used for drinking purpose.
- Network of piping for safety shower and eyewash.
- Number of safety showers and eye wash points required.
- pH and free Chlorine analyzer at the pump discharge.

7.6 **DMWater**

The DM water plant capacity has been considered as 25 m3/h without any stand by unit. Plant shall be in line for 22 hrs. in day and remain out for 2 hrs. for resin regeneration. Provision shall also be made for storage of DM water, process water and steam condensate with associated pumps.

**Demineralized / Polish Bed Water**

Water contains various impurities such as dissolved salts of Chlorides and calcium which should be removed before feeding to Boiler. 25 M3/Hr. demineralization plant is proposed for boiler Feed water. 200 M3 storage tank is proposed for storage of Demineralized water. Polishing bed is proposed at this stage for reuse of Steam condensate as a boiler feed water, the capacity of which will be decided later.
Design Basis

The design basis for the demineralization plant would consist of the following:

- Normal demineralization water requirement is 10m³/h
- At this stage 25 m³/h unit consisting of Cation and Anion exchanges are considered
- Cation exchanger would be counter current - counter pressure design.
- Anion exchanger would be counter current - counter pressure design.
- Chemical requirement per regeneration
  - Acid (H₂SO₄) = in kg 100% (vendor specific) as in detail engineering
  - Alkali (NaOH) = in kg 100% (vendor specific) as in detail engineering
- Requirement of a condensate polishing unit shall be verified to treat the return contaminated condensate from the plants.
- The return condensate water from the plant could be quite hot and the ion exchange resin while specifying should be capable of withstanding high temperature.
- Polished water storage of 100 m³ capacity can be considered.

Demineralization / Polish Bed Piping and Vessel Design

- The ion exchanger vessels, CS and internally rubber lined or of suitable material for demineralization plant.
- The piping shall be carbon steel rubber lined or of suitable material for demineralization/polish bed units (acid and alkali).
- All the valves and fittings shall be rubber lined or Polymer based suitable for both the units.
The vessel and piping should can withstand a pressure of 1000 kPag and temperature of 100 degC.

The regeneration circuit piping and valves shall be PVC or equivalent material that can withstand Sulfuric acid and Sodium Hydroxide.

Ejectors used to draw the dilute acid/alkali from the regeneration day tank shall be suitable for acid and alkali.

Flow transmitter is required at the outlet of the Ejector to measure the regenerated flow to the ion exchangers. Its material should be suited to acid and alkali.

Bulk acid and alkali storage is required.

The water storage tank should be made from SS or suitable material.

The neutralizing pit pump suction piping and the pumps should be capable of pumping salt and water from the reaction of acid and alkali.

### 7.7 Catalyst

For Ammonia plant:

- **Desulfurization catalyst** – Cobaltmolybdenum.
- **Reforming catalyst**- Nickel chromium alloy.
- **Shift conversion reaction** - Iron oxide.
- **Methanation** – Nickel.
- **Ammonia Synthesis** – Iron.

For Nitric Acid Plant:

- **For ammonia Oxidation** - Precious metal (Pt/Rh) gauze. The net catalyst consumption per ton of nitric acid is including the credit of Pt/Rh recovery from the “getter” made by the gauzes manufacturer is 50 mg/ton of acid 100%.

- **DeNOxAbater catalyst** for tail Gas Treatment to meet the strictest environmental standards related to NOx emissions.
Ammonium Nitrate manufacturing process does not require any Catalyst.

7.8 Electrical Power

A reliable power supply arrangement is a pre-requisite for stable operation of the plant at rated capacities on long-term basis. The normal power requirement for the project would be around 8.5 MW. The entire power requirement is proposed to be taken from the State Electricity Board grid. The power to the plant shall be fed through 132 KV state grid/transmission lines passing along the plot boundaries.

Dynamic UPS system with Diesel Generator shall be provided for supply of uninterrupted / emergency power. To meet the emergency power requirement in plant, one DG set of 2000 KVA shall be installed.

The Nitric Acid plant is also equipped with turbo generator coupled to air compressor and can supply 5-6 MW if required.

Emergency Power Supply and Diesel Fuel Supplies

In the case of a power outage, an emergency diesel driven generator would be provided and sized to run critical users in the plant. Storage facilities will be needed for diesel fuel. 50 m3 bulk storage has been considered at this stage, will be confirmed after carrying out detail engineering. The bulk diesel storage tank capacity will be determined in the next phase based on the requirements for the consumers listed below:

- Firewater diesel
- Emergency diesel driven generator

The emergency power will be supplied by a diesel driven engine generator, capable of supplying essential LV consumers for at least 12 hours. Except for
the firewater pump, an 8 hours' storage capacity day tank or vendor standard supply package item with the equipment should be allowed in the design.

**Emergency Power**

The essential (critical users) loads to include:

- Safety and automation systems;
- Controls;
- Emergency lighting (plant and buildings);
- Lube oil pumps and ventilation fans in turbines, generators & other major plant loads;
- Jockey pump;
- Communication systems;
- Process control systems;
- Shutdown systems; and
- Portable water pumps;
- Instrument Air Compressor

The emergency generator system is self-contained and located away from the main power generator building. The diesel engine will start automatically on loss of main power and the generator connected to the bus through a transfer switch on failure of main power. Arrangements for black start will also be provided.

**7.9 Fuel &Steam:**

One START UP Coal fired service boiler of 60 T/hr. shall be installed to generate steam at 61 bar pressure and 450 deg C temperatures with turn down capacity of 25% of normal capacity. The capacity of boiler has been derived based on start-up case of Nitric Acid Plant.
The entire requirement of steam in the complex will be met by this boiler. Suitable let down station with de-superheating facilities shall be provided to cater the steam pressure and temperature as per the requirement of downstream process.

The start-up requirements of Nitric Acid plant require further investigation at the next phase of work. But during the normal operation of all plant, there will be hardly any additional requirement of steam in the process plants other than the waste steam. However, to keep the boiler in operating condition at minimum turndown ratio of 25% continuously to make the steam available readily in case of shutdown/ eventuality in WNA or in any other plant, some of the drives like BFW and FD fan of boiler, CW pump etc shall operate on condensing type turbine. This will also ensure continuous operation of WNA plant during the power failure.

At peak load, Coal requirement will be around 120 TPD which will be required only during the start-up of Nitric acid plant. Normal requirement will be 50 TPD. Hence, eight days Coal storage capacity (1000 MT) on peak load basis shall be installed. (FO fired Boiler is also being considered as an alternative possibility)

**Steam and Condensate System & Process Description**

Boiler feed water to the plant is produced from two sources, one from the demineralization plant and the other from condensate water polishing unit. The filtered water from Raw Water Treatment unit is sent to the demineralization plant whereas return condensate water from the plant is routed to condensate polishing unit to remove the dissolved solids.

The demineralization plant is designed to 25 m³/h capacity. The condensate polishing unit will be designed in the later stage.

Low pressure steam from LP header would be used for stripping the dissolved oxygen from the condensate water in the de-aerator. Oxygen scavenger dosing
is required to remove any residual oxygen present in the condensate water at the outlet of the de-aerators. The condensate from the de-aerator would be approximately 100 deg C, and routed to the Boiler Feed Water (BFW) pumps. Since the BFW is at boiling point, the de-aerators will be elevated to avoid pump cavitation.

The BFW pump suction piping design will also take in to account the pump NPSH requirements, frictional losses in the suction piping, vapor pressure, high fluid temperature and other similar requirements.

Condensate from the surface condenser in Nitric Acid plants will be recycled back to the Waste heat boilers in those plants. Any shortfall in condensate will be made up by DM Water

**General Steam Piping Design**

- All steam lines shall be insulated with hot insulation material and cladding.
- The steam header shall be designed with slight gradient towards the steam trap.
- The steam header shall be provided with steam traps at suitable location.
- Pocketing of the steam line shall be avoided. Steam trap shall be provided at the low point of the pocketed section.
- Provision of a by-pass around the trap as required for a start-up shall be provided.
- Proper line rating shall be considered once the P&ID’s are developed.

### 7.10 Cooling Water System

The cooling tower provides indirect cooling to the heat exchangers to remove the heat duty from the circulating water. The circulating cooling (cooling medium)
water would be used as a close loop circulating water to cool the coolers/heat exchangers in ammonia, nitric acid and ammonium nitrate plants. The circulated water from the outlet of the individual plant would return via a circulating water return header back to the cooling tower.

An induced draft, cross flow type cooling tower will be used for supply of cooling water to different section of the plant. Maximum temperature difference of 10°C is desirable in the cooling tower. This will be associated with CW circulating pumps, side stream filtration, chemical dosing system etc. Three cooling water pumps (electric motor driven) will be running to meet the process requirements. The water losses calculated from the cooling tower includes drift and evaporation loss as well as blow down loss. The blow down rate from the cooling tower would vary, and depend on the water quality being maintained.

Circulating Cooling Water Flow in m$^3$/h

<table>
<thead>
<tr>
<th>Plan</th>
<th>Actual Flow</th>
<th>Design Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid Plant</td>
<td>----</td>
<td>7079</td>
</tr>
<tr>
<td>ANS Plant</td>
<td>----</td>
<td>968</td>
</tr>
<tr>
<td>Ammonia plant</td>
<td>-----------</td>
<td>6800</td>
</tr>
<tr>
<td>AN Prill Plant</td>
<td>----</td>
<td>648</td>
</tr>
<tr>
<td>Utilities area</td>
<td>----</td>
<td>500</td>
</tr>
<tr>
<td>Total</td>
<td>----</td>
<td>15995</td>
</tr>
</tbody>
</table>

**Pumps Design**

The main pumps shall be designed with a discharge pressure required to overcome the highest static head of the downstream process in the Complex and associated frictional losses. This requires further investigation based on the plant layout and will be considered in the next phase of work. The discharge pressure requirements need to be reviewed once the header piping and equipment layouts are finalized.

**Design Considerations**

- The pump sizing is based on very preliminary information. The sizing shall be reviewed later when the equipment layout and piping layouts are available.
The cooling water header should have high point vents and low point drains.

To check the cooling water pumps performance, provision for flow measurement is advantageous at the individual pump discharge header.

Proper chemical and hypochlorite treatment would be required to keep the Legionaries bacteria under control.

**Cooling Water Chemistry**

Actual cooling water chemistry and quality will be determined upon site selection and water source and treatment. Cooling water chemistry requires some amounts of free chlorine, phosphate and dispersant to prevent corrosion, scaling by keeping the impurities in suspended form.

Free chlorine also keeps bacterial and organic growth under control. Provision of descale chemical injection point would be required in cooling water circuit.

### 7.11 Air Systems (Compressed Air)

The facilities shall have 2x 1,500 Nm³/hr. oil free compressors which shall cater the requirement of instrument and Plant Air of the complex. One compressor will be in line and another shall be kept as standby. A 1,200 Nm³/hr. of drying unit shall be installed to necessary conditioning of the air to be used as instrument air.

Detail requirement of complex instrument & plant air will be freeze during detail engineering stage of project.

System will comprise one plant air receiver and one instrument air receiver.

**Instrument Air**

The consumption rate for instrument air is based on all instruments operating plus the design margin. Since P&ID’s are not available or the instrument loop diagram, an assumption has been made to arrive at the capacity requirement. It is important that once the details are available the capacity requirement need
to be revisited after detail engineering.

**Plant Air**

No specific information is available and a small continuous requirement is considered *(assumed)* for design purpose. The plant air would be typically about 800 kPag, but will be confirmed after detail engineering.

**Design Parameters for Compressed Air System**

The instrument air pressure is set by the instrument specification. Typically, it is 700 kPag measured immediately downstream of the final driers.

<table>
<thead>
<tr>
<th>Description</th>
<th>Operating</th>
<th>Design</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant air header</td>
<td>8 bar g</td>
<td>10 bar g</td>
<td></td>
</tr>
<tr>
<td>Instrument air header pressure</td>
<td>7 bar g</td>
<td>10 bar g</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Ambient</td>
<td>65 dig C</td>
<td></td>
</tr>
<tr>
<td>Instrument air dew point</td>
<td>– 40 deg C</td>
<td></td>
<td>At 7 bar g</td>
</tr>
</tbody>
</table>

**Compressor and Air Drier, Receiver Sizing**

The system design is based on the following:

☐ The compressor is sized to 1500 Nm3/h flow considering 300 instrument components for the whole plant and considering 5 Nm3/h consumption per instrument. Detail requirement of instrument air will be estimated and freeze during detail engineering.

☐ Dry running oil free reciprocating compressor type is preferred.

☐ Inter-cooler and after cooler should be part of the compressor vendor skid.

☐ Instrument air driers have a design dew point of – 40 deg C at the operating pressure
Driers will be reactivated by desorption which is a package item

Two Filters of 100% capacity are provided upstream and downstream of the driers to provide dust free air supply.

**Instrument Controls**

The compressed air system shall include the following controls:

- Operation and control of the compressors within the package (by the vendor)
- Control of the driers within the package (by the vendor)
- Start and stop of the duty compressor with the air demand (low/high instrument air header pressure)
- Failure of the duty compressor, and further fall in instrument air header pressure, the control system should start the stand-by compressor automatically.
- Due to criticality, preference would be given to instrument air header pressure over the plant air. Therefore, in the event of fall in instrument air header pressure, plant air supply will be shut. As discussed, the stand-by compressor would come online to cope with the additional demand.
- One of the two instrument air compressors would be connected to the emergency power system for black start scenario.

**7.12 Fire Water System**

Fire water system will be provided as per the regulation.

The firewater system should be designed to the following criteria:

- The main firewater pumps (both diesel and electric drive) designed to
have water which will be finalized during detail engineering stage of project. The sizing of the pumps and the firewater headers assume that at any given time five monitors each of 55 m3/h would be required to fight fire.

- A minimum of two main independent power 100% for firewater pump systems are available. One Electric motor and one diesel engine driven pump shall be provided.

- The main pumps shall can operate for 24 hrs. continuously.

- The main pump shall be capable of developing pressure of 9 bar g at the discharge flange.

- Firewater pumps shall be located within a safe area if possible, such that a fire in one area will not put both the fire pumps out of action.

- The electrical jockey pump capacity of 10 m3/h shall be provided.

- The jockey pump should can maintain the firewater system pressure at 8 barg.

Firewater tank would be designed to 3 hrs. capacity at the water flow rate of 275 m3/h.

- Diesel driven firewater pump will be a package item. The package should include the following:

  1. Start-up – Cranking (battery / Air receiver / Hydraulic)
  2. Diesel day tank should have capacity for 8 hrs. continuous operations
  3. Auxiliary system
  4. Local control panel

- The firewater ring main sized to 350 m3/h.

- The firewater piping design to 16 bar g and the firewater pump shutoff head not to exceed the FW header design pressure.
- Firewater pumps should be designed to applicable NFPA / API codes
- A provision of a spill back line is provided back to the FW storage to bleed-off the excessive pressure from the firewater header

7.13 **Product Handling**
Ammonium Nitrate melt shall be dispatched through road Tankers. Tanker loading system will be provided for handling product evacuation. Prilled Ammonium Nitrate (TAN) shall be bagged in bags in Bagging Plant. Filled bags shall be loaded in trucks and then dispatched by road. Truck loader shall be provided for loading the bags in truck. All precautions as per latest AN rule shall be taken during storage and delivery stages.

7.14 **Manpower**
The manpower required for the operation of the proposed facility will be met by deployment of personnel with requisite experience and skill. The manpower will be adequately trained before start of operation. Focus shall be training and employing locals to the extent possible and based on availability of workforce with required skill sets.

7.15 **Laboratory**
Adequate laboratory facility will be provided to check the all the raw materials, products, by products, water and steam system, effluent system parameters during day to day operation.

8. **PROCESS FLOW BLOCK DIAGRAM OF NITRIC ACID PLANT**
See Annexure-1 for Ammonia, A, ANS & TAN Process Flow Block Diagram
9. RAW MATERIAL & PRODUCT SPECIFICATION


<table>
<thead>
<tr>
<th>Description</th>
<th>Min</th>
<th>Avg</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia content</td>
<td>99.5</td>
<td>Balanc</td>
<td>% wt</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>0.5</td>
<td></td>
<td>% wt</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td>10</td>
<td></td>
<td>ppm wt</td>
<td></td>
</tr>
<tr>
<td>Organics</td>
<td>Not detectable</td>
<td></td>
<td>ppm wt</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>2</td>
<td></td>
<td>ppm wt</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-34</td>
<td></td>
<td>20</td>
<td>Deg C</td>
</tr>
<tr>
<td>Liquid Ammonia Density</td>
<td>674.4</td>
<td></td>
<td>670.3</td>
<td>kg/m3</td>
</tr>
</tbody>
</table>

Ammonia Storage

Imported ammonia shall be brought by ships while domestic ammonia if available shall be brought by road tankers. The Ammonia shall be stored in atmospheric storage tanks existing in the neighboring plant. Ammonia at –33 Deg C shall be pumped directly to DFPCL’s TAN process plants through a pipe line. Only a small Ammonia bullets (2) of 250-300 MT capacity shall be provided at DFPCL site to meet the demand in case of interruption from supplier and due to power failure etc.

More information can be furnished after carrying out the Detail Engineering.

9.2. Products Specifications

9.2.1 Weak Nitric Acid

<table>
<thead>
<tr>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>HNO3</td>
<td>58</td>
<td>62</td>
<td>% wt.</td>
</tr>
<tr>
<td>NOx (as NO2)</td>
<td></td>
<td>0.005</td>
<td>% wt.</td>
</tr>
<tr>
<td>Chloride (as HCl)</td>
<td>1</td>
<td></td>
<td>Ppm</td>
</tr>
<tr>
<td>Silica (as SiO2)</td>
<td>1</td>
<td></td>
<td>Ppm</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>40</td>
<td>45</td>
<td>Deg C</td>
</tr>
</tbody>
</table>
9.2.2 Technical Ammonium Nitrate Prills (LDAN)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Nitrogen by mass</td>
<td>34</td>
<td>% wt. min</td>
</tr>
<tr>
<td>Ammonium Nitrate</td>
<td>99</td>
<td>% wt. min</td>
</tr>
<tr>
<td>Humidity (H2O)</td>
<td>0.20</td>
<td>% wt. max</td>
</tr>
<tr>
<td>Acidic Nature (pH)</td>
<td>4.8 – 5.2</td>
<td>- min</td>
</tr>
<tr>
<td>Oil Absorption</td>
<td>6</td>
<td>% wt. min</td>
</tr>
<tr>
<td>Free Flow Bulk Density</td>
<td>0.72 –</td>
<td>g/cm3</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>0.2</td>
<td>% max</td>
</tr>
</tbody>
</table>

9.2.3 Technical Ammonium Nitrate Prills (HDAN)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium Nitrate</td>
<td>99</td>
<td>% wt. min</td>
</tr>
<tr>
<td>Humidity (H2O)</td>
<td>0.50</td>
<td>% wt. max</td>
</tr>
<tr>
<td>Acidic Nature (pH)</td>
<td>4.8</td>
<td>- min</td>
</tr>
<tr>
<td>Chloride as Cl</td>
<td>10</td>
<td>ppm max</td>
</tr>
<tr>
<td>Iron as Fe</td>
<td>10</td>
<td>ppm max</td>
</tr>
<tr>
<td>Sulphates as H2SO4</td>
<td>15</td>
<td>ppm max</td>
</tr>
</tbody>
</table>

9.2.4 Ammonium Nitrate Melt

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium Nitrate</td>
<td>84 - 86</td>
<td>% wt. min</td>
</tr>
<tr>
<td>Humidity (H2O)</td>
<td>14 - 16</td>
<td>% wt. max</td>
</tr>
<tr>
<td>Acidic Nature (pH)</td>
<td>5</td>
<td>- Min</td>
</tr>
</tbody>
</table>

10. ENVIRONMENTAL CONSIDERATIONS

Climate and Meteorology

Meteorology plays a vital role in affecting the dispersion of pollutants into the environment after their discharge into the atmosphere. Jagatsinghpur District enjoys a temperate climate. Winters are cold, while summers are hot and humid. The District is prone to cyclonic rainfalls during the monsoons. The maximum temperature of the District is 38°C and minimum temperature is 12°C. The average rainfall measured in the District is 1765.1-mm.

The state experiences four seasons, these are:

Winter (December to February), Pre-monsoon (March to May), Monsoon (June to September), Post-monsoon (October to November).

**Winter Season:** Occasional rains with average 40-mm rainfall is received during this period, the average minimum temperature goes to 5°C or below in interior districts and in coastal areas it remains around 12-15°C. Normally
the winter brings a clear sky, light winds and abundant sunrays during the daytime.

**Summer Season:** The average temperature in the coastal districts remains 30-35°C and in interior districts remained around 35-42°C. There are some hot pockets in the western belt, where the temperature goes as high as 45-50°C. During March to May often a high-pressure area created over the Bay of Bengal, forcing moisture-laden wind to the coastal districts of the State. This situation brings thunderstorm, hail storm, dust storm and light rains to the area.

**Monsoon Season:** The period mid-June to end of September or early October is considered as monsoon season. Southwest monsoon sets in over the State by the mid-June brining rain. About 80% of the total rainfall (average more than 1480.0-mm) occurs during this period.

**Post-monsoon Season:** The monsoon usually continues up to the end of September and to the early part of October. Then the sky becomes clear and the day temperature starts decreasing and the night temperature drops sharply. During the post-monsoon period, the interior parts of the State receive about 75.0-150.0-mm rainfall and the coastal districts receive about 200 to 220-mm rainfall. Another feature of this period is occurrence of intense low-pressure system over the Bay of Bengal creating cyclonic storm, often striking Orissa coast.

Following waste shall be generated during the process

<table>
<thead>
<tr>
<th>Environmental Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>11.</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th></th>
<th>Inland, coastal, marine or underground waters</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>There is a river called Mahanadi at 5.40km, N and Santra Nallah 1.84km, SW, Antrabanki.4.18 km, SE, Mahanga Nallah,4.89km, SW Bay of Bengal,6 km, SE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>State, National boundaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>There are no state State, National boundaries</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>NH-5A,5.26 km, E and Ranigarh RD,0.23 km, E</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Defense installations</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>There are no Defense installations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Densely populated or built-up area</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Paradip,2.78km, NE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Areas occupied by sensitive man-made land uses (hospitals, schools, places of worship, community facilities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>DAV Public School,2.08 km, SE Port Trust Hospital,6.41km, SE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Areas containing important, high quality or scarce resources (ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Areas already subjected to pollution or environmental damage. (Those where existing legal environmental standards are exceeded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Areas susceptible to natural hazard which could cause the project to present environmental problems (earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Project area falls in the seismic zone-III(Moderate damage Zone)</td>
</tr>
</tbody>
</table>
- Oily cotton rags from maintenance activities
- Filter media used for filtration of air / water / cutting or lubricating oil

Empty chemical containers, drums
Include NOx abator used catalyst & Ammonia plant used catalyst.

The wastes indicated above are of special concern since they could be eco-toxic or hazardous and special attention needs to be given to their handling, treatment and disposal.

**Spent Filter Cartridge:**
After analysis under hazardous waste these wastes will be disposed off at their hazardous waste site in sealed containers after obtaining requisite approvals.

The other generated waste is municipal solid waste, scrap – metal, paper, plastics, waste packaging material etc. These miscellaneous wastes will also be disposed of through local / federal approved vendors.

**10.2 Liquid Effluent:**
During the normal operation of the plant there will be no liquid effluent from WNA plant but a small quantity of Nitrate bearing effluent will generate from AN wet plant. Some quantity of Nitrate and Nitric acid containing effluent from WNA and AN wet plant will also generate during the plant upset or startup/shutdown condition. In addition to this process effluent, blow down water from cooling tower, boilers, backwash of DM plant resins and side stream filters of cooling tower, domestic waste from canteen etc will also be part of main effluent.
A suitable effluent treatment plant shall be installed to take care of all the effluents. Following will be the characteristics and quantity of the liquid effluent.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Source</th>
<th>Qty</th>
<th>pH</th>
<th>TSS</th>
<th>O &amp; G</th>
<th>BOD</th>
<th>COD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid Plant</td>
<td>Floor Washing</td>
<td>9</td>
<td>2-7</td>
<td>50</td>
<td>5</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td>Nitric Acid Plant</td>
<td>Boiler Blow down</td>
<td>53</td>
<td>11-12</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>Ammonia Plant</td>
<td>Synthesis loop NH3 recovery section &amp; floor washing</td>
<td>50</td>
<td>7-8</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>Ammonia plant cooling water</td>
<td>Blowdown and filter Backwash</td>
<td>600</td>
<td>7-9</td>
<td>20</td>
<td>&lt;10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>AN Solution Plant</td>
<td>Floor Washing</td>
<td>9</td>
<td>3-9</td>
<td>50</td>
<td>5</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td>AN Solution Plant</td>
<td>Clean/Proces</td>
<td>222</td>
<td>5-8</td>
<td>5</td>
<td>NIL</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>TAN</td>
<td>Plant washings</td>
<td>17</td>
<td>3-9</td>
<td>50</td>
<td>5</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>AN Storage and Plant</td>
<td>Spillage and Plant</td>
<td>5</td>
<td>2-7</td>
<td>50</td>
<td>5</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Nitric Acid Storage Area</td>
<td>Spillages and plant</td>
<td>5</td>
<td>2-7</td>
<td>50</td>
<td>5</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td>Boiler Area + DM Water Plant</td>
<td>Boiler Blow Down</td>
<td>20</td>
<td>11-12</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Boiler Area + DM Water Plant</td>
<td>Plant washing, regeneration</td>
<td>79</td>
<td>7-8</td>
<td>10</td>
<td>5</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Cooling Water Tower</td>
<td>Blowdown and filter</td>
<td>1104</td>
<td>7-9</td>
<td>20</td>
<td>&lt;10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Domestic effluent</td>
<td>Domestic Effluent</td>
<td>48</td>
<td>5.5-7</td>
<td>160-200</td>
<td>20-30</td>
<td>250-300</td>
<td>400</td>
</tr>
</tbody>
</table>

The total amount of industrial effluent that is envisaged to be generated Based on Ammonia plant capacity, shall be 2221 m3/Day.

Liquid effluent from process plants / ancillary units shall be collected through drain channels and taken to a centralized effluent treatment plant for Primary and Secondary bio-treatment consisting of a stripper, equalization tank, aeration basin, clarifier etc to further reduce the COD and Nitrate contents to the levels well below the specified limits. In addition to the above, a guard pond shall also be provided to collect the initial washings from the storm water drains during the first monsoon shower. The washings shall be routed though
the effluent treatment plant.
Special Civil Works

- The open drain lining shall be resistant to acid and alkali.
- Underground neutralizing pit may be considered for mixing the acid and alkali before discharging to effluent treatment plant.

Effluents Plant Design Basis

The process water effluents from the Ammonia, AN, NA and Utilities area are effluents included in the effluent plant design. The effluent water from the plant would be segregated and routed to a holding pond or evaporation pit prior to treatment and disposal. The holding pond or evaporation pit should be lined to prevent soil contamination/pollution.

The composition of the pond water may change drastically during turn-around due to the discharge of large amounts of acid or other product effluent from the plant.

The following are important while designing and segregation.

1. Determination of composition and amount of each stream entering the holding pond.
2. Determination of cyclic change, discharge period and frequency.
3. Determination of corrosively, suspended solids, and compatibility of the various streams.

Effluent treatment plant design is based on the constituents present and the quality of water to be achieved at the outlet of the treatment plant. The options are a batch or continuous process.

Provision of RO system for near zero discharge:
To conserve the water and achieve minimum discharge from the complex, we may plan to install RO system to remove majority of dissolved salts, organics, bacteria and suspended solids from aqueous liquid effluent and recover pure water which will be suitable for make up as cooling towers and other process
use. Around 70% recycle of ETP treated water will be targeted.

Requirement of an RO unit shall be separately studied and a unit shall be provided if the need so arises.

In case RO becomes essential the reject stream from the RO unit will be further concentrated and used as landfill unless the reject or the solid concentrate can be suitable used for alternate application.

10.3 **Gaseous Emission:**
The major source of air emissions from Process area during the operational phase of the Ammonia plant reformer, gas engines, CO2 stacks as mentioned.

Ammonia Plant gaseous emissions stacks:

1) Reformer stack.
2) Gas engine.
3) CO2 scrubber.

More details of emissions will be included based on existing Ammonia facility of Taloja plant.

- **NOx in Tail gas from the Nitric Acid Plant:** Before venting the tail gas in to atmosphere, NOx level in the tail gas shall be reduced to the acceptable limit by selective catalytic reduction with ammonia in presence of Vanadium pentoxide, platinum or iron/chromium oxides catalysts.

- **Ammonia and ammonium nitrate laden air from the prilling scrubber:** This air is cooled and scrubbed to remove most of the ammonia and Ammonium Nitrate from them.

- **Air emission from utility area is through boiler stack which will operate on fuel oil.** Dedicated stack will be attached for the service boilers.
The approximate quantity and quality of gaseous emission from Spent Air and boilerstack are furnished below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Tail Gas from Nitric Acid Plant</th>
<th>Service Boiler</th>
<th>Waste air from prilling scrubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stack gas temp (°C)</td>
<td>130</td>
<td>150-</td>
<td>40-45</td>
</tr>
<tr>
<td>2</td>
<td>Stack gas velocity (m/sec)</td>
<td>30-35</td>
<td>Later</td>
<td>20-25</td>
</tr>
<tr>
<td>3</td>
<td>Stack gas volume m³/hr.</td>
<td>15500</td>
<td>Vendor' scope</td>
<td>About 1,10,000</td>
</tr>
<tr>
<td>4</td>
<td>Stack height (m)</td>
<td>Will be furnished after detail engineering</td>
<td>Will be furnished after detail engineering</td>
<td>Will be furnished after detail engineering</td>
</tr>
<tr>
<td>5</td>
<td>Stack diameter (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Emission rate (mg/Nm³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- SO₂</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td>- CO</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td>- NOₓ</td>
<td>As per norm</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>7</td>
<td>SPM</td>
<td>NIL</td>
<td>&lt;150 mg/m³</td>
<td>&lt;150 mg/m³</td>
</tr>
</tbody>
</table>

The other non-specific sources of gaseous emissions are from vents of storage tanks, Vessels and other process equipment.

12. PROJECT IMPLEMENTATION PLAN & TIMESCHEDULE

11.1 Scope of Project

The proposed project would include site development, main process plants along with Offsites&Utilities, Raw material and product storages, Electrical substation, Covered Ware houses, Plant and non-plant buildings etc. The project scope shall also include the construction of cross country facilities for bringing Ammonia, fuel, Raw material, and Power to the site.

11.2 Location

TAN Plant will be in the eastern part of India at “Kujang (Tehsil),
11.3 Implementation Modalities

Implementation of project would involve several activities, of which some are pre-project activities and others are related to physical execution of the project. The total project including offsite facilities will be executed by DFPCL on EPCM basis with the help of reputed consultant who will provide services for detailed engineering, procurement, construction supervision and supervision of pre-commissioning & commissioning activities (EPCM) and multiple site contractors working in parallel and interfacing where appropriate. License, know-how and basic engineering is being obtained by DFPCL from reputed process licensors. Site contractors will have additional project management personnel. A Project Management Plan, which defines scope and responsibilities and details the procedures and practices to be used to deliver the complete ammonium nitrate complex has been developed by the Contractor.

11.4 Pre-project Activities

The pre-project activities to be completed before the physical execution of the project are briefly enumerated below:

a) Approval of the project by competent authority.

b) Preparation of Environment Impact Assessment (EIA) study and/or clearance by State and Central Pollution Control Boards, as may be required.

c) Soil investigation work for ascertaining soil characteristics of the area identified within the present boundary for location of the new facilities.

d) Selection of Technologies – completed

e) Selection of Detailed Engineering Consultant.

f) Mobilization of resources for construction facilities.

g) Appointment of Owner’s Project Management team.

h) Firming up of arrangement for supply of raw materials from concerned agency – in progress.
11.5 Project Execution

Based on the above philosophy, DFPCL plans to implement the project by entering an agreement with a reputed Process licensor to provide Know-how and Basic engineering of the plant. DEC’s scope of work shall be on EPCM basis to include detailed engineering, Assistance during procurement, inspection and expediting of all equipment and materials, construction supervision and commissioning of plant, including Offsite and Utilities facilities.

To perform the above activities, DFPCL has a project management group consisting of highly competent, dedicated and qualified team of professionals with wide experience in the field to co-ordinate and follow-up to ensure completion of the project within projected time schedule.

11.6 Project Management

The project will be managed by DFPCL’s in-house PMC team to utilize the experience obtained over 30 years and building 5 Nitric Acid and 4 Ammonium Nitrate units. The learning from previous projects and operations over years have been incorporated during basic and detailed design of the plants.

DFPCL has a formidable and highly dedicated project team of qualified engineers of various disciplines and a very skilled and experienced workforce. The team has recently executed a Rs. 600 cr brown field AN-complex at Taloja. A team comprising of Operation group and Project group will be constituted to implement the project and will be responsible for Overall Project Management. This team will be composite with Engineers from various disciplines including Finance and Accounts and Materials Management personnel.
11.7 **Engineering:**

**Basic Process Engineering**

The basic engineering is carried out by a reputed process licensor and will be issued to the Detail Engineering Contractor to carry out the detail engineering.

**Detail Engineering & Process Equipment Procurement**

Detail engineering work will follow from basic process engineering.

The selected Detailed Engineering Contractor (DEC) shall carry out the detailed engineering of plants and off-sites, which will form the basis for plant construction. It will comprise all discipline design services necessary for the procurement, construction and commissioning of the plant and associated infrastructure including:

- Prepare calculations and design/construction drawings in a suitable format for fabrication and construction;
- Prepare data sheets, standards and technical specifications and for all materials and equipment;
- Develop scope of work documentation for supply and construction contracts; undertake constructability reviews;
- Prepare the process control philosophy and manage control system programming;
- Participate in HAZOP studies;
- Perform technical evaluation of all supply and construction tenders;
- Provide technical clarification and support during the construction and commissioning phases;
- Prepare Operations and Maintenance manuals;
- Prepare As-built drawings.

The data provided will cover all the activities necessary for procurement of equipment’s, plans, elevations and isometrics of different sections for civil design.
and equipment erection etc. The Detail Engineering Contractor will require the vendor design information from the process equipment vendors and the utilities equipment vendors. The procurement group will expedite this vendor information for the detail design contractor.

11.8 Procurement

The EPCM Contractor’s procurement team will provide services for the procurement, expediting, inspection and delivery of all mechanical equipment except for the Propriety Equipment. Orders will be placed with qualified vendors based on technical compliance, quality, price and delivery.

Principle activities undertaken in the procurement phase will include:

- Prepare tender lists for all packages and submit for Deepak approval;
- Prepare and issue tender documentation, perform evaluations and submit recommendations for award to Deepak;
- Deepak shall award the purchase orders and Carry out all management requirements, inclusive of financial guarantees, vendor data, spares and maintenance documentation, during the term of the order;
- Review all suppliers Inspection and Test Plans (ITPs) and perform all necessary inspection and expediting activities to ensure the specified quality and delivery schedule requirements are met;
- Receive and review all vendors invoices and prepare recommendations for payment;
- Close out all purchase orders upon completion;
- Provide support to the construction group as required.

11.9 Contracts –Construction Contractors

The Contractor will be required to tender and administer construction contracts on Deepak’s behalf. Key activities will be of similar nature to those described above. It is anticipated that contracts will be a mix of schedule of rates and lump sum.
11.10 Project Control

An accurate project controls system is critical to manage the Project. The principal function of the controls system will be the monitoring and reporting of actual progress and cost against the baselines established at the commencement of project implementation. Secondary functions of control will provide progress reports, establish quality standards and maintain a comprehensive document control system. The EPC Contractor’s PMMP will include the basis for these control and reporting systems.

11.11 Quality

It is a fundamental requirement that all aspects of the Project are executed in accordance with specified technical requirements, be they performance, compliance with technical specification or manufacturing and fabrication standards. The EPC Contractor will develop a Quality Management Plan (QMP) defining quality objectives, identifying all standards applicable to the Project and practices, such as design reviews, vendor inspections and audits etc to be performed to ensure the quality objectives are met.

11.12 Document Control

It is critical that all Project documentation is clearly identified and traceable to the end user. There will be an agreed document and drawings numbering system, document registers maintained, protocol for revision management of drawings and a drawing transmittal system for all external document issue.

11.13 Construction:

Construction activities for the main plants and off-sites will be grouped per the nature of the jobs and bids invited from pre-qualified contractors. The bids will be evaluated based on the experience of the contractors, their background, cost and time schedule. The overall responsibility for the construction would be that of the
DFPCL. The chief of the construction group shall look after the co-ordination of all the construction activities. He will be assisted by a group of Engineers, managers and other staff.

11.14 Construction Management

Project construction will be carried out by suitably experienced discipline contractors operating under the management of Deepak and the Local EPCM Contractor’s site team.

The EPCM team will have the following key responsibilities:

- Safety;
- Contract management;
- Verification of contractor’s quality compliance;
- Interface management;
- Resolution of technical queries;
- Progress monitoring and reporting;
- Contractor progress and claim certification;
- Survey control;
- Materials management.

11.15 Materials Management

As each consignment reaches the site, it will be unloaded and inventoried. Material receipt reports and report of overages, shortages and damaged goods will be generated and distributed to appropriate management and accounting groups. Everything receiving information will be entered the materials tracking system. After inventory, equipment and materials will be stored either in the construction warehouse or in a secure, fenced area. Equipment designated as free issue to contractors will be issued upon written request.
11.16 Construction Contractor’s responsibilities

- **Construction Equipment**
  Construction contractors will provide their own equipment, tools, construction power, fuel, supplies and facilities. Contractors will be expected to furnish all materials and equipment required to complete their contract works in accordance with their contract requirements.

- **Quality Control/Quality Assurance**
  Contractors will furnish their own Quality Control program in accordance with contract documents. This will include all testing requirements including compaction, concrete strength, weld and electrical installation testing.

- **Construction Personnel**
  Contractors will be responsible for provision of all supervisory and trades personnel. The contractor shall follow all statutory rules & regulations for labor working / deployed at site.

11.17 Commissioning

The pre-commissioning and commissioning activities will be carried out by the commissioning team with assistance from vendor’s representatives plus the construction contractor’s resources as required. With detailed planning, systems can be handed over to the commissioning team progressively to facilitate the commissioning process.

Commissioning, sustained load run and guarantee test will be under the total responsibility of the licensor for the main plants. The owners must make arrangement for the supply of raw materials in adequate quantities. The utility requirements like power, water etc. would be kept ready to be supplied whenever necessary. The owner will also supply the necessary operators, engineers and skilled and non-skilled worker, who will be involved in the commissioning process.
activities. Commissioning spares also must be procured before the commissioning activities start.

11.18 Scheduling & Monitoring

Scheduling and monitoring of the main plants and overall scheduling and monitoring of entire Project will be the responsibility DFPCL project group. PERT/CPM chart will be prepared incorporating main activities in each section discipline wise. The activities will cover design, engineering, procurement, transportation, civil construction etc.

Cost Control

Following confirmation of the Project capital cost estimate, the estimate will then become the Project budget. The budget for the project will then be entered in to database cost control system utilizing a coding structure that identifies all equipment, materials and discipline activities. Throughout the course of the Project all commitments and expenditure will be entered in the cost control system. Forecasts to complete and variances will be updated monthly and contingency drawdown will be managed. Efficient and accurate cost control will be critical to ensure the Project is completed within budget.

Reporting

During the Project, there will be the need for on-going communication of project status to Deepak from all parties involved. The monthly progress reports shall be prepared and shall be circulated by DFPCL project group.

Key issues to be reported will include:

- Safety;
- Environmental;
Progress in all discipline (measurement and narrative);

- Procurement and contract status;
- Costs;
- Quality;
- Project issues and concerns; The principal reporting forums will be;
  - Weekly progress meeting;
  - Formal monthly report including narrative and updated project controls reports and forecasts.

11.19 Schedules

The project will be monitored with the help of the following schedules.

a) Overall project schedule
b) Engineering schedule
c) Procurement schedule
d) Construction Schedule.

The physical progress of the project will be monitored based on schedules S-curves as follows.

- Overalls-curve
- S-curve for engineering, procurement and construction.

All the networks/CPM will be computerized for working out the earliest/latest start and finish dates and floats/slacks available in each activity.
11.20 **Time Schedule**

The overall time schedule for the proposed project including pre-project activities is 36 months. There shall be overlap in procurement to reduce the overall time schedule.

A preliminary bar chart showing the details of activities and their completion time is provided on the next page.
13. **PROJECT COST & FINANCIALS**

**Cost Estimate**

The estimate has been built up from the following inputs:

**Base Equipment List**

The base equipment list reflects current technology offer by Grande Paroisse, France and as presented in Section 4 of this report. Prices of proprietary equipment reflect data base prices prepared by our internal team out of our project and operating exposure to the relevant manufacturing set-up. For the current study, it is assumed that the balance of the ISBL/OSBL equipment is procured in India and our internal team has prepared this pricing based on current data base pricing for Indian supply as well as capital committed on previous projects of similar nature.

**Plant Layout**

The plant layout has been developed about information from previous geotechnical investigations on this site as well as from our experience. The plant layout has been stepped in two levels to minimize the site earthworks. The minimum elevation of the plant is 3.2 m AMSL to remain above to the tide and storm surge water level. Refer Infrastructure & Plant Layout (preliminary) at the end of this section.

<table>
<thead>
<tr>
<th>Item</th>
<th>UOM</th>
<th>Base Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost</td>
<td>Rs Cr</td>
<td>1750</td>
</tr>
<tr>
<td>Project IRR</td>
<td>%</td>
<td>18.3%</td>
</tr>
<tr>
<td>Equity IRR</td>
<td>%</td>
<td>24.8%</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>Yrs</td>
<td>4.8</td>
</tr>
<tr>
<td>DSCR-Avg</td>
<td>%</td>
<td>2.05</td>
</tr>
<tr>
<td>Cash Breakeven capacity</td>
<td>%</td>
<td>14%</td>
</tr>
<tr>
<td>Avg cap utilization</td>
<td>%</td>
<td>96%</td>
</tr>
<tr>
<td>CORM</td>
<td>Rs/(MT of</td>
<td>12283</td>
</tr>
</tbody>
</table>
**Infrastructure & Plant Layouts**

The building of the Ammonium Nitrate plants being a grass root project shall consist of the following process and non-process units/facilities:

**Inside Battery limit process units:**

1) Main Battery limit plant for Weak Nitric Acid
2) Main Battery limit plants for Ammonium Nitrate Solution – melt
3) Main Battery limit plants for Ammonium Nitrate Solution – TAN prills

**Outside Battery limit units /facilities:**

4) Power receiving switch yard and sub-station
5) DG set
6) Complete firefighting system
7) Fire and smoke / gas detectors
8) Intake pipeline for water
9) Water treatment plant
10) Water reservoir
11) DM Water plant
12) DM Water tank
13) Condensate tank
14) Process water tank
15) Cooling Tower including pumps, motors / turbine and dosing system
16) Boilers and stack
17) Instrument air compressors, receivers and dryer
18) Effluent treatment plant including Reunite
19) Storage tanks including pumps for;
a) Nitric Acid
b) Ammonia
c) Diesel
d) Furnace oil
e) Caustic soda
f) Sophoricoside

20) Ammonia & Natural gas transfer pipeline

21) Weighbridges

22) Bagging facility

23) Tanker loading bay

24) Buildings to house
   a) Control system, Electrical switchgears, MCCs
   b) Plant offices
   c) Laboratory
   d) Administrative offices & canteen
   e) Workshop
   f) Engineering & chemical stores
   g) Security/Fire & safety
   h) First aid/Medical Centre
   i) Restrooms

25) Pipe racks & cable racks

The preliminary & conceptual lay out is displayed below. The detailed layout shall be finalized during engineering stage incorporating all statutory regulations/ guidelines.
ANNEXURE 1: PROCESS FLOW
DIAGRAMS NITRIC ACID UNIT

PFD: AMMONIA PLANT

PDF: NITRIC ACID
Process Flow Diagram for Ammonium Nitrate Manufacturing

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Operations</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Ammonia</td>
<td>Evaporation</td>
<td></td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>Reaction Neutralization</td>
<td>Flash Evaporation</td>
</tr>
<tr>
<td>Ammonia injection Steam</td>
<td>Storage</td>
<td>Vapours to ammonia separator Condensate (NH₃, ammonium nitrate)</td>
</tr>
<tr>
<td>Steam</td>
<td>Secondary Evaporation</td>
<td>Mixing</td>
</tr>
<tr>
<td>Additive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td>Gramulation</td>
<td>Prilling</td>
</tr>
<tr>
<td>Scrubbed Air</td>
<td>Drying</td>
<td>Screening</td>
</tr>
<tr>
<td>Steam Heated Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold dry air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditioned Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bags</td>
<td>Coating &amp; bagging</td>
<td></td>
</tr>
</tbody>
</table>