REPORT

ON

RISK ANALYSIS & DISASTER MANAGEMENT PLAN

FOR

COAL BASED NEW AMMONIA (2200 MTPD) & UREA (3850 MTPD) FERTILIZER PROJECT
AT
CLOSED UNIT OF FCIL TALCHER (ODISHA)

OF

M/s TALCHER FERTILIZERS LIMITED
PLOT NO. 2/H, KALPNA AREA, BJB NAGAR
KHURDA, BHUBANESHWAR-751014

Prepared By

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An ISO 9001:2015, OHSAS 18001:2007 Certified & ISO/IEC 17020:2012 Accredited Co.

PROJECTS & DEVELOPMENT INDIA LIMITED
(A Govt. of India Undertaking)
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2	SEPTEMBER, 2017	RA & DMP REPORT	G. Bandopadhyaya	DK Chatterjee	G. Deshmukh
REV	DATE	PURPOSE	PREPARED	REVIEWED	APPROVED

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ATTACHMENT

EXECUTIVE SUMMARY

INTRODUCTION

The closed unit of Talcher Fertilizer complex of the Fertilizer Corporation of India Limited (FCIL) was based on the gasification of coal. Since 2002 FCIL Talcher is totally closed and there is no activity related to production of Urea. Several attempts were made to revive Talcher fertilizer unit by Government of India.

A proposal was put-up before Cabinet Committee of Economic Affairs (CCEA) for setting up a coal based fertilizer and chemical complex within plant premises of closed unit of FCIL Talcher. The CCEA also approved formation of Joint Venture Consortium (JVC) to set up proposed fertilizer plant. As per the approval of CCEA, a JVC was proposed to be incorporated jointly by Rashtriya Chemicals & Fertilizers Ltd (RCF), GAIL (India) Limited, Coal India Ltd. (CIL) & Fertilizer Corporation of India Limited (FCIL).

Formation of JVC was already in the process after approval of CCEA and after completing all the formalities, a JVC in the name of Talcher Fertilizers Limited (TFL) was formed in 2015 and incorporated on 13 November 2015. It is registered at Registrar of Companies, Cuttack with registered office at Plot No. 2/H, Kalpna Area, BJB Nagar, Khurda, Bhubaneshwar-751014. RCF, CIL, GAIL (India) Limited & FCIL are the members of the consortium.

RCF & FCIL are Public Sector Units under the Ministry of Chemicals & Fertilizers, CIL is public sector undertaking under the Ministry of Coal, Govt. of India and GAIL (India) Limited is the public sector undertaking under the Ministry of Petroleum & Natural Gas, Govt. of India.

Initially after approval of CCEA in 2013 and when the formation of JVC was under process, the project proposal was to install five plants like Coal Washery, Ammonia, Urea, Nitric Acid and Prilled Ammonium Nitrate. The Terms of Reference (TOR) was awarded by MoEFCC vide *J-11011/231/2013-IA II (I) dated 23.06.2013* on the basis of installation of above five plants. After formation of JVC in the name of TFL, the project proposal has now been revised and TFL has decided now to go for installation of two major plants like Ammonia of 2200 MTPD and Urea of 3850 MTPD. TFL has abandoned installation of three major plants like Coal Washery, Nitric Acid and Prilled Ammonium Plants.

After formation of the JVC- TFL, the project proposal was revised as per prevailing Govt. Policy for revival of old closed units of FCIL and it was decided to install coal based Ammonia and Urea plants only. TFL now proposes to set-up coal based new 2200 MTPD Ammonia and 3850 MTPD Urea plants along with necessary offsite and utilities available/reusable within the premises of FCIL at Talcher Unit.

The project proposal is to set up coal based new ammonia and urea fertilizer plants based on recent best available technology comprising of Coal Gasification, Ammonia, Urea and related offsite & utility facilities.

With the above objectives in view, Projects and Development India Ltd. has been retained by M/s TFL to conduct Risk Analysis (RA) & Disaster Management Plan (DMP) studies of the proposed plant in the state of Odisha. PDIL's broad scope of work includes the following:

(i) Identify vulnerable sections of the plant, which are likely to cause damage to the plant, operating staff and the surrounding communities in case of any accident due to the plant facilities.

(ii) Assess overall damage potential of the hazardous events in relation to plant and environment.

(iii) Assessment of total individual risk for activities in the plant.

(iv) Assessment of societal risk due to the plant.

(v) Disaster Management Plan Preparation

The present study is based on the information made available by M/s TFL to PDIL before undertaking RA & DMP. The study does not take into account the risk for any deliberate maloperations or any act of sabotage. Also the study does not include the secondary risk effects from industries/ installations outside the plant boundary limit and domino effect.

PLANT LOCATION

The proposed fertilizer plant will be set up within the existing land of FCIL- Talcher unit. Total area of proposed fertilizer plant is 904.53 Acre. Out of this total area, 584.15 acres of land is available for fertilizer plant and remaining area is for residential colony.

Geographically, the project site falls at 20054'46.27"N and 85009'45.02"E at an elevation of 104m above MSL.

Old closed Talcher fertilizer unit is located at Vikrampur village in Angul district of Odisha on the Cuttack - Sambalpur National Highway, NH-42 passing at distance of about 8 km from the site. The nearest railway station is Talcher at about 7 km and nearest airport Bhubaneswar is at 150 km, 3 hours journey by road/ rail from proposed site. Nearest port is Paradeep, at 200 km by rail/road. The project site is well connected with Cuttack and the capital of Odisha- Bhubaneswar by rail and road. Major lotic system Brahmini, a perennial river is located at a distance of about 8km from site. The requirement of water for the proposed project shall be met from Brahmini River with the existing pumping station at the bank of river and existing network of pipelines shall also be utilized after necessary refurbishment. An alternate arrangement to meet power requirement during emergency/CPP failure shall be met from the existing substation of Odisha state electricity board (OSEB) which is about 2 km from the site.

CLIMATE AND METEOROLOGY

The climate of the study area falls under tropical monsoon climate zone. The study area experiences heavy rainfall of about 1287 mm during rainy season. The bulk of the rainfall, i.e., about 79% is received during south-west monsoon. Relative Humidity is high throughout the year. The relative humidity at an average is above 82% during the south-west monsoon period. During the rest of the year, the relative humidity is in the range of 33% to 75%.

Ambient temperature varies from the minimum of 13.90C to 40.20C. The highest monthly mean wind speed of 9.6 kmph has been reported in the month of May and the lowest mean wind speed of 4.8 kmph is reported in the month of January.

RISK ANALYSIS

Risk analysis of the plant includes identification of various credible and non-credible failure scenarios and consequences of those scenarios leading to various phenomena like toxic dispersion, pool fire, jet fire, and unconfined vapor cloud explosion, BLEVE etc (if any). Frequency of the failure cases, magnitude of hazards and hazard distances has also been dealt with. The principal conclusions drawn from the risk analysis and recommendations based thereon are summarized under next section.

PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS

The principal conclusion and recommendations that arise out of the risk analysis study are as follows.

CONCLUSIONS

The acceptable total individual risk (1 x 10^{-6}/year) contour for activities in the plant mainly remains within the plant premises only goes outside at a distance of 93m towards Eastern direction. The societal risk (F-N Curve) also goes remains with the acceptable limit.

RECOMMENDATION:

1. The downwind distances to ground level concentration of ammonia and chlorine may extend beyond factory boundary. Hence, the population outside should be made aware of the properties of gases and what to do in case of any leakage.
2. In order to reduce the frequency of undesired incidents further and thus to reduce the level of individual risk, it is necessary to adopt due care in design, engineering, construction, inspection, operation and maintenance of the plant and equipment.
3. In order to reduce the frequency of failure of various items like pipelines, equipment & machinery, valves & fittings etc. Good operating and maintenance practices must be followed. They should be tested periodically by non-destructive testing.
4. The Fertilizer Project of M/s TFL at Talchar shall be designed and engineered by internationally reputed process licensors, designers and engineers so risk reduction and operability measures are considered from very beginning stage.
5. Testing of plant safety system is to be carried out systematically at regular intervals and record should be kept.
6. Safety audit and health monitoring of the pipeline and equipment are to be done at regular intervals and necessary corrective measures taken immediately.
7. Fire fighting facilities in the plant should be as per TAC guidelines. The facilities will be extended for the new project and approval from competent authority will be taken wherever necessary. People residing inside and outside the premises should be aware of emergencies that may arise in the plant.
8. Mock drills are to be conducted at regular intervals to cope up with any emergency.
9. Mutual Aid arrangement should be done with the neighbouring industries, fire stations, hospitals etc.
10. Both On-Site and Off-Site emergency plan should be prepared and practiced.
11. Minimization of Ammonia vapour cloud formation from the evaporation of liquid pools by covering it with foam whenever such leakage is observed. Such failure may be caused in the vicinity of ammonia collector, Ammonia Storage Tank (AST) & associated facilities, intermediate liquid ammonia storage etc.
12. Suitable no. of flammable gas, ammonia & chlorine detectors to be provided for early warning of a leak in potential sources of emissions such as pump seals, compressor seals, process drains, vents and other flammable materials containments. Smoke detectors should also be provided in control rooms to detect leakage.
13. To minimize the dispersion of NH_3 vapour cloud in the vicinity of leakage/rupture, arrangement for water curtains to be made to absorb the ammonia vapour formed especially in the area like vicinity of ammonia collector, Ammonia Storage Tank (AST) & associated facilities, intermediate liquid ammonia storage tank etc.

14. Facilities to provide sufficient ventilation, putting on personal protective equipment (PPE) before entering the contaminated area and remain in the upwind direction in case of leakage of NH_3 should be kept in mind and strictly followed. If the situation is more alarming, the vapour cloud may be minimized by spraying water so that necessary manual action can be taken to stop the dispersion of ammonia.
15. Water jet should not be applied over the pool of liquid NH_3 due to leakages, since the heat produced will trigger a high evaporation rate.
16. Regular NDT of all the yard piping for ammonia/flammable/other toxic material transfer with high pressure should be carried out.
17. All the dykes should be made leak proof and their drain valves should be always kept in close position.
18. The control button of all Emergency Isolation Valves (EIVs) should be at safe and approachable distance from the maximum possible hazard source (such as leakage in mechanical pump seals, compressor seals etc.), so that it can be operated safely.
19. All EIVs should be tested at regular intervals. In case, they cannot be tested without upsetting the production, then must be tested fully during normal shutdown.
20. Valve closure may be initiated from a remote location and should be fire proof.
21. The size and frequency of (Gasket joints) leaks can be reduced by using spiral-wound gaskets in place of compressed asbestos fiber ones. Screwed joints should not be used.
22. In order to reduce the frequency of undesired incidents, further it is recommended to continue to adopt standard codes & practices in inspection, operation and maintenance of the plant and equipment.
23. In order to reduce the frequency of failure of various items like pipelines, equipment & machinery, valves & fittings etc good operating and maintenance practices must be followed/ continued.
24. The practice of Mock drills to be continued to cope up with any emergency and special attention must be given to the mock drills in Chlorine tonner/ cylinder handling areas owing to severe toxic effects in case of leakage.
25. The concerned plant personnel of operation & maintenance department must give special attention towards emergency preparedness in case of toxic gas leakage. Maintenance & working of ammonia and Chlorine detectors should be checked regularly to ensure its immediate response.
26. Testing of plant safety system are to be continued systematically at regular intervals.
27. Safety audit and health monitoring of the pipeline and equipment to be done at regular intervals and necessary corrective measures to be taken immediately.
28. Permanent sprinklers/ drench systems are very effective in controlling potentially large fires at an early stage. Water curtains should be installed in storage tank farms to cool adjacent structures and neighboring tanks in the event of fire.
29. Ammonia gas sensors should be installed all around the periphery of atmospheric ammonia storage tank area as well as TFL to detect/ prevent any off-site toxic hazards.
30. Both On-Site and Off-Site emergency plan should be prepared and approved from the statutory body before commissioning of the plant.

1.0 INTRODUCTION

1.1 BACKGROUND

Fertilizer Corporation of India Limited (FCIL) has the credit of being the first Public Sector Undertaking (PSU) of Government of India after independence. FCIL operated four fertilizer production units in different parts of the country namely at Sindri, Gorakhpur, Ramagundam and Talcher.

The Talcher Fertilizer complex of FCIL was based on the gasification of coal. The plants were conceived and designed to utilize the indigenously available feed stock coal. Talcher fertilizer unit, with a designed capacity to produce 900 TPD of Ammonia, 1500 TPD of Urea and other off-site facilities were commissioned in November, 1980. However, due to various limitations in process & equipment and non-availability of coal of desired quality, the plants could not achieve the designed capacity utilization. Due to continuous loss, the net worth of the company became negative and the whole FCIL including FCIL Talcher was referred to BIFR in April 1992 under the sick Industrial Companies (Special provision under Act 1985). Since 2002, FCIL Talcher is totally closed. Several attempts were made to revive Talcher fertilizer unit but could not be materialised.

Urea is pre-dominantly used in our country as fertilizer. There is a huge gap between demand & supply of Urea and the indigenous production is unable to meet the domestic (local) requirement. To fulfill the large gap, Urea is being imported every year. In order to meet the growing demand of nitrogenous fertilizer (Urea), the concept of installation of single stream mega capacity Ammonia and Urea plants became essential. Considering the increasing demand for fertilizers in the country and as an alternative to Natural Gas based fertilizer, it was proposed to set-up coal based new Ammonia (2700 MTPD) and Urea (3850 MTPD) fertilizer plants. To convert the concept into reality, a proposal was put-up before Cabinet Committee of Economic Affairs (CCEA) for setting up a coal based fertilizer plant within existing plant premises of old closed unit of FCI Talcher. The CCEA also approved formation of Joint Venture Consortium (JVC) to set up proposed fertilizer complex. Accordingly, a JVC in the name of Talcher Fertilizers Limited (TFL) has been formed & incorporated on 13th November 2015. It is registered at Registrar of Companies, Cuttack. M/s Rashtriya Chemicals & Fertilizers Ltd (RCF), M/s Coal

India Ltd. (CIL), GAIL (India) Limited & Fertilizer Corporation of India Ltd. (FCIL) are the members of the consortium.

Initially, before formation of JVC in the name of TFL, the project proposal was to establish a coal based fertilizer and chemical complex compirising five major plants like Coal Washsery, Ammonia, Urea, Nitric Acid and Ammonium Nitrate Plants. Form-I application was submitted and TOR was also approved by MoEFCC on the basis of establishment of above five major plants.

After formation of the JVC- TFL, the project proposal was revised as per prevailing Govt. Policy for revival of old closed units of FCIL and it was decided to install coal based Ammonia and Urea plants only. TFL now proposes to set-up coal based new 2200 MTPD Ammonia and 3850 MTPD Urea plants along with necessary offsite and utilities available/reusable within the premises of FCIL at Talcher Unit.

1.2 PROJECT PROPOSAL

1.2.1 Proposed facilities

The project proposal is to set up coal based new Ammonia and Urea fertilizer plants based on recent best available technology comprising of Coal Gasification, Ammonia, Urea and related offsite & utility facilities. Some of important facilities are as under:

Table-1.1

Summary of Main Plants

Sl. No.	Name of the Main Plants	Capacity
01.	Coal Gasification Plant	Synthesis Gas: 242978 Nm^3/hr
02.	Ammonia	2200 MTPD
03.	Urea (Neem Coated)	3850 MTPD

The proposed project shall also utilize some of the existing facilities after refurbishment for smooth and reliable operation of the process plants. Provision for refurbishment of township and other facilities has been made while finalizing the total capital requirement. Additional 350 nos. of new residential quarters have also been considered. The details of plants & facilities to be provided for proposed project have been presented in Table-2.1, Chapter- 2.0 of the RA report.

1.3 PROJECT COST

The total cost of the above proposed project has been estimated to be *Rs. 10741.05 Crores* and it is expected to be completed within 41 months.

2.0 BRIEF DESCRIPTION OF THE PROJECT

2.1 Main Plants & Facilities

The proposed coal based fertilizer project comprises two main plants namely ammonia and Urea. The project would essentially consist of Coal Gasification, Ammonia-Urea plants and related offsite and utility facilities. Considering utilisation of some of the existing facilities, provision has been made for refurbishment as necessary for smooth and reliable operation of the process plants. Provision for refurbishment of township and welfare facilities has been made while finalising the total capital requirement. Additional 350 nos. of new residential quarters have been considered. The list of plants and facilities to be provided for new project has been presented in Table-2.1.

Table- 2.1

Plants & Facilities Considered in the proposed Project

Sl.No.	Plants & Facilities	Provisions
1.	Coal Gasification plant	Ammonia Syn. Gas:242978 Nm^3/hr
2.	Ammonia Plant	2200 MTPD
3.	Urea Plant	3850 MTPD
4.	Product Storage & Handling Facilities	
	a) Silo Urea (Existing to be used after refurbishing)	45000 MT
	b) Empty Bag Storage	2.0 Million
	c) Bagged Storage	1000 MT (on platform)
	d) Bagging Plant	10 (8+2) bagging streams each of capacity 60 T/hr with semi/fully automatic bagging and stitching facilities
5.	**Cooling Tower**	
	a) Ammonia Plant	(4+1) cells, Cap. 15000 m^3/hr
	b) Urea Plant	(5+1) cells, Cap. 16500 m^3/hr
	c) CGP	(6+1) cells, Cap. 22500 m^3/hr
	d) CPP	(5+1) cells, Cap. 18750 m^3/hr
6.	**Ammonia Storage (atm.)**	10000 MT (2x5000 MT)
7.	**Power Generation & Supply**	
	a) Power Generation(STG)	(2+0) × 40 MW
	b) Substation for receiving power from State Grid	Provided
	c) Emergency D.G. Set	1 × 2000 kVA
8.	**Steam Generation Facilities**	
	Pulverised Coal fired boilers	(2× 450 + 2x50* + 2x100*) MTPH
9.	**Water Supply Treatment & Distribution**	
	a) Raw Water Supply System	From Brahmini river (existing pipeline, pump house, reservoir)
	b) DM Water Plant	(2+1)×150 m^3/hr
	c) Condensate Polishing Unit	(4+1)×200 m^3/hr

Sl.No.	Plants & Facilities	Provisions
10.	Yard Piping	Considered as per requirement
11.	**Instrument Air Facilities** a) Compressor b) Drying Unit c) Receiver	 (1+1)×3000 Nm^3/hr (1+1)×3000 Nm^3/hr Considered
12.	Safety & Fire Fighting System including fire water ring with Hydrant System	Considered
13.	Effluent Treatment	450 m^3/hr
14.	Auxiliary services, workshop equipment, laboratory equipment, weighbridge, fire engine, continuous monitoring system, NDT equipment, telephone, Public Address System, etc.	Considered
15.	General & Welfare Facilities	Refurbishment of existing facility
16.	**Transport Facilities** a) Locomotive b) Railway Siding and lead line c) Road Transport	 02 nos., 1200 HP Lead line available, Railway siding to be renovated for new provision. Considered
17.	Construction equipment	Considered
18.	Township & Public Building	Refurbishment of existing facility & 350 nos. of new quarters
19.	Non-plant Building	Refurbishment of existing facility

2.2 Raw Materials

Coal

Coal & Pet Coke are the raw materials used for this project. Coal is required for both as a feedstock for gasification and as fuel for steam generation. Pet Coke is used for Coal Blending. The ash content in the coal considered for the proposed project is in the range of above 40%. The hourly requirement of feed is as under:

Coal (as Feed) : 120.8 MT*

Coal (as Fuel) : 208.7 MT

Pet Coke (as Feed) : 40.3 MT*

Lime stone (as fluxant) : 22.6 MT

*(*considering transportation loss @5% for feed)*

The Run-Off Mines (ROM) coal (120.8 MT+208.7 MT) will be transported by CIL to the project site.

Water

Treated water requirement for the proposed project has been estimated to be 1785 m^3/hr. The water for the proposed project shall be brought from Brahmini river through a 900 mm size underground pipeline network. FCIL (JVC-TFL) has been allotted to draw 64,800 m^3/day (2700 m^3/hr) of water from Brahmini River by State Government. The present water requirement is about 81% of the quantity allotted by State Government to FCIL.

2.3 Transportation of Raw Materials & Finished Products

Transportation of ROM coal shall be through closed pipe conveyors or any other means to the site by CIL. Latest new generation trucks/vehicles shall be used for transportation of neem coated Urea from factory premises to designated locations.

2.4 Offsite and Utility Facilities

2.4.1 Product Storage, Handling and Bagging

For storage of finished product urea, existing silo of 45,000 MT has been considered. To bag urea, two separate bagging units have been considered. For urea, (8+2) × 60 MTPH bagging streams have been considered. Modern and automatic system has been envisaged for bagging and loading of product into railway wagons/trucks. The system broadly consists of lifting of empty bags from the sack magazine, placement of empty bags on the bag holder, stitching of filled bags and flattening of filled bags on subsequent flat belt conveyor. Loading of filled bags into rail wagons/trucks shall be completely automatic involving very little manual labour.

2.4.2 Steam Generation Plant

The capacity of high-pressure steam generation plant has been fixed on the basis of requirement of steam in Coal Gasification unit, Ammonia plant, Urea plant and Captive Power plant. The boilers are complete with BFW pumps, pulverised mills, superheaters, air preheaters, economizers, ID/ FD fans and oil firing system for start up. BFW pumps will be turbo as well as motor driven. Provision also includes chemical dosing. Ash handling has also been considered.

2.4.3 Captive Power Plant

The power requirement for the whole complex shall be generated by Steam Driven Turbo Generator (STG) sets (1+1) x 40 MW using steam generated in the coal fired boiler. Provisions have also been made for emergency power supply to the complex which comprises of emergency DG set of 2000 KVA capacity.

2.4.4 Raw Water Supply, Storage, Treatment and Distribution

Raw water will be sourced from existing intake well of pump house near the Brahmini River at about 8 km away from the site. The existing pump house will be revamped. Existing reservoir (2×11,000 m^3) and pre-treatment plant will be used after refurbishing. Besides this, DM plant and condensate polishing unit (CPU) have also been envisaged. The plant includes equipments like flash mixer, clariflocculators, filters, chemical dosing system and process water distribution pipeline. Provision have also been made for construction of water reservoirs as mentioned below:

Fire water storage reservoir: 1 x10,000 m^3

Overhead reservoir: 2 x 150 m^3

2.4.5 Cooling Towers

The cooling towers of induced draft, cross flow dual air intake type would be provided separately for coal gasification, Ammonia plant and Urea plants. Installed capacity of 18750m^3 (5+1 cells) with circulation rate @ 7194 m^3/hr for CGP, 15,000m^3 (4+1 cells) with circulation rate @ 12840 m3/hr for Ammonia & 16,500m^3 (5+1 cells) with circulation rate @ 14,300 m^3/hr for Urea has been provided including turbine & motor driven pumps to meet the normal circulation requirement of respective plants. A side stream filtration plant has been provided to reduce the cooling tower purge and improve the quality of cooling water to the plants. The system also includes chemical dosing unit.

A make-up water requirement for CGP cooling tower equivalent to 329 m^3/hr, Ammona Cooling tower equivalent to 257 m^3/hr and for Urea Cooling tower, equivalent to 290 m^3/hr have been considered.

2.4.6 Instrument Air Facilities

The normal instrument air requirement for the Plant will be met from the Process Air Compressor. However, as instrument air is very vital for process control instruments, (1+1) Centrifugal Air Compressors each having a capacity of 3000 Nm^3/hr along with air dryer and receiver units have been provided for the Project. This arrangement will add to the fail-safe system of instrument control.

2.4.7 Fire Fighting System

Provision has been made for firewater ring, fire tenders and other required facilities.

2.4.8 Effluent Treatment & Disposal

Urea plant shall be provided with deep Urea Hydrolyser System which will send the recovered ammonia back to the system and generate condensate for its re-use in the DM water plant itself after treatment in condensate polisher unit. Disc-oil separator shall be provided for removal of oil from oil bearing effluents generated in various compressor systems of the ammonia-urea plants. The ash generated in the coal gasification and power plant shall be disposed-off in the form of slurry to designated abandoned coal mines. The capacity of existing effluent collection pond is not sufficient to meet the requirements hence, provision has been made to construct new generation ETP for the proposed project.

Sources of liquid effluent:

- Overflow from Fly ash slurry pond in gasification section contaminated with water treatment chemicals.
- Water contaminated with water soluble pollutants from gasification unit.
- Sludge from water pre-treatment plant, regeneration waste from DM Water plant and condensate polishing unit.
- Blowdown from Urea & Ammonia cooling Towers including their side stream filter backwash
- Plant washings and miscellaneous washing waste

The effluent shall be treated and used for ash transportation after meeting the requirement as prescribed by Indian standard for surface water discharge.

2.4.9 Fuel Oil, Diesel Handling & Storage

The provision includes two vertical conical roof type storage tanks one each for fuel oil and LDO with capacity of 5000 and 500 MT respectively. Necessary unloading arrangements for fuel oil and LDO from road tanker/ rail wagon have been included.

2.4.10 Yard Piping

It includes all the pipe racks, trestles and inter plant piping along with all the valves and fittings.

2.4.11 Auxiliary & General Welfare Facilities

The following facilities have been considered under this head.

- Fire and Safety
- Smoke detection system
- Workshop Equipment
- Communication System
- NDT Equipment
- Laboratory Equipment including Lab. Chemicals
- Weigh Bridges
- Public address system
- Computers & Software
- Pollution Monitoring System
- Furnitures & Fittings (Plants & Township)
- Office, Canteen, First Aid etc. Equipments
- Hospital Equipments

2.4.12 Transport Facilities

Provisions for 2 nos. of locomotives of 1200 HP each, two Nos. of Cars, two Nos. of Jeeps, one ambulance and one bus, etc. has been made for the proposed project. New railway siding and development of parking area for truck movement within the complex has been considered.

2.4.13 Construction equipment

The following have been considered under this head:

- 400 MT Crane (1 No.)
- 75 MT Crane (1 no.)
- 12.5 MT Tyre Mounted Crane (1 No.)
- 5 MT Tyre Mounted Crane (2 No.)
- Tractor with trailer (2 nos.)
- Fork Lift (4 nos.)
- Bull dozer (2 no.)
- Fire Tenders (2 Nos.)
- Tools and Tackles
- Hutments & Shelters
- Shed yards
- Fencing

2.4.14 Township and other Facilities

FCIL Talcher has a well-developed township along with Shopping Centre, Recreational Centre, Club, School, etc. In view of this, no extra provision except 350 nos. of new quarters has been envisaged. However, provision for refurbishing and maintenance for quarters, public building, new furniture and fixtures etc. has been kept.

3.0 RISK ANALYSIS

3.1 INTRODUCTION

Risk assessment of the proposed Talcher Fertilizer project has been done keeping in view the hazardous nature of materials stored, handled and processed for production of Ammonia and Urea.

The fertilizer project of TFL at Talcher will pose fire, explosion and toxic hazards due to unwanted and accidental release of process gas containing CO, H_2 and toxic gases like NH_3 and Cl_2. The effect zones of the fire and explosion hazard are generally restricted within the plant boundary limits and near the source of generation itself. However, effect of release of ammonia and other toxic gases may go outside the factory premises. This section deals with the failure modes, listing of failure cases leading to different hazard scenarios, consequence modeling and the risk evaluation.

Consequence analysis is basically a quantitative study of the hazard due to various failure scenarios to determine the possible magnitude of damage effects and to determine the distances up to which the damage may be affected using internationally accepted mathematical models. For the purpose of risk evaluation and Consequence Analysis, latest version of ***PHAST-RISK Software of DNVGL (UK)*** has been used. The reason and purpose of consequence analysis are manifold like:

- For computation of risk
- To aid-in better plant layout to reduce hazards
- For evaluating damage and protection of other plants
- To ascertain damage potential to public and evolve mitigation measures
- For preparation of effective *ON-SITE* and *OFF-SITE* Disaster Management Plan

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs and to get information about how to deal with possible catastrophic events. It also gives the plant authorities, workers and the public living outside in the vicinity of the plant an understanding of the hazard potential and remedial measures.

3.2 FAILURE MODE ANALYSIS

There are various potential sources of large/ small leakages, which may release the hazardous flammable, explosive and toxic materials to the surrounding atmosphere. Leakage from failure of pipes, flanges and holes of different sizes has been considered for risk analysis study. Some typical modes of failure and their possible causes are discussed in Table-3.1.

Table -3.1

Sl. No.	Failure Mechanism	Probable cause	Remarks
1.	Flange/ gasket failure	Incorrect gasket, Incorrect Installation.	Careful attention to be paid during selection of gasket & installation.
2.	Weld failure	Incorrect use of welding material, Incorrect welding procedure, lack of inspection during welding.	Welding to be done by certified welder only with proper quality of welding rod under strict inspection with stepwise checking & acceptance after final radiography.
3.	Pipe over stress causing fracture	Error in stress analysis, Improper pipe material, Inappropriate design code and incorrect supports, Lack of inspection during erection	Pipe stress may also cause flange leakage unless there exists a combination of cause. Stress analysis of piping & proper support selection to be done during design. Strict inspection to be ensured during erection.
4.	Over-pressurization of pipeline causing rupture	Incorrect selection of safety relief valves, Incorrect setting of SRVs. SRV fails to operate	Careful attention is needed for selection and setting of SRV. SRV to be maintained properly.
5.	Failure of pipeline due to corrosion/ erosion	Failure of Corrosion protective layer and poor corrosion allowance in design	Thickness monitoring to be done at regular intervals.
6.	Leaking valve to atmosphere	Gland failure packing failure, spindle/plug cock flow-out	
7.	Instrument connection failure	Bourdon tube failure, level gauge glass failure, Failure of instruments connection	

		etc.	
8.	Internal explosion	Air ingress due to inadequate purging & local source of ignition	
9.	Overpressure	Inadequate relief, fire impingement, Rapid building of pocketed superheated liquid, High pressure gas breakthrough	
10.	Valve body failure	Catastrophic valve body/ bonnet failure	

3.3 DAMAGE CRITERIA

The damage effects are different for different failure cases. In order to visualize the damage effects produced by various failure scenarios, it shall be prudent to discuss the physical effects of release of flammable, explosive and toxic materials e.g. thermal radiation, blast wave and physiological response to toxic release.

i) Flammable and explosive vapours released accidentally will normally spread out in the direction of wind. If it comes in contact with any source of ignition between its lower and upper flammability limit, a flash fire is likely to occur and the flame may travel back to the source of leakage. Any person caught in the flash fire is likely to suffer from severe burn injury. Therefore in consequence analysis, the distance to LFL value is usually taken to indicate the area, which may be affected by flash fires. Any other combustible material within the flash fire is likely to catch fire and may cause secondary fires. In the area close to the source of leakage of flammable vapour, there is possibility of depletion of oxygen, if the flammable vapour is heavier than air. A minimum of 16% oxygen in air is considered essential for human lives.

ii) Thermal radiation due to pool fire, jet flame or fireball may cause various degree of burn on human bodies. Also its effects on inanimate objects like equipment, piping, building and other object need to be evaluated. The damage effect with respect to thermal radiation is given in Table - 3.2.

Table - 3.2

DAMAGE DUE TO INCIDENT THERMAL RADIATION INTENSITY

Thermal radiation intensity (KW/m^2)	Type of damage	Casualty Probability
37.5	100% lethality can cause heavy damage to process equipment, piping, building etc.	1.0
32.0	Maximum heat flux for insulated Thermally protected tanks.	-
12.5	50% lethality. Minimum energy required for piloted ignition of wood, melting of plastic tubing etc.	0.5
8.0	Maximum heat flux for un-insulated tanks.	-
4.5	First degree burn. Sufficient to cause pain to personnel if unable to reach cover within 20 seconds.	0.0
1.6	Will cause no discomfort to long exposure.	0.0
0.7	Equivalent to solar radiation.	0.0

In case of transient fires, total thermal dose level is used to estimate threshold damage level.

iii) In the event of dispersion of flammable and explosive vapours, if the cloud comes in contact with an ignition source between its flammability limits and the mass of the explosive materials is sufficient, an explosion may occur. The resultant blast effect may have damaging effects on the equipments, buildings, structures etc. The collapse of buildings and structures may cause injury or fatality. Damage effects of blast overpressures are given in Table-3.3.

Table - 3.3

DAMAGE EFFECTS OF BLAST OVERPRESSURE

Blast Over-pressure (PSI)	Damage Type	Casualty Probability
0.30	Major Structural damage (assumed fatal to the people inside building or within other structure)	0.25
0.20	Storage tank failure	-
0.17	Eardrum damage	0.10
0.10	Repairable damage, pressure vessels remain intact, light structure collapse	0.0
0.03	Window breakage, possibly causing some injury	0.0

iv) In the event of release of toxic gases, the released gases shall disperse in the direction of wind. As the gases disperse downwind, mixing with the surrounding air takes place and the concentration of the gases in air comes down. Toxic gas may have damaging effects on the people in the neighborhood of the plant. The physiological effects of Ammonia, Nitrogen dioxide and Chlorine are toxic gases that may accidentally release from the Fertilizer plant are given in following tables.

Table - 3.4

PHYSIOLOGICAL EFFECTS OF AMMONIA ON HUMAN BODIES

Vapour Concentration (ppm by v/v)	General Toxic Effect	Exposure Period
5	Odour detectable by most persons	-
25	No adverse effect	Recommended exposure limit – long term 8 hours TLV
35	No adverse effect	Recommended exposure limit – short term 15 minutes
50	Irritation just detectable by most person but not persistent	-
70	No prolonged effect for average worker	Maximum exposure for long periods not permitted
400-700	Immediate nose & throat irritation	½ - 1 hr. exposure causes no serious effect
1700	Severe coughing, severe eye, nose & throat irritation	Could be fatal after ½ hrs.
2000-5000	Severe coughing, severe eye, nose & throat irritation	Could be fatal after ¼ hrs.
5000-10000	Respiratory spasm, rapid asphyxia	Fatal within minutes

For consequence analysis of ammonia discharge 15 minutes exposure time has been considered. The consequences of this exposure period to various concentrations are as follows:

8484 mg/m^3 (12177 ppm) : LC_{50} for 15 min. exposure time

5574 mg/m^3 (8001 ppm) : LC_{20} for 15 min. exposure time

4474 mg/m^3 (6421 ppm) : LC_{10} for 15 min. exposure time

Where; LC_{50} (50% Lethal Concentration), LC_{20} (20% Lethal Concentration) and LC_{10}: (10% Lethal Concentration) of a toxic chemical is the concentration required to kill 50%, 20% and 10% respectively of the defined population after inhalation for 15 Mins.

(Ref. probit equation as per TNO green book)

Table - 3.5

PHYSIOLOGICAL EFFECTS OF CHLORINE ON HUMAN BODIES

Vapour Concentration (ppm by v/v)	General Toxic Effect
1.0 TLV	No adverse effect
3.0 STEL	Least detectable odour
4.0	No serious disturbance
5.0	Noxiousness, impossible to breath
15.0	Irritation of throat
30.2	Cause coughing
40 – 60	Dangerous for exposure ranging from 30-60 min.
100	May be lethal
1000	Dangerous to life even with a few deep inhalation

For consequence analysis of chlorine leakage, 10 minutes exposure time has been considered. The consequences of exposure period to various concentration of chlorine are as follows:

1620 mg/m^3 (557 ppm) : LC_{50} for 10 min. exposure time

1124 mg/m^3 (386 ppm) : LC_{20} for 10 min. exposure time

929 mg/m^3 (319 ppm) : LC_{10} for 10 min. exposure time

Where; LC_{50} (50% Lethal Concentration), LC_{20} (20% Lethal Concentration) and LC_{10}: (10% Lethal Concentration) of a toxic chemical is the concentration required to kill 50%, 20% and 10% respectively of the defined population after inhalation for 10 Mins.

(Ref. probit equation as per TNO green book)

Dispersion and Stability Class

In calculation of effects due to release of hydrocarbons, dispersion of vapour plays an important role as indicated earlier. The factors which govern dispersion are mainly Wind Velocity, Stability Class, Temperature as well as surface roughness. One of the characteristics of atmosphere is stability, which plays an important role in dispersion of pollutants. Stability is essentially the extent to which it allows vertical motion by suppressing or assisting turbulence. It is generally a function of vertical temperature profile of the atmosphere. The stability factor directly influences the ability of the atmosphere to disperse pollutants emitted into it from sources in the plant. In most dispersion, problems relevant to atmospheric layer is that nearest to the ground. Turbulence induced by buoyancy forces in the atmosphere is closely related to the vertical temperature profile.

Temperature of the atmospheric air normally decreases with increase in height. The rate of decrease of temperature with height is known as the *Lapse Rate*. It varies from time to time and place to place. This rate of change of temperature with height under adiabatic or neutral condition is approximately 1^0C per 100 metres. The atmosphere is said to be stable, neutral or unstable according to the lapse rate is less than, equal to or greater than dry adiabatic lapse rate i.e. 1^0C per 100 metres.

Pasquill has defined six stability classes ranging from A to F.

A = Extremely unstable
B = Moderately unstable
C = Slightly unstable
D = Neutral
E = Stable
F = Highly stable

3.4 Properties of Hazardous Materials

Ammonia

Ammonia is a highly toxic gas. It is also a combustible gas and explodes under certain circumstances. It forms an explosive mixture between 16% to 25% (v/v) in air and its auto ignition temperature is 650^0C. As the minimum ignition energy requirement of ammonia is quite high, more than 100 MJ and flammability limit is high, it catches fire with much difficulty. Also it is lighter than air and hence, disperses quickly to below its lower flammability limit (LFL). The main hazard with ammonia is toxic hazard.

Ammonia causes damage on contact with skin and eye. Its TLV is 25 ppm and may be fatal for short time exposure above 5000 ppm concentration.

Chlorine

Chlorine is a highly toxic gas. Its TLV is 1 ppm. It may be fatal for short time exposure above 500 ppm.

Chlorine is used for the treatment of water in the plant and shall be stored in chlorine tonners. Chlorine tonners present in the plant are kept in the storage shed at a time and thus the amount of chlorine stored in the plant would not be significant. Nevertheless, because of its high toxicity, a leakage even in a tonner holding 900 Kg of chlorine may be hazardous.

Hydrogen

Hydrogen is present in the process gas and its concentration in process gas varies from about 52% to 75% at different stages of the process. Hydrogen is highly inflammable gas and its flammability limit is in between 4% to 74% (v/v) in air, with auto ignition temperature of 400^0C. The minimum ignition energy requirement of hydrogen is 0.019 MJ and burns with an invisible flame. As the ignition energy requirement is quite low, it catches fire easily.

Carbon Monoxide

Carbon monoxide is present in process gas is about 14.1% before it is converted to CO_2 and H_2 in shift conversion section where its concentration is reduced to about 0.2%. Carbon monoxide is an extremely toxic gas and may be fatal for short time exposure above 1000 ppm. Its TLV is 50 ppm.

The gas is flammable and forms explosive mixture in between 12.5% to 74% (v/v) in air. Its auto ignition temperature is 615^0C. As mentioned above, the gas is quickly converted into CO_2 and H_2, and the risk posed by it may at best be considered as transient risk only.

3.5 FAILURE CASE LISTING

The mode of approach adopted for the study is to first select the failure cases and then to conduct the consequence analysis of the same which are listed in Table-3.6. Failure cases and consequence analysis are mainly confined to the equipment for the proposed Talcher Fertilizer project.

Table - 3.6
SELECTED FAILURE CASES

Sl. No.	Failure Cases (For Ammonia Plant)	Failure Mode	Consequence
01.	Make-up synthesis gas to Ammonia synthesis section failure i) 25% Gasket failure ii) 15mm dia. hole iii) 10mm dia. hole	Random failure	Jet fire, UVCE
02.	Ammonia Converter outlet line failure i) 25mm dia. hole ii) 15mm dia. hole	Random failure	Toxic Dispersion, UVCE

	iii) 10mm dia. hole		
03.	Ammonia Re-circulator Outlet line Failure i) 25 mm dia. hole ii) 15 mm dia. hole iii) 10 mm dia. hole	Random failure	Jet fire, UVCE
04.	Liquid Ammonia Line Inlet to Liquid Ammonia Reservoir in Urea Plant Failure i) 20% CSA Failure ii) 25mm dia. hole iii) 15mm dia. hole iv) 10mm dia. hole	Random failure	Toxic Dispersion
Failure Cases (For Urea Plant)			
05.	HP liquid NH_3 pump to ejector failure i) 20% CSA Failure ii) 25mm dia. hole iii) 15mm dia. hole iv) 10mm dia. hole	Random failure	Toxic Dispersion
06.	Liquid NH_3 from Ammonia Reservoir to liquid NH_3 Booster pump line pressure gauge nozzle failure	Random failure	Toxic Dispersion
07.	Urea Reactor outlet line to HP Stripper failure i) 20% CSA Failure ii) 50 mm dia. Hole iii) 25 mm dia. Hole	Random failure	Toxic Dispersion
Failure Case (For Chlorine Storage)			
08.	Chlorine Tonner Failure	Random failure	Toxic Dispersion

The purpose of listing of failure cases as given in Table-3.6 is to examine the consequence of the failure individually or in combination. The frequency of occurrence of failure varies and can be estimated. Generic data could be used, as it is available for almost every component. However, their use may sometimes give erroneous result, if not used judiciously. It has been observed that the guillotine failure of pipelines of higher sizes has a lower frequency of occurrence. On the other hand, failure frequency of small bore pipelines up to say 10 mm pipe size, development of cracks equivalent to say 5% or 10% of the cross sectional area of the pipe, failure of pump mechanical seal, gasket etc. are relatively high and may be considered “foreseeable” or “credible” and may contribute higher risk, though the release rate may be small in these cases and consequences will not be grave.

3.6 FAILURE FREQUENCY

The failure frequencies are given in Table-3.7.

Table - 3.7
FAILURE FREQUENCY DATA

Sl. No.	Item	Failure Frequency / 10^6 Years
1]	Shell Failure (a) Process/pressure vessel (b) Pressurised Storage Vessel	 3 1
2]	Full Bore Vessel Connection Failure (Diameter mm) < 25 .... 40 .... 50 .... 80 .... 100 .... >150 …….	 30 10 7.5 5 4 3
3]	Full Bore Process Pipeline Failure d <50 mm .... 50 <d <150 mm .... d >150 mm	0.3 * 0.09 * 0.03 *
4]	Articulated Loading / unloading arm failure	$3x10^{-8}$**

* Failure frequency expressed in (/m/10^6 years)
** Failure frequency expressed in (/hr of operation)

3.7 CONSEQUENCE ANALYSIS

Consequence Analysis of selected failure cases as listed in Table-3.6 are detailed below:

3.7.1 Make-up Synthesis Gas to Ammonia Synthesis Section Failure

Make-up synthesis gas comes from preceding section i.e. gasification & synthesis gas preparation section. The synthesis gas enters the synthesis section through a 30" dia. line size and the compositions of the gases are detailed below.

Components	**Composition (Mole %)**
Hydrogen	74.76
Nitrogen	24.94
Argon	0.31

For consequence analysis the following phenomena have been considered:

i) 25% Gasket Failure
ii) 15mm dia. Hole
iii) 10mm dia. Hole

In case of any one of the failures as stated above in the pipeline, the gas shall come out as gas jet and may disperse in atmosphere which on getting any source of ignition may form UVCE. The Thermal Radiation distances due to jet fire and overpressure distances due to UVCE are given in Table-3.8 and 3.9.

Table - 3.8
HAZARD DISTANCES OF THERMAL RADIATION DUE TO JET FIRE

Thermal Radiation KW/M^2	Hazard distances (m) for Wind speed (m/sec) and stability classes			
	2F	2B	3D	5D
Case-I 25% Gasket Failure (RR:2.52 Kg/sec, Duration: 180 sec)				
37.5	NR	NR	NR	NR
12.5	27	27	29	31
4.5	37	37	38	39
Case-II 15 mm dia. hole (RR: 0.37 Kg/sec, Duration: 180 sec)				
37.5	NR	NR	NR	NR
12.5	NR	NR	NR	NR
4.5	13	13	14	15
Case-III 10 mm dia. hole (RR: 0.17 Kg/sec, Duration: 180 sec)				
37.5	NR	NR	NR	NR
12.5	NR	NR	NR	NR
4.5	6	6	6	6

RR: Release Rate; NR: Not Reached

It is evident from the above table that hazard distance to thermal radiation of 4.5 KW/m^2 (1st degree burn) will go up to a maximum distance 39 meters in case of 25% gasket failure in synthesis gas line.

Table - 3.9
HAZARD DISTANCES TO OVERPRESSURE DUE TO UVCE

Sl. No	Wind Speed (m/sec) / Stability Class	Hazard distances (m)		
		0.3 Bar	0.1 Bar	0.03 Bar
Case-I 25% Gasket Failure				
1.	2F	62	75	109
2.	2B	61	73	103
3.	3D	60	72	102
4.	5D	50	60	88
Case-II 15 mm dia. hole				
1.	2F	26	30	45
2.	2B	25	29	42
3.	3D	24	28	41

4.	5D	23	27	40
Case-III 10 mm dia. hole				
1.	2F	13	17	26
2.	2B	13	16	24
3.	3D	13	16	24
4.	5D	13	16	23

It is evident from the above table that the hazard distance to overpressure of 0.3 bar goes up to a maximum distance of 62 m for 25% gasket failure in the synthesis gas inlet line and can damage other equipments and pipelines downwind.

3.7.2 Ammonia Converter Outlet Line Failure

Ammonia converter outlet gas will be entering the waste heat boiler.

The composition of the waste heat boiler is as follows:

Components	Composition (Mole %)
Hydrogen	57.02
Nitrogen	19.07
Methane	0.03
Ammonia	19.79

The gas is entering the waste heat boiler at a temperature of 439^{0}C and pressure of 154 Kg/cm^{2}g. Full Bore failure of 30" dia. pipeline is an incredible phenomenon, hence the following cases have been considered for consequence analysis.

i) 25mm dia. Hole

ii) 15mm dia. Hole

In case of any one of the failures stated above in the Synthesis Reactor outlet line, the gas shall come out as jet or may disperse in atmosphere which on getting any source of ignition may form jet fire and/ or UVCE. Since the gas contains ammonia, toxic effect shall also be there. The toxic hazard distances and overpressure distances due to UVCE are given in Table-3.10 and 3.11.

Table – 3.10
DOWNWIND DISTANCES TO GLC OF AMMONIA

Wind speed (m/s) / Stability Class	Downwind distances (m) for concentration of			
	LC_{50} (12177 ppm)	LC_{20} (8001 ppm)	LC_{10} (6421 ppm)	IDLH (300 ppm)
	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)

Case-I 25 mm dia. hole				
2F	5.2/11.5	6.0/17.33	6.28/20.23	8.9/55.57
2B	6.9/10.8	8.7/19.99	9.54/24.67	17.31/102.3
3D	7.17/11.03	9.21/20.68	10.0/25.57	17.8/105.97
5D	7.3/11.2	9.38/20.9	10.2/26.1	23.16/143.8
Case-II 15 mm dia. Hole				
2F	3.7/5.17	4.22/7.9	4.4/9.27	6.2/25.7
2B	4.74/4.58	6.26/9.0	6.83/11.3	13/51.9
3D	4.87/4.57	6.5/9.25	7.12/11.7	13.6/55.33
5D	5.38/5.08	7.22/10.5	7.85/13.3	18.8/83.0

It is evident from the above table that hazard distance to IDLH value (300 ppm) will go up to a maximum distance of 23.16 meters in case of formation of 25 mm dia. hole in Synthesis reactor outlet line.

Table - 3.11
HAZARD DISTANCES TO OVERPRESSURE DUE TO UVCE

Sl. No	Wind Speed (m/sec) / Stability Class	Hazard distances (m)		
		0.3 Bar	0.1 Bar	0.03 Bar
Case-I 25 mm dia. hole				
1.	2F	32	44	77
2.	2B	41	53	83
3.	3D	41	52	83
4.	5D	40	51	79
Case-II 15 mm dia. hole				
1.	2F	18	26	47
2.	2B	27	35	55
3.	3D	27	35	54
4.	5D	26	34	52

It is evident from the above table that the hazard distance due to overpressure of 0.3 bar goes up to a maximum distance of 41 m by 25 mm dia. hole formation in the synthesis reactor outlet line and can damage other equipments and pipelines downwind.

3.7.3 Ammonia Recirculator Outlet Line Failure

Ammonia Recirculator outlet line is of 24" dia. size. The composition of the gas coming out of the reciculator is as follows:

Components	Composition (%)
Hydrogen	69.23
Nitrogen	23.15
Methane	0.03
Argon	4.96
Ammonia	2.63

The gas is entering the synthesis section at a temperature of 34^{0}C and pressure of 150 Kg/cm^{2}g. Full Bore failure of 24" dia. pipeline is an incredible phenomenon, hence the following cases have been considered for consequence analysis:

25 mm dia. Hole, 15 mm dia. Hole and 10 mm dia. Hole

In case of any one of the failures as stated above in the Ammonia Recirculator outlet line, the gas shall come out as jet or may disperse in atmosphere which on getting any source of ignition may form jet fire and or UVCE. The Thermal Radiation distances due to jet fire and overpressure distances due to UVCE are given in Table- 3.12 and 3.13.

Table – 3.12
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No	Thermal Radiation (KW/M^2)	Hazard distances (m)			
		2F	2B	3D	5D
Case-I 25 mm dia. hole					
1.	4.5	15	15	16	16
2.	8.0	12	12	13	14
3.	12.5	NR	NR	NR	NR
4.	32.0	NR	NR	NR	NR
5.	37.5	NR	NR	NR	NR
Case-II 15 mm dia. hole					
1.	4.5	6	6	6	6
2.	8.0	NR	NR	NR	NR
3.	12.5	NR	NR	NR	NR
4.	32.0	NR	NR	NR	NR
5.	37.5	NR	NR	NR	NR

NR: Not Reached

It is evident from the above table that hazard distance to thermal radiation of 4.5 KW/m^2 (1st degree burn) will go up to a maximum distance 16 meters in case of 25 mm dia. hole of Ammonia Reciculator outlet line.

Table - 3.13
HAZARD DISTANCES TO OVERPRESSURE DUE TO UVCE

Sl. No	Wind Speed (m/sec) / Stability Class	Hazard distances (m)		
		0.3 Bar	**0.1 Bar**	**0.03 Bar**
Case-I 25 mm dia. hole				
1.	2F	26	31	46
2.	2B	25	30	44
3.	3D	25	30	44
4.	5D	24	29	41
Case-II 15 mm dia. hole				
1.	2F	14	17	25
2.	2B	13	16	24

3.	3D	13	16	24
4.	5D	12	15	23

It is evident from the above table that the hazard distance to overpressure of 0.3 bar goes up to a maximum distance of 26 m for 25 mm dia. hole of recirculator outlet line and can damage other equipments and pipelines downwind.

3.7.4 Liquid Ammonia Line Inlet to Liquid NH_3 Reservoir in Urea Plant Failure

Liquid Ammonia from Ammonia Plant goes to liquid NH_3 reservoir in Urea Plant through an 8" dia. line at a temp. of 25^oC and pressure of 26 Kg/Cm^2.

Full Bore failure of the line is an incredible phenomenon. Hence, consequence analysis has been done for the following cases.

i) 20% CSA Failure
ii) 25mm dia. Hole
iii) 15mm dia. Hole
iv) 10mm dia. Hole

The liquid ammonia after coming out from the hole/ fracture of the pipeline will form gas and will disperse in downwind direction. The distance and area upto which ammonia will disperse (GLC) are given in Table- 3.14.

Table – 3.14
DOWNWIND DISTANCES TO GLC OF AMMONIA

Wind speed (m/s) / Stability Class	Downwind distances (m) for concentration of			
	LC_{50} (12177 ppm)	LC_{20} (8001 ppm)	LC_{10} (6421 ppm)	IDLH (300 ppm)
	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)
Case-I 20% CSA Failure				
2F	-	60/107	82/283	490/13328
2B	-	45/39	66/178	451/16744
3D	-	48/40	73/198	558/17332
5D	-	-	58/95	507/14940
Case-II 25 mm dia. hole				
2F	-	-	-	196/2170
2B	-	-	-	151/1866
3D	-	-	-	164/1776
5D				86/643
Case-IV 15 mm dia. Hole				
2F	-	-	-	123/ 851
2B	-	-	-	73/ 434
3D	-	-	-	68/ 318

5D	-	-	-	39/82
Case-III 10 mm dia. Hole				
2F	-	-	-	69/247
2B	-	-	-	35/61
3D	-	-	-	32/22
5D	-	-	-	-

It is evident from the above table that the toxic hazard distance to IDLH of Ammonia goes up to a maximum distance of 558 m and covers an area of 17332 m^2 downwind due to 20% CSA failure of the line. In other cases the distance and area is less. Hence, the pipeline should be checked periodically by Non-destructive testing.

3.7.5 Urea Plant

HP Liquid Ammonia Pump to Ejector Failure

HP liquid ammonia pump delivers liquid ammonia to ejector to carry recycle carbamate to Urea reactor. The size of the line is 12". Full-Bore failure of this line is incredible.

Hence, following cases have been considered:

i) 20% CSA Failure
ii) 25 mm dia. Hole
iii) 15 mm dia. Hole
iv) 10 mm dia. hole

In case of any of the above failures liquid ammonia will come out and form gas. The gas may disperse in atmosphere downwind. The dispersion distances for LC_{50}, LC_{20}, LC_{10} & IDLH and area covered are given in table 3.15.

Table – 3.15
DOWNWIND DISTANCES TO GLC OF AMMONIA

Wind speed (m/s)/ Stability Class	Downwind distances (m) for concentration of			
	LC_{50} (12177 ppm)	LC_{20} (8001 ppm)	LC_{10} (6421 ppm)	IDLH (300 ppm)
	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)
Case-I 20% CSA Failure				
2F	1950/702546	2500/ $1.46x10^6$	2834/ $2.02x10^6$	11437/$4.98x10^7$
2B	2026/976542	2600/ $1.95x10^6$	28233/2.58 $x10^6$	5572/$1.83x10^7$
3D	2141/902124	2801/ $1.90x10^6$	3086/ $2.56x10^6$	6866/$2.20x10^7$
5D	2335/919400	$1.75x10^6$	3075/ $2.26x10^6$	6766/$1.86x10^6$

Case-II 25 mm dia. Hole				
2F	313/10143	564/36381	684/77821	2171/2.16x10^{6}
2B	334/11608	593/51876	680/88248	1615/1.19x10^{6}
3D	337/10367	550/36408	650/60676	1811/1.23x10^{6}
5D	355/9674	493/25666	557/37205	9674/ 797717
Case-III 15 mm dia. Hole				
2F	174/2440	283/9370	424/20952	1441/946358
2B	175/2263	305/10528	383/20300	1100/505818
3D	174/2025	305/9143	375/16585	1338/480979
5D	167/1572	268/6132	315/9809	1158/263273
Case-IV 10 mm dia. Hole				
2F	100/468	178/2977	231/6306	1050/489422
2B	87/242	176/2711	235/6123	822/224652
3D	86/236	174/2304	229/5021	889/201204
5D	60/85	153/1387	189/2845	764/110914

It is evident from the above table that for 20% CSA failure, the distance to LC_{50} covers a distance of 2335 m and area of 919400 m^2. For IDLH maximum distance covered is 11437 m and area covered is 4.98 x 10^7 m^2. These distances goes outside the battery limit and people outside the factory premises will be affected. Hence, awareness program in case of Ammonia leakage should be done periodically for the people outside and the ammonia lines should be tested periodically.

3.7.6 Liquid NH_3 from Ammonia Reservoir to Liquid NH_3 Booster Pump Line Pressure Gauge Nozzle Failure

Pressure gauge line is of ¾" dia. Hence, Full-Bore failure case has been considered:

In case of the above failure the liquid ammonia shall come out as jet which will form gas and will disperse downwind. The dispersion distance for LC_{50}, LC_{20}, LC_{10} & IDLH are given in Table 3.16.

Table – 3.16
DOWNWIND DISTANCES TO GLC OF AMMONIA

Wind speed (m/s)/ Stability Class	Downwind distances (m) for concentration of			
	LC_{50} (12177 ppm)	LC_{20} (8001 ppm)	LC_{10} (6421 ppm)	IDLH (300 ppm)
	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)
Full-Bore Failure				
2F	158/2832	306/15520	353/27573	957/518596
2B	156/2385	240/8975	276/14035	667/196840
3D	152/1944	230/6922	264/10674	880/225553
5D	126/991	182/3365	210/5109	760/122435

It is evident from the above table that toxic hazard distance to LC50 will go up to a maximum distance 158 meters. IDLH concentration will go upto a maximum distance of 957 m and area covered is 518596 m^2.

3.7.7 Urea Reactor Outlet line To HP Stripper Failure

From Urea Plant Reactor the liquid goes to HP Stripper for separation of unconverted Carbamate and Ammonia. In case of failure, Ammonia from the liquid will evaporate and disperse downwind. The line size is 12".

Hence, following cases have been considered:

i) 20% CSA Failure
ii) 50 mm dia. Hole
iii) 25 mm dia. Hole

The dispersion analysis of Ammonia for LC_{50}, LC_{20}, LC_{10} & IDLH at different wind velocities and stability classes are given in Table 7.19. Since the gas contains ammonia, toxic effects on human beings may occur in downwind direction.

Table – 3.17
DOWNWIND DISTANCES TO GLC OF AMMONIA

Wind speed (m/s)/ Stability Class	Downwind distances (m) for concentration of			
	LC_{50} (12177 ppm)	LC_{20} (8001 ppm)	LC_{10} (6421 ppm)	IDLH (300 ppm)
	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)
Case-I 20% CSA Failure				
2F	1415/103558	2374/294399	3136/510592	12000/ $2.03x10^7$
2B	1646/160045	2463/436893	2785/606489	7550/ 5.39x 10^6
3D	1676/141119	2621/392695	3051/569303	12355/ 1.0x 10^7
5D	1762/139461	2500/316794	2900/450391	12441/ 9.6x 10^6
Case-II 50mm dia. hole				
2F	417/8073	740/24305	968/42913	4619/ 3.08x 10^6
2B	416/8430	781/29606	983/52131	3383/919064
3D	449/8811	800/28382	1000/47805	4400/ 1.28x 10^6
5D	496/8842	800/24709	967/37769	3569/963170
Case-III 25mm dia. hole				
2F	171/1195	314/4253	429/7822	2733/925266
2B	149/997	288/3701	410/7299	1839/334777
3D	168/1143	333/4214	460/8011	2155/388188
5D	164/962	327/3637	427/6345	1715/202658

It is evident from the above table that toxic hazard distance to LC50 for 20% CSA failure will go upto 1762 m and will cover an area of 160045 m^2. IDLH value distance will go upto 12441 m and cover an area of 9.6 $x10^6$ m^2. This will affect people outside factory premises.

3.7.8 CHLORINE STORAGE

Chlorine Tonner Failure

Chlorine is used as biocide in Cooling Tower Circulating Water to prevent generation of algae & fungi. In case of chlorine tonner, the most foreseen accident scenario is the chlorine tonner outlet nozzle failure. Details used for the dispersion modelling are as follows:

Capacity of Chlorine Tonner : 900 Kg

Chlorine Tonner Outlet Nozzle Size : 10 mm

The result i.e. ground level chlorine concentrations for Chlorine Tonner Outlet nozzle failure are given in Table- 3.18.

Table - 3.18
DOWNWIND DISTANCES TO GLC OF CHLORINE

Wind speed (m/s)/ Stability Class	Downwind distances (m) for concentration of			
	LC_{50} (557 ppm)	LC_{20} (386 ppm)	LC_{10} (319 ppm)	IDLH (10 ppm)
	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)	Dis.(m)/ Area(m^2)
2F	226/79149	282/111497	319/133847	5098/ 3.46x10^6
2B	264/67911	297/83799	307/92892	903/58210^6
3D	209/68040	326/84302	348/95103	1989/ 1.09x10^6
5D	336/60196	363/74613	379/82753	2209/ 1.07x10^6

From the above table, it is concluded that the 319 ppm concentration of chlorine (LC_{10}) for the wind speed of 2 m/sec and atmospheric stability class of F may extend upto a distance of 379 m due to release of chlorine. In case of chlorine tonner outlet nozzle/line failure, arrangement should be made to stop the leakage within shortest possible time and chlorine gas absorption system should be run. The personnel should vacate the place immediately. However, chlorine detectors are to be provided in chlorine tonner rooms. The IDLH goes up to a maximum distance of 5098 m for the above case i.e. outside the factory premises.

3.8 PRINCIPAL CONCLUSION & RECOMMENDATION

The principal conclusion and recommendations that arise out of the risk analysis study are as follows.

CONCLUSIONS

The acceptable total individual risk (1×10^{-6}/year) contour for activities in the plant mainly remains within the plant premises only goes outside at a distance of 93m towards Eastern direction. The societal risk (F-N Curve) also remains with the acceptable limit.

RECOMMENDATION:

1. The downwind distances to ground level concentration of ammonia and chlorine may extend beyond factory boundary. Hence, the population outside should be made aware of the properties of gases and what to do in case of any leakage.

2. In order to reduce the frequency of undesired incidents further and thus to reduce the level of individual risk, it is necessary to adopt due care in design, engineering, construction, inspection, operation and maintenance of the plant and equipment.

3. In order to reduce the frequency of failure of various items like pipelines, equipment & machinery, valves & fittings etc. Good operating and maintenance practices must be followed. They should be tested periodically by non-destructive testing.

4. The Fertilizer Project of M/s TFL at Talcher shall be designed and engineered by internationally reputed process licensors, designers and engineers so risk reduction and operability measures are considered from very beginning stage.

5. Testing of plant safety system is to be carried out systematically at regular intervals and record should be kept.

6. Safety audit and health monitoring of the pipeline and equipment are to be done at regular intervals and necessary corrective measures taken immediately.

7. Fire fighting facilities in the plant should be as per TAC guidelines. The facilities will be extended for the new project and approval from competent authority will be taken wherever necessary. People residing

inside and outside the premises should be aware of emergencies that may arise in the plant.

8. Mock drills are to be conducted at regular intervals to cope up with any emergency.
9. Mutual Aid arrangement should be done with the neighbouring industries, fire stations, hospitals etc.
10. Both On-Site and Off-Site emergency plan should be prepared and practiced.
11. Minimization of Ammonia vapour cloud formation from the evaporation of liquid pools by covering it with foam whenever such leakage is observed. Such failure may be caused in the vicinity of ammonia collector, Ammonia Storage Tank (AST) & associated facilities, intermediate liquid ammonia storage etc.
12. Suitable no. of flammable gas, ammonia & chlorine detectors to be provided for early warning of a leak in potential sources of emissions such as pump seals, compressor seals, process drains, vents and other flammable materials containments. Smoke detectors should also be provided in control rooms to detect leakage.
13. To minimize the dispersion of NH_3 vapour cloud in the vicinity of leakage/rupture, arrangement for water curtains to be made to absorb the ammonia vapour formed especially in the area like vicinity of ammonia collector, Ammonia Storage Tank (AST) & associated facilities, intermediate liquid ammonia storage tank etc.
14. Facilities to provide sufficient ventilation, putting on personal protective equipment (PPE) before entering the contaminated area and remain in the upwind direction in case of leakage of NH_3 should be kept in mind and strictly followed. If the situation is more alarming, the vapour cloud may be minimized by spraying water so that necessary manual action can be taken to stop the dispersion of ammonia.
15. Water jet should not be applied over the pool of liquid NH_3 due to leakages, since the heat produced will trigger a high evaporation rate.

16. Regular NDT of all the yard piping for ammonia/flammable/other toxic material transfer with high pressure should be carried out.

17. All the dykes should be made leak proof and their drain valves should be always kept in close position.

18. The control button of all Emergency Isolation Valves (EIVs) should be at safe and approachable distance from the maximum possible hazard source (such as leakage in mechanical pump seals, compressor seals etc.), so that it can be operated safely.

19. All EIVs should be tested at regular intervals. In case, they cannot be tested without upsetting the production, then must be tested fully during normal shutdown.

20. Valve closure may be initiated from a remote location and should be fire proof.

21. The size and frequency of (Gasket joints) leaks can be reduced by using spiral-wound gaskets in place of compressed asbestos fiber ones. Screwed joints should not be used.

22. In order to reduce the frequency of undesired incidents, further it is recommended to continue to adopt standard codes & practices in inspection, operation and maintenance of the plant and equipment.

23. In order to reduce the frequency of failure of various items like pipelines, equipment & machinery, valves & fittings etc good operating and maintenance practices must be followed/ continued.

24. The practice of Mock drills to be continued to cope up with any emergency and special attention must be given to the mock drills in Chlorine tonner/ cylinder handling areas owing to severe toxic effects in case of leakage.

25. The concerned plant personnel of operation & maintenance department must give special attention towards emergency preparedness in case of toxic gas leakage. Maintenance & working of ammonia and Chlorine detectors should be checked regularly to ensure its immediate response.

26. Testing of plant safety system are to be continued systematically at regular intervals.

27. Safety audit and health monitoring of the pipeline and equipment to be done at regular intervals and necessary corrective measures to be taken immediately.

28. Permanent sprinklers/ drench systems are very effective in controlling potentially large fires at an early stage. Water curtains should be installed in storage tank farms to cool adjacent structures and neighboring tanks in the event of fire.

29. Ammonia gas sensors should be installed all around the periphery of atmospheric ammonia storage tank area as well as TFL to detect/ prevent any off-site toxic hazards.

30. Both On-Site and Off-Site emergency plan should be prepared and approved from the statutory body before commissioning of the plant.

4.0 DISASTER MANAGEMENT PLAN

4.1.1 General

Disaster is an undesirable occurrence of events of such magnitude and nature that adversely affect production, cause loss of human lives and property as well as damage to the environment. Industrial installations are vulnerable to various kinds of natural and manmade disasters. Examples of natural disasters are flood, cyclone, earthquake, lightning etc. and manmade disasters are like major fire, explosion, sudden heavy leakage of toxic/poisonous gases, civil war, nuclear attacks, terrorist activities etc. It is impossible to forecast the time and nature of disaster which might strike an undertaking. However, an effective disaster management plan helps to minimize the losses in terms of human lives, plant assets and environmental damage and then resumes working condition as soon as possible.

Risk analysis forms an integral part of disaster management plan and any realistic disaster management plan can only be made after proper risk analysis study of the activities and the facilities provided in the installation. Correct assessment and evaluation of the potential hazards, advance meticulous planning for prevention and control, training of personnel, mock drills and liaison with outside services available can minimize losses to the plant assets, rapidly contain the damage effects and effectively rehabilitate the damage areas.

4.1.2 Proposed project set-up

The proposed fertilizer project will be set up within plant premises of FCIL-Talcher unit. Total Area of Talcher Fertilizer complex is 904.53 Acre. Out of this total area, 584.15 acres of land shall be made available for establishment of fertilizer project and remaining area shall be occupied by residential colony.

4.1.3 Population of nearby villages within 5 Kms from the site

The population of nearby villages in the study area is summarized below in Table- 4.1

Table: 4.1
Village-wise population data within study area

Sl. No.	Name of Village	Total No. of House hold	Population Total
DISTRICT ANGUL			
1	Hensamul	409	1935
2	Ambamunda	14	56
3	Nakulbaspur	12	57
4	Langijoda	116	465
5	Purunapani	130	677
6	Balangi	178	797
7	Derang	796	3827
8	Kanhei Nagar	64	266
9	Deulabeda	115	534
10	Handigoda	363	1389
11	Rodhasar	72	316
12	Ghantapada (CT)	3564	15169
13	Bagachar	67	281
14	Diajharan	86	399
15	Tentoloi	71	308
16	Jaganathpur	277	1196
17	Teheranpur	446	1924
18	Nuagan	204	888
19	Bantol	186	739
20	Kukudanga	765	3446
21	Nuapada	76	313
22	Lachhamanpur	25	113
23	Jamubahali	243	1212
24	NALCO P.S	11790	50375
25	Barsinga	270	1157
26	Gobara	832	3802
27	Karadapal	38	172
28	Karnapur	536	2585
29	Jorada(Sana)	177	825
30	Ekagharia	177	704
31	Tentoi	151	784
32	Bikrampur P.S	5795	25772
33	Kendupali	134	604
34	Khamana	113	442
35	Paniola	65	238
36	Bhogabereni	432	1770
37	Nirakarpur	25	122
38	Kusupangi	151	639
39	Pingua	148	602
40	Tentoloi	233	1076
41	Balaramprasad(Part)	1882	8423
42	Mundapada	49	218
43	Kainsiripali	93	393
44	Rajanpal	48	177
45	Rankasinga	120	554
46	Suleimal	45	203
47	Ghunchapal	133	619
48	Kurudu	20	69
49	Balaramapadar	34	145
Total			**138777**

Source: District Census Hand Book 2011

4.1.4 General Nature of Hazard

In the proposed Talcher Fertilizer project, which includes Ammonia & Urea plants and associated units, hazardous materials shall also be handled. The basic raw material, ROM Coal, shall be made available by CIL from nearby coalfields. Liquid ammonia produced in ammonia plant is also highly toxic and contact of liquid ammonia with skin causes cold burn. Other hazards in Ammonia plant and Urea plant may be due to leakage of Chlorine from the Chlorine Tonners which is used as biocide in cooling tower. Chlorine is a highly toxic gas.

In Urea plant, the main hazard is from liquid ammonia which is highly toxic and Carbon Dioxide which is an asphyxiant

The credible hazard scenarios are -

(i) Flange gasket failure

(ii) Instrument Connection failure

(iii) Small bore pipe failure

(iv) Holes in pipeline

As rupture of pipelines and vessels due to explosion/ bursting or any other reason cannot be ruled out, release of hazardous materials may pose threat to the people inside and outside the plants. The vulnerable area due to release and subsequent dispersion of Ammonia and other toxic gases may extend beyond the plant premises, if release quantity is more and weather condition is favorable.

The failure and consequent hazard can be minimized by:

i) Regular physical check up.

ii) Regular monitoring of health of vessels and pipelines by non destructive testing followed by suitable action.

iii) A well organized trained manpower for operation of the plant safely

iv) Regular inspection and maintenance of moving machineries as per schedule

v) Regular check up of instrumentation, control & trip systems.

In addition to the above, following are necessary:

i) A quick responsive containment, control system requiring well planned safety and fire fighting arrangement.

ii) Well-trained personnel to handle safety and firefighting equipment as well as to operate the plant safely.

iii) A well formulated Disaster Management Plan both ON-SITE as well as OFF-SITE which covers well coordinated planning involving mutual aid between different organization, district administration, hospitals and moreover training/ awareness of the employees as well as the people living around the factory.

4.1.6 Hazard Assessment

Hazard potential of the proposed project due to different scenarios has been discussed in Risk Assessment, Chapter 3.0.

4.2 PREVENTIVE AND PRE-EMPTIVE MEASURES

4.2.1 General

After identification and assessment of disaster potential, the next step in Disaster Management Plan is to formulate and practice the preventive and pre-emptive measures. Proper preventive and pre-emptive measures can reduce the disaster potential to a minimum.

Preventive and pre-emptive measures are taken from the design stage itself. Preventive measures to be taken during design stage are:

i) Use of proper material of construction for equipment and piping as per relevant code/ specification.

ii) Judicious layout of the equipment and pipelines with proper safety distances, operating space and proper supports for pipelines.

iii) Use of SRVs of proper size and capacity.

iv) Use of instrumentation for proper operation, safety with automatic alarm and shutdown system, if the operating parameters suddenly go out of control.

v) Installation of water sprays and fire fighting system e.g. fire hydrants, monitors, emergency power system for proper operation of fire fighting and for cooling as well as providing water curtain during emergency.

vi) Installation of gas detectors for Ammonia & Chlorine.

vii) Earthing of electrical, mechanical equipment/ machineries etc.

Similar precautions should be taken regarding procurement of materials, installation/erection of the equipment, piping and instruments. Precautions to be taken during procurement and installation can be categorized as follows:

a) Procurement of machineries, pipes, flanges, gaskets, valves, SRV's, instruments, etc. as per proper code / specification.
b) Inspection of the materials by some reputed inspection agency.
c) Selection of experienced contractors specialized in erection job.
d) Supervision of work by experienced engineers.

Next step in pre-emptive measure is to formulate a detailed Disaster Management Plan (both ON-SITE as well as OFF-SITE) where actions to be taken before, during and post-disaster period are clearly mentioned.

Authorities of TFL, Talcher shall provide the information about the possible hazards and their effects to the district administration which will help in preparation of OFF-SITE Disaster Management Plan.

4.2.2 Awareness

Creation of awareness amongst employees/ public living in the vicinity of the factory and the role they have to play in case of any disaster occurring is very important. The employees of the factory are educated they should be made aware as to what should be done by them to take care of them as well as to protect the properties in case of emergency. For public, awareness shall be created through film shows and by distribution of leaflets in local language through village Panchayat periodically.

4.2.3 Mock Drill

Mock drill is very important to know the strength and weakness of the disaster control response plan. Efficient fire fighting arrangement shall be provided judiciously in the factory premises. Plants will be surrounded by fire hydrants and monitors as well as cooling water spray system. Mock drill for fire shall be conducted every month and mock drill for emergency shall be done every six months for fire as well as for toxic release. The practice shall continue regularly.

4.2.4 Communication

In order to facilitate proper and timely communication to the members of the response team, which helps to minimize the effect of disaster through suitable and timely action, internal as well as external telephones shall be provided in sufficient numbers. In addition, public address system shall be provided for communication in all the plants. In addition, manual call points shall be provided at different places for informing fire services department. Sirens of 5 Km range shall be provided to inform the employees as well as the public outside about emergency / disaster.

4.2.5 Entry of Personnel

Entry of personnel should be restricted for preventing sabotage or any untoward incident due to inadvertence. This will eliminate any terrorist activity.

4.2.6 Mutual Aid Scheme

In many cases, facilities and arrangements available under control of the factory administration may be inadequate to combat the disaster. Under these circumstances, outside help may be necessary to contain and control the situation. For this, facilities in the nearby industries such as fire tenders with trained personnel, experts need to be called whenever such situation arises. Industries in nearby areas may not have fire tenders. However, help from fire fighting station of State Govt. at Talcher shall be available. Medical help from state hospitals situated at Talcher and other primary health centers are available at Talcher.

4.3 DISASTER CONTROL PLAN

4.3.1 Objectives of the Plan

Disaster arrives unexpectedly and without any warning despite all precautions and preventive measures taken. However, an efficient control/ response plan can minimize the losses in terms of property, human lives and damage to environment.

Main objective of the plan is to minimize the effect of the disaster. The plan is developed in such a way as to make best possible use of the resources at the command of the unit as well as resources available like

State Fire Services, Police, Civil Administration, Hospitals etc. and the neighboring industries.

Advance and meticulous planning minimizes chaos and confusion, which normally occurs in such a situation, and reduces the response time of Disaster Management Organization.

The objectives of Disaster Management Plan are:

i) To contain and control the incident

ii) To rescue the victims and treat them suitably in quickest possible time

iii) To safeguard other personnel and evacuate them to safer places

iv) To identify persons affected or dead.

v) To give immediate warning signal to the employees as well as the people in the surrounding area in case such situation arising

vi) To inform relatives of the casualties

vii) To provide authoritative information to news media and others

viii) To preserve the affected area as well as the equipment as evidence for enquiry/ investigation

ix) To restore normal working condition at the earliest

x) To investigate the cause of the accident so that similar happenings do not occur

Both ONSITE as well as OFFSITE Disaster Management Response Plan can be subdivided into Equipment Plan, Organizational Plan, and Action Plan. Outline of the plans are discussed below:

4.3.2 Equipment Plan

During an emergency easy access to the required equipment and facilities are of paramount importance. Equipment plan needs arrangement of sufficient and proper appliances to combat any disaster after careful study of requirements including alarm and communication system as well as provision of vehicles for communication and relief measures.

<u>On-Site Emergency</u>

Efficient and adequate measures shall be available within premises of the Talcher complex to combat any "On-site Emergency". An efficient fixed-fire-fighting arrangement as well as portable fire-fighting facilities, supported by safety appliances shall be available within the premises to take care of emergency condition.

Fire Fighting Equipment and Facilities

Talcher fertilizer complex will have fire tenders, fire water reservoir, fire water pumps, hydrants and monitors also other portable fire fighting appliances such as fire extinguishers of different types in sufficient numbers. In addition, fog nozzle, water curtain nozzle etc shall be provided particularly in case of ammonia leakage.

Safety and Personal Protective Appliances

Various types of safety and personal protective appliances in adequate numbers shall be available in each plants, fire department as well as stores and emergency control centre.

Emergency Control Centre

An Emergency Control Centre shall be set-up at a safe place from where Chief Emergency Coordinator shall function for ON-SITE emergency. The Emergency Control Centre (ECC) is provided with adequate personal protective equipment, alarm and communication network (Siren, local as well as P&T Telephone, Public Address system), route map, fire hydrant and monitor layout, wind rose chart, copy of detailed Disaster Management Plan (where names, telephone numbers of the response team members and their responsibilities are clearly written as well as names and telephone numbers of key personnel from outside agencies in Mutual Aid Scheme and district authorities, Fire Stations, State Hospital and doctors are provided), first aid kit, material safety data sheets of chemicals etc. The Disaster Management Manual also contain map of the factory & surrounding areas, evacuation routes, fire hydrant network and other important information.

Assembly Point

Assembly points will be set up near to the likely hazardous event sites where pre-designated persons from TFL complex should assemble and meet the Site Incident Controller. This may be regarded as Site Incident Control Room where Incident Controllers will receive instruction and furnish information to the Chief Emergency Coordinator. The site incident control room will be provided with efficient communication system, adequate personal protective equipment, copy of Disaster Management Manual etc.

Emergency Shelter

Emergency shelter places shall be earmarked sufficiently away from expected hazard sites. Employees who are not in the emergency management team shall be asked to take shelter. The place is chosen such that the employees taking shelter are not affected by fire, explosion and release of toxic gases. More than one emergency shelter may be designated so that proper shelter point can be chosen depending on wind direction and other factors.

Wind Socks

Wind socks shall be provided on the top of tall structures/towers & tall buildings e.g. Administrative building to indicate the wind direction.

4.4 ORGANIZATIONAL PLAN

This part of Disaster Management Plan is a systematic list of persons in the emergency management team and their functions i.e. *"Who will do what and How-Before, during and After Emergency"*. The disaster management organization is capable of quick response at any time of the day or night to tackle the emergency situations arising from "On-site" as well as "Off-site". The plan gives a detailed chain of command, area of responsibility of each personnel involved in the plan, the information flow pattern to be followed and co-ordination activities required to tackle the emergency. List of key personnel in On-site Emergency Plan of *TFL*, Talcher and their responsibilities are given in the following Table-4.2

TABLE- 4.2

LIST OF KEY PERSONNEL

Key Personnel during Emergency	Designation	Major roles during Emergency
Main Site Controller	Sr.General Manager (Unit Head)	Overall in-charge for Localization control & mitigation of the emergency.
Incident Controller (T)	General Manager alternate Plant I/C (Prodn.) of the affected Plant	Overall in-charge for the incident control including fire fighting and engineering activities
Incident Controller (NT)	Advisor (P&A) Alternate DGM (P&A)	In charge of logistic activities like First-Aid & Medical, Securities, Communication, Rescue, Evacuation, Transportation & Roll Call.
Leader Fire Fighting & Safety Team	DGM (F&S) Alternate I/C (F&S)	In charge of fire fighting & Safety activities
Leader-Incident Controller Team	Plant in-charge (Prodn.) Alternate Dy. Plant I/C (Prodn.)	In-charge of combat activities
Leader Engineering Team	GM (Maint.) Alternate Sectional Head (Mech.) of Affected Plant	In charge of Emergency maintenance activities
Leader First– Aid & Medical Team	Chief Medical officer Alternate Medical officer	In charge of treatment of affected persons
Leader- Security, Communication & Rescue	Chief Security Officer Alternate Manager (SIS)	In charge of Security, Communication, Evacuation & Rescue activities
Leader-Transport Team	Advisor (P&A) Alternate DGM (P&A)	All transportation arrangements
Leader Roll Call Team	DGM (P&A) Time Office alternate Advisor (TPT)/ Manager (P&A)	I/C of Assembly & Roll Call Activities
Telephone Operation	Receptionist Alternate Staff of Time Office	Communication to different key persons
Store Keeper	Chief Manager (Materials)Alternate Sr. Manager (Materials)	Issue of materials for emergency activities

Main Site Controller shall take the charge of the whole situation and guides Incident Controllers and various leaders under his control to contain and control the incident.

It is a fact that first few minutes after start of the incident is most vital in prevention of its escalation. The personnel available in the plant round the clock basis play an important role. Important role shall be played by operators, shift in-charge, in-charge of fire & safety at the very initial period of the incident and when emergency is declared it should be guided by Main Site Controller.

4.4.1 ACTION/ RESPONSE PLAN

The action plans for tackling emergency include the following:

i) Actions to be taken in Pre-emergency Period.
ii) Action during Emergency/ Disaster.
iii) Actions to be taken in Post Disaster Period

Pre-emergency Actions

Some of the preventive and pre-emptive measures have already been discussed. Other pre-emergency measures in case of "On-site" emergency/ disaster can be listed as follows.

i) Ensure implementation of Disaster Planning.
ii) Ensure that all drafted for emergency undergo regular training.
iii) Ensure all team members in different disciplines to be prepared for tackling emergency/ disaster.
iv) Ensure simulated emergency condition to be regularly arranged and Mock Drills are performed to assess the strength and weaknesses of the response team/ plan.
v) Ensure awareness among employees through regular training.
vi) Ensure good liaison with all agencies and industries in the neighborhood for getting help, if situation arises.

Action during Emergency

The duties and responsibilities of some of the key personnel are defined below:

Site Controller/ Chief Emergency Coordinator:

Sr. General Manager (Unit head) i.e. the highest authority of the unit or his nominated personnel (Jt. General Manager), will report at the Emergency Control Centre and will assume the overall responsibility for the situation. His/ Her duties are:

i) To assess the magnitude of the disaster and decide a major emergency condition exists and declare emergency.

ii) Mobilize other members of his/ her team and exercise direct operational control of the areas for combating emergency.

iii) Activate Disaster Management Plan (DMP) and ensure implementation.

iv) Inform all statutory authorities, District Collectorate, Fire Brigade, Mutual Aid members on the magnitude of the disaster, help needed, casualties etc.

v) Review continuously the situation in consultation with Incident Controller (T) & Incident Controller (NT).

vi) Keep liaison with the senior official of police, Factory inspectorate and pass on the possible effects in the surrounding areas outside the factory premises.

vii) Assess whether evacuation of the employees and public are necessary and direct accordingly.

viii) Keep liasion with different service coordinators and check whether they are rendering their service properly.

ix) Ensure persons affected are getting proper care for relief and rehabilitation and next of kin are informed.

x) Release authoritative information to press, Radio, TV and advice about possible effect on surroundings.

xi) Conduct enquiry about the incident and bring normalcy as early as possible.

Incident Controller (T):

Joint General Manager (Prod.)/ Sectional In-charge of the affected plant will rush to the spot on hearing the alarm siren or getting the message through telephone and take charge of the situation. He/ She will assess the situation and decide whether a major emergency exists or likely to develop. He/ She will inform Chief Emergency Coordinator accordingly. His/ Her other duties are:

i) He/ She will take overall charge of the situation for controlling all operations including fire fighting.
ii) Ensure proper Co-ordination and implementation of DCMP. Due priority to be given to the safety of personnel, minimize damage to the plant properties and environment.
iii) Direct emergency shutdown of the plant and arrange evacuation of the area affected or likely to be affected by the disaster in consultation with Incident Controller (NT).
iv) Arrange alternative power connection for lighting in case of normal failure of electricity if the disaster occurs at night.
v) Keep constant touch with Chief Emergency Coordinator and report the developments to him at intervals.
vi) Preserve the evidence in the affected area to facilitate investigation into the cause of the accident (arrange photographs etc.)

Incident Controller (NT):

Advisor (P&A) will act as Incident Controller (NT). He will also rush to emergency control room. He will arrange for evacuation, First Aid, Communications, assembly, roll call activities & transportation activities as per directive of Chief Emergency Coordinator.

Leader of respective activities will act as per direction of Incident Controllers. Their activities are as given in key personnel chart. Speedy implementation of response procedure under organized chain of command prevents escalation of emergency and helps to combat emergency in well organized manner.

Leader (Fire Fighting & Safety)

i) Liason with Incident Controller (T) and organize the team for fire fighting.
ii) Direct all operation within the affected areas with priorities for safety of personnel, operating facilities and environment.
iii) Keep the ring min. hydrant pressurized for uninterrupted supply of water for fire fighting.

iv) Assist Fire Brigade personnel in operating water monitor, water curtains to cool the affected area and isolate it as far as practicable.

Leader (First Aid & Medical Team)

i) Arrange first aid and remove the affected persons to Hospitals in Talcher and other hospitals as per necessity and situation after giving first aid treatment. A record of persons sent to different hospitals should be maintained.

Plant Personnel

As stated earlier, persons present in the plant (specially operators, shift in-charges etc.) plays a crucial role. They should try to tackle the situation at the very onset. Their duties are:

i) Try to isolate the source
ii) Operate the manual call point information system and the public address system.
iii) Inform Fire & Safety Dept.
iv) Inform Plant Manager
v) Inform Joint General Manager, Dy. GMs of the respective plant.

Post Disaster Activities

The post Disaster Activities mainly covers the followings:

i) Arrange for proper enquiry/investigation about the real cause and conditions of the accidents to prevent similar occurrences.
ii) Arrange for proper relief and rehabilitation of the affected employees.
iii) Payment of compensation to the next of kin of the causalities.
iv) Bring back normalcy as early as possible.

4.5 SCENARIO SPECIFIC DISASTER MANAGEMENT PLAN

4.5.1 It has been seen from Hazard Assessment that major emergency situation can arise mainly from release of ammonia and other toxic gases. The situation can be grave or minor depending on the scenario occurring causing the release of ammonia and other toxic gases. Care should be taken to tackle the minor incident. A list of emergency response functions that are identified for large-scale release of ammonia and other toxic gases is given as follows:

i) Alarm, warning and signaling
ii) Communication
iii) Operations
iv) Fire and Safety
v) Toxic Gas Spreading Protection
vi) Emergency Shelter
vii) Medical Services
viii) Transport Services for transportation of injured persons and evacuation
ix) Welfare activities.

4.5.2 Resources Planning

Resource planning needs to be done so that the functions mentioned above can be operated smoothly. Regular Mock drill and training is essential for proper and timely response.

Since, the large scale leakage of ammonia, chlorine and other toxic gases can affect employees within *TFL, Talcher* as well as the public, creation of awareness is must. The employees and public should also be taught the actions to be taken to save themselves.

4.5.3 Medical Services

The doctors in first aid post and the outside shall be trained for treatment of personnel by gas leakage. Necessary apparatus and drugs should also be available in first aid post inside the factory and other hospitals nearby.

Advisor (P&A) & Doctor in First Aid Post should have good liaison with the authorities of nearby hospitals, nursing homes and primary health centers as well as doctors outside so that help may be available when required.

4.5.4 Transport and Communication

Ambulance Van should be available under the command of Advisor (P&A) inside the factory. However, in case of disaster all the vehicles in transport department will be used. In case of necessity vehicles will be requisitioned from outside.

4.5.5 Safety Appliances

Gas masks, BA set and respirators are to be made available in plants. They should be checked and kept in good working order. Ammonia suits should be procured and distributed in Ammonia storage and production section.

4.5.6 Operational Functions

Specific actions with respect to operational functions are as follows.

i) Detection of leakage and isolation from the source to prevent the leakage is the most important activity in the beginning. ROVs shall be provided at different places in Ammonia storage & production. It may also be necessary to isolate the line or equipment by closing the isolation valves. The functional requirement may be one or more operators to close the isolation valves manually in the area with high toxic concentration and possibility of liquid ammonia splashes on the body. The personnel should wear the ammonia suit with self-contained breathing apparatus. The operating personnel should be fully drilled in proper and safe use of the safety appliances.

ii) Plant or section of the plant to be shut down.

iii) On release of liquid ammonia from the pipeline or equipment due to any reason 20% of the liquid ammonia flashes immediately and the balance 80% will form a liquid pool.

Attempt should be made to contain this quantity by immediate dyking etc. Otherwise, it will make its way to storm water drain. This will lead to spreading all around, rapid evaporation and acute pollution problem also.

iv) Sand bags and other devices should be made available and some employees should be engaged for the job wearing sufficient personal protective appliances.

v) Operator/ Shift-In-Charge should inform immediately to Fire & Safety Deptt. as well as Concerned Chief Manager of the Plant, who in turn will communicate Chief Emergency Coordinator.

vi) Emergency is to be declared and other actions are to be taken by them.

vii) Since, ammonia is readily soluble in water, a water curtain may be prepared at downwind direction by the fire services to decrease the concentration of ammonia vapour in air and its dispersion.

viii) Rescue of the personnel affected and evacuation of other employees to emergency shelter room may be needed. Emergency shelter should be located at a safe place at up wind direction.

ix) Medical help may be necessary to the affected personnel. Leader-First Aid and Medical Team and Leader-Transport Team to take proper care under guidance of Incident Controller (NT).

OFF-SITE EMERGENCY PLAN

An integral part of the Disaster Management Plan is the Off-Site Emergency Plan. The plan is mainly dependent upon a very close co-ordination and assistance from the Local Administration like Police, Fire Brigade, Medical Services (hospitals) etc.

OFF-SITE ACTION

The Chief Controller will inform about the incident like Fire, Explosions and toxic gases to

(i) Police and District Collector
(ii) Fire Brigade
(iii) Medical Services
(iv) Technical Agencies
(v) Rehabilitation Agencies
(vi) Electricity Board

RESPONSIBILITIES OF THE SERVICES

1] Police

1 To control traffic & mob by cordoning off the area.
2 Arrange for evacuation of people on advice from the Site Controller/ District Collector.
3 Broadcast/ communicate through public address systems to the community on advice from the District/Sub Collector.
4 Inform relatives about details of injured and casualties.

2] Fire Brigade

1 Fighting fire & preventing its spread.
2 Rescue & salvage operation.

3] Medical/Ambulance

1 First Aid to the injured persons.

2 Shifting critically injured patients to the hospitals.

3 Providing medical treatment.

4] **Technical/Statutory Bodies**

(Constitutes Factory Inspectorate, Pollution Control Board, Technical Experts from Industries)

1 Provide all technical information to the emergency services, as required.

2 Investigate the cause of the disaster.

5] **Rehabilitation**

1 Arrange for evacuation of persons to nominated rescue centre and arrange for their food, medical and hygienic requirements.

2 Coordinating with the Insurance Companies for prompt disbursement of compensation to the affected persons.

3 Maintain communication channels of the affected industry like telephone, mobile, internet etc. in perfect working condition.

6] **Electricity Board**

To put off the power supply to the plant, if specifically asked for by TFL Talcher.

7] **PERSONAL PROTECTIVE EQUIPMENT**

The following of personal protective equipment should be available during an emergency.

(i) Fire proximity suit

(ii) Self Contained Breathing Apparatus with one spare cylinder (30 mints)

(iii) Water jel blankets.

(iv) Safety helmets

(v) Rubber hand gloves for use in electrical jobs

(vi) Low temp. rubber hand gloves for LPG emergency

(vii) Low temp. Suit for LPG emergency

(viii) Resuscitator

(ix) Ear Plugs

(x) Air Mask

(xi) Eye Goggles

8] IMPORTANT TELEPHONE NOS.

STD Codes: Angul-06764, Talcher- 06760, Athamallik- 06763, Pallahara- 06765, Chhendipada- 06761			
Officer	**Office No.**	**Residence No.**	**Fax No.**
Collector, Angul	230567	230234	230685
ADM, Angul	230491	236052	-
Superintendent of Police, Angul	230316	220616	-
PD, DRDA, Angul	230144	231248	-
Sub-Collectors, Angul	230302	030301	-
Sub-Collectors, Athamallik	22222	-	-
Sub-Collectors, Pallahara	279221	279222	-
Sub-Collectors, Talcher	240720	240444	-
Dist. Emergency Officer, Angul	230980	-	-
Few Imp. Hospitals & Health care Centers			
Nehru Satabdi Central Hospital, Talcher	06760-269184		
SS Hospital, Angul	09937420397		
Railway Dispensary, Talcher	08455887508		
Ashalok Hospital, Talcher	06760-246056		
Karunakar Seba Sadan, Talcher	09439724035		
Surendra Hospital, Angul	06764-236244		

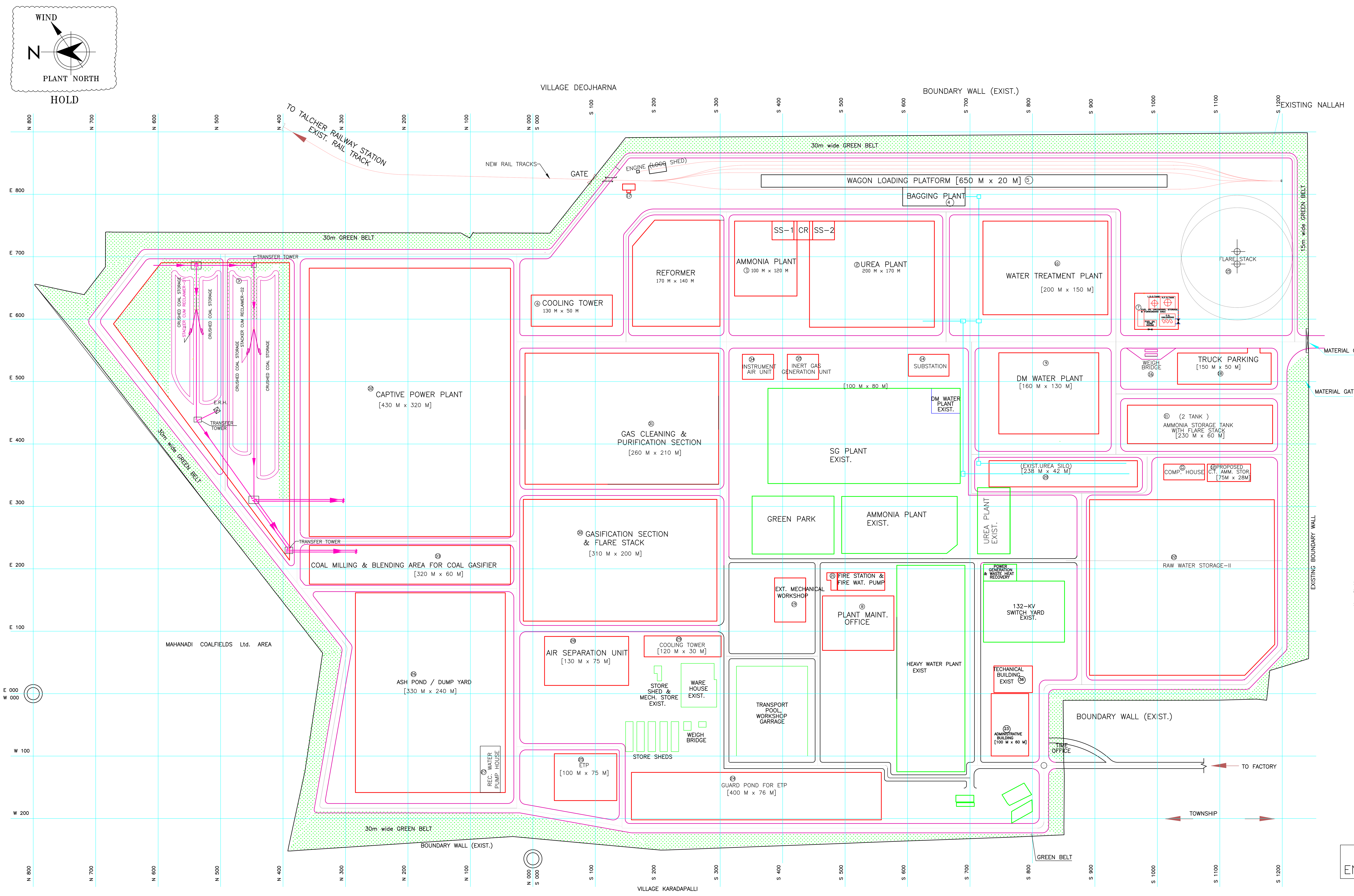


TABLE FOR FACILITIES/UNITS

SL.NO.	BLOCK DESCRIPTION	SIZE IN METRE	REMARKS
1.	AMMONIA PLANT	100 M x 120 M	
2.	UREA PLANT	200 M x 170 M	
3.	CRUSHED RAW COAL STORAGE	200 M x 50 M	
4.	BAGGING PLANT	100 M x 30 M	
5.	WAGON LOADING PLATFORM	650 M x 20 M	
6.	COOLING TOWER	130 M x 50 M	
7.	FUEL OIL UNLOADING, STORAGE & FORWARDING AREA	70 M x 55 M	
8.	PLANT MAINTENANCE OFFICE	100 M x 80 M	
9.	PROPOSED DM WATER PLANT	160 M x 130 M	
10.	WATER TREATMENT PLANT	198 M x 148 M	
11.	PROPOSED AMM. STORGE TANK(2 Nos) WITH FLARE STACK	230 M x 60 M	
12.	PROPOSED C.T. AMM. STORAGE	75 M x 28 M	
13.	AMM. STORAGE COMPRESSOR HOUSE	65 M x 25 M	
14.	AMM. STORAGE SUB-STATION	65 M x 35 M	
15.	FLARE STACK	-	
16.	TRUCK/ LORRY WEIGH BRIDGE	-	
17.	RAIL WEIGH BRIDGE	-	
18.	TRUCK PARKING	150 M x 50 M	
19.	MECHANICAL WORKSHOP (EXIST.)	-	
20.	UREA SILO (EXIST.)	238 M x 42 M	
21.	FIRE STATION & FIRE WATER PUMP	-	
22.	PROPOSED RAW WATER STORAGE - II	-	
23.	ADMINISTRATIVE BUILDING	100 M x 60 M	
24.	PROPOSED GUARD POND FOR ETP	422 M x 76 M	
25.	PROPOSED ETP	100 M x 75 M	
26.	ASH POND / DUMP YARD	330 M x 240 M	
27.	REC. WATER PUMP HOUSE	-	
28.	AIR SEPARATION UNIT	130 M x 75 M	
29.	COOLING TOWER FOR CGP	120 M x 30 M	
30.	PROPOSED GASIFICATION SECTION & FLARE STACK	260 M x 225 M	
31.	PROPOSED GAS CLEANING & PURIFICATION SECTION	200 M x 220 M	
32.	CAPTIVE POWER PLANT	430 M x 320 M	
33.	COAL MILLING & BLENDING AREA FOR COAL GASIFIER	320 M x 60 M	
34.	INSTRUMENT AIR UNIT	50 M x 40 M	
35.	INERT GAS GENERATION UNIT	50 M x 40 M	
36.	TECHNICAL BUILDING (EXIST.)	-	

LEGEND :-

PROPOSED FACILITIES
EXISTING FACILITIES
NEW RAILWAY TRACKS
ROAD FACILITIES [TO BE USED]
GREEN BELT AREA
PROPOSED ROAD FACILITIES

NOTE:-

1. BLOCK FACILITIES ARE INDICATIVE ONLY.
2. BIDDER TO CONSIDER ADDITIONAL SPACE FOR ONE FUTURE GASIFIER. CURRENT GASIFIER SCENARIO (2 WORKING + 1 FOR FUTURE SPACE)
3. BIDDER TO CONSIDER ADDITIONAL SPACE FOR ONE FUTURE SULPHUR RECOVERY UNIT CURRENT SCENARIO (2 WORKING + 1 FOR FUTURE SPACE)

ISSUED FOR ENVIRONMENTAL CLEARANCE

DRAWING No. 01

REFERENCE DRAWINGS	NUMBERS
04. MASTER PLAN OF MINING	FURNISHED BY CLIENT
03. MASTER PLAN [FCI, TALCHER UNIT].	DRG. NO. 501
02. INDEX PLAN [FCI, TALCHER UNIT].	DRG. NO. 635
01. PLANTS LAYOUT [FCI, TALCHER UNIT].	TFU-M-GN-6341

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
1_Open	28.06.2017	ISSUED	SAH	NS	AMAR
0	24.05.2017	ISSUED	SAH	NS	AMAR

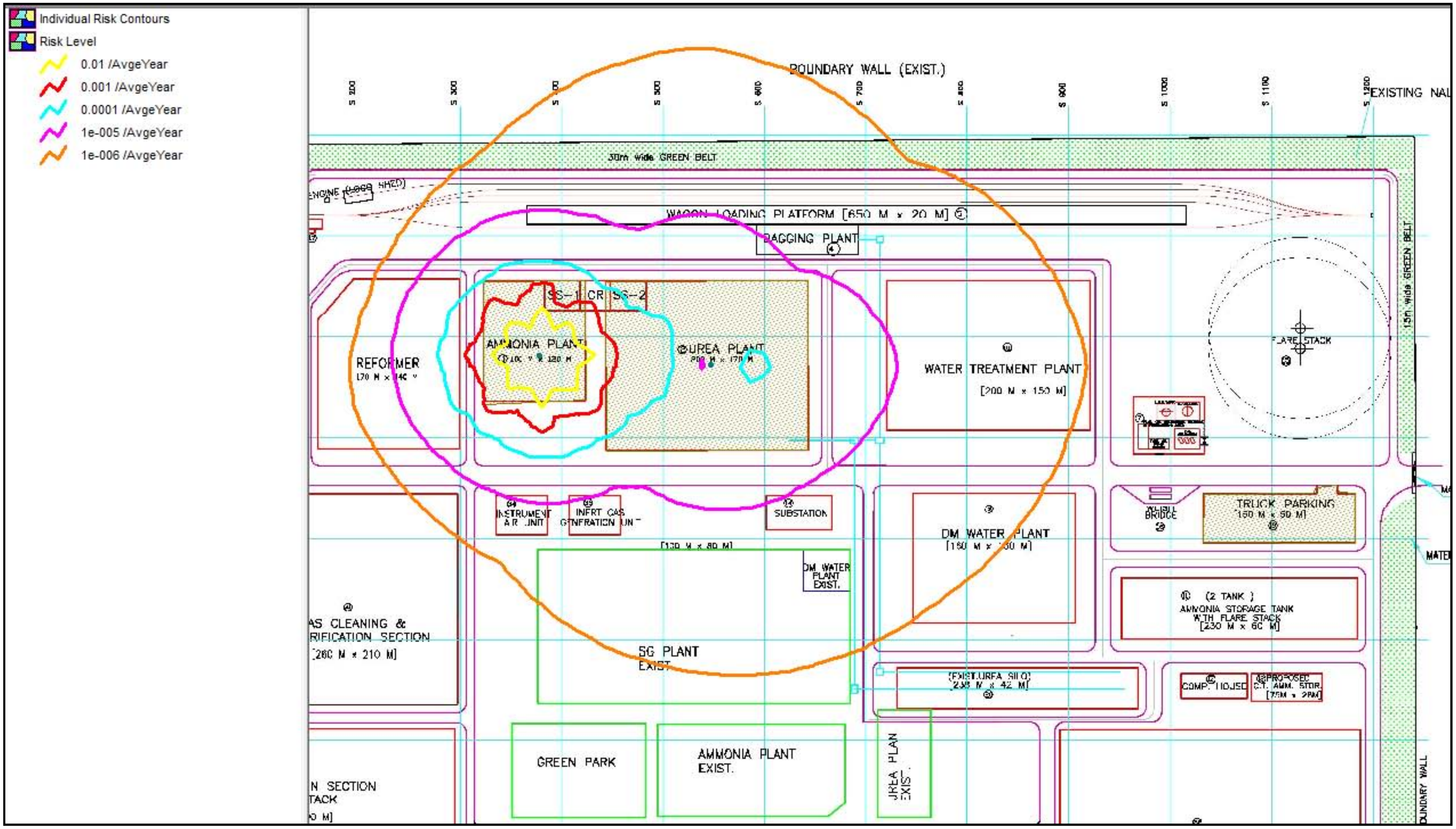
CLIENT : M/s. TALCHER FERTILIZER LIMITED

LOCATION : TALCHER, ANGUL DISTRICT, ODISHA(INDIA)

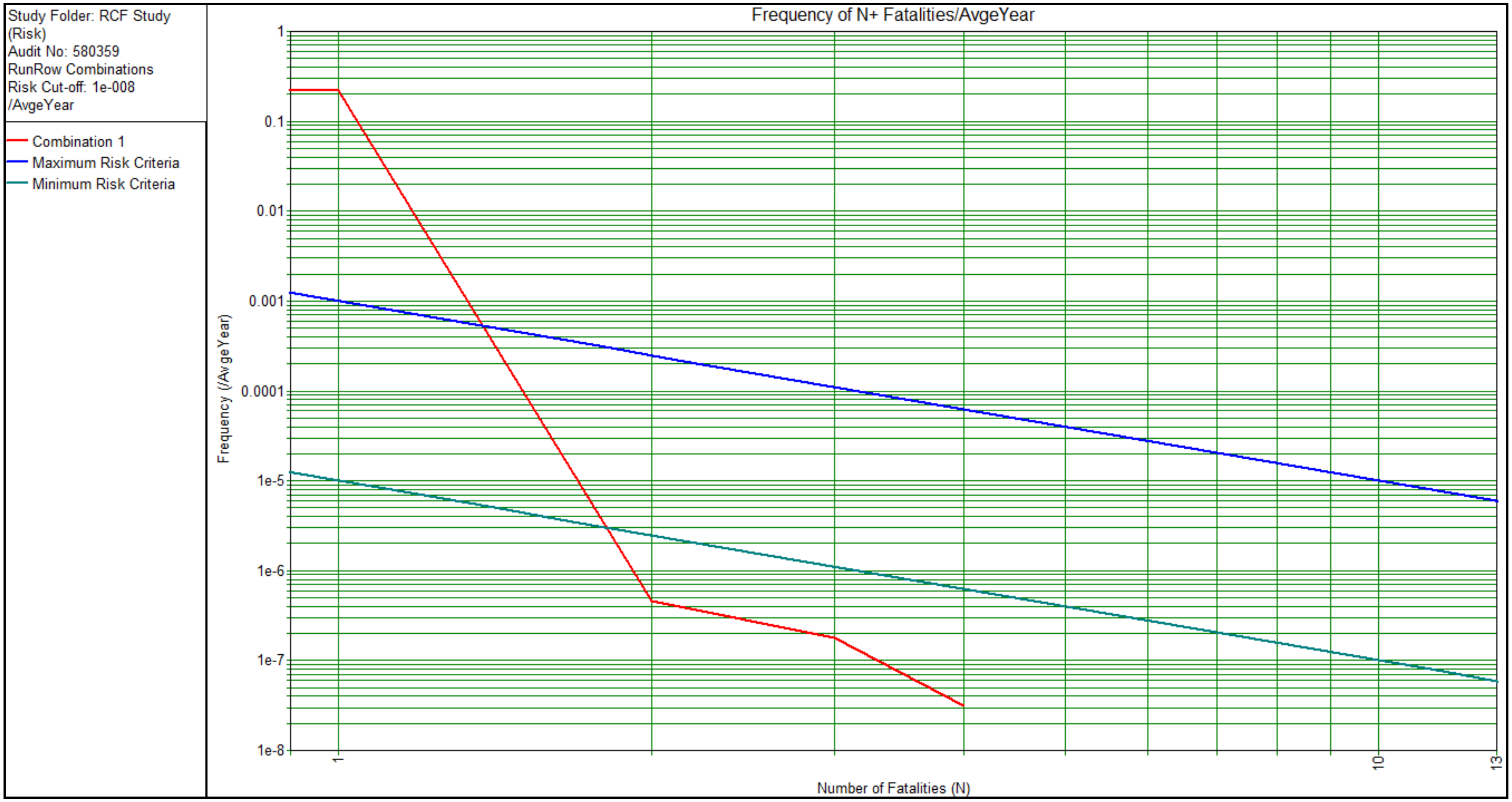
TITLE : PLOT PLAN OF PROPOSED INTEGRATED COAL BASED FERTILIZER AND CHEMICALS COMPLEX

REV. 0
SHEET 1 OF 1
SCALE :- 1 : 2200
DRG. No.:- PC009-0000-0001
FILE :- PC009-0000-0001 Rev.1

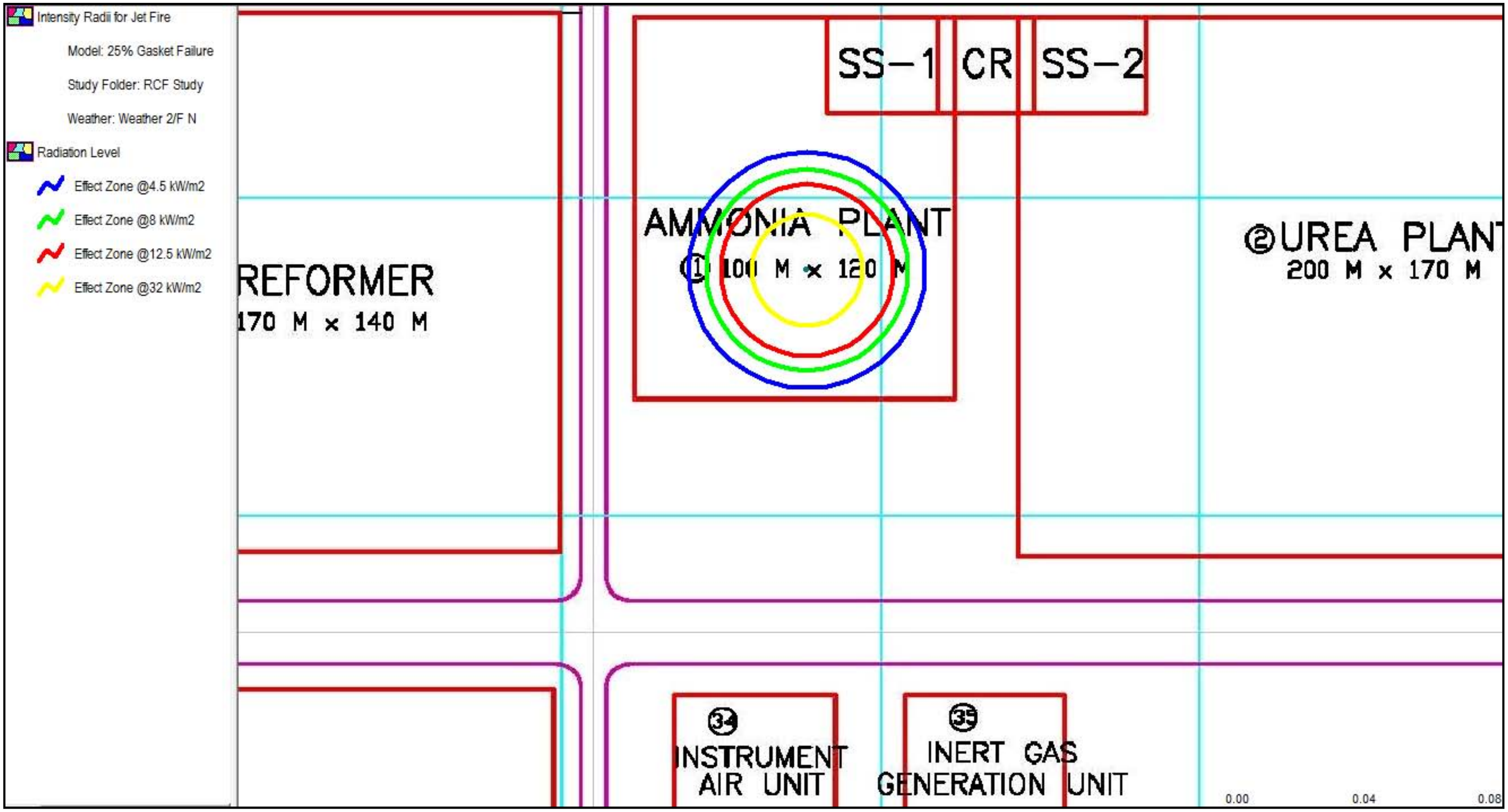
PDIL
PROJECTS & DEVELOPMENT INDIA LTD. NOIDA



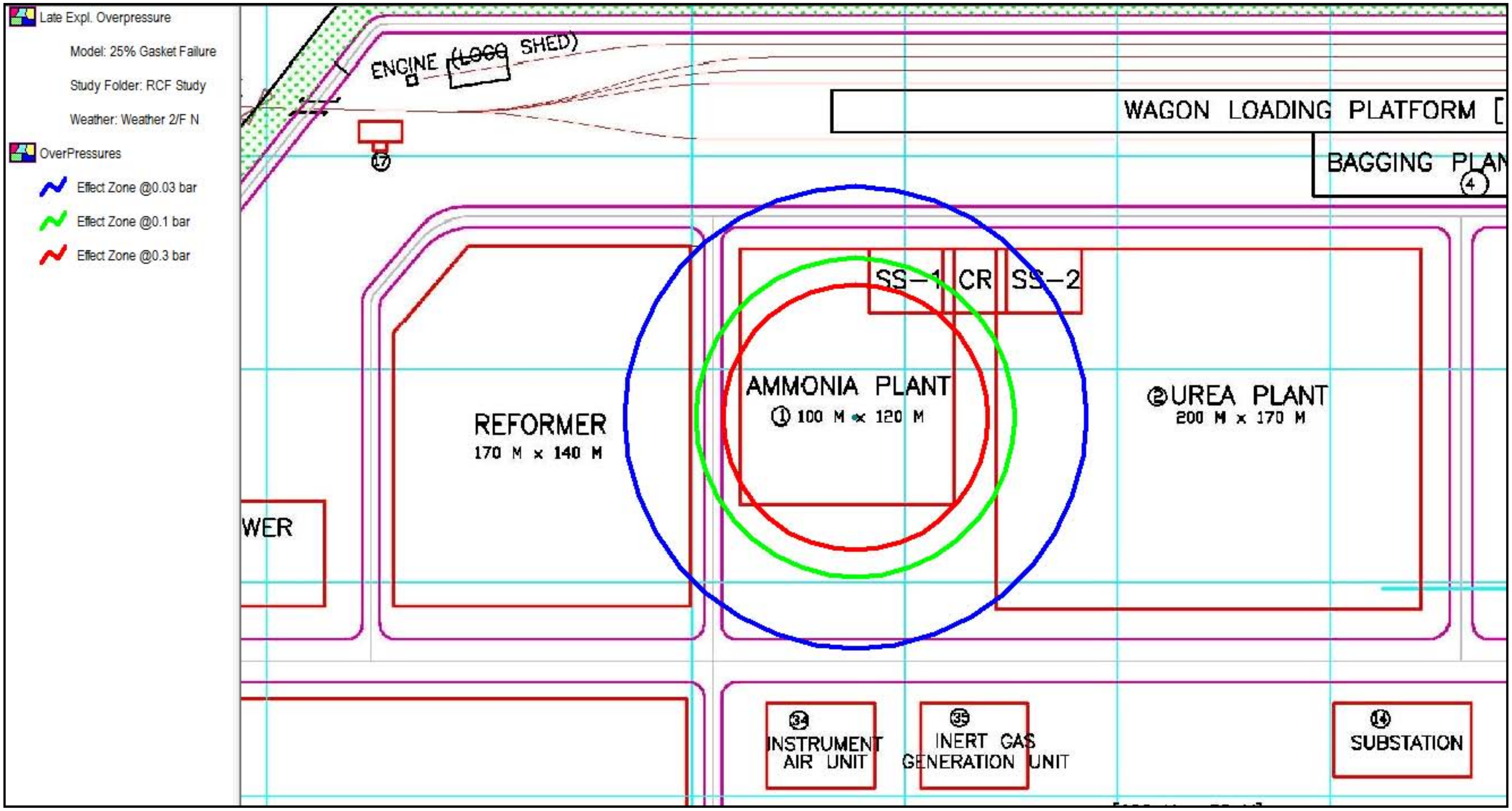
Drg. No. 2 (Iso-Risk Contour for Coal based New Ammonia (2200 MTPD) & Urea (3850 MTPD) Fertilizer Project of M/s TFL at closed unit of FCIL, Talcher)



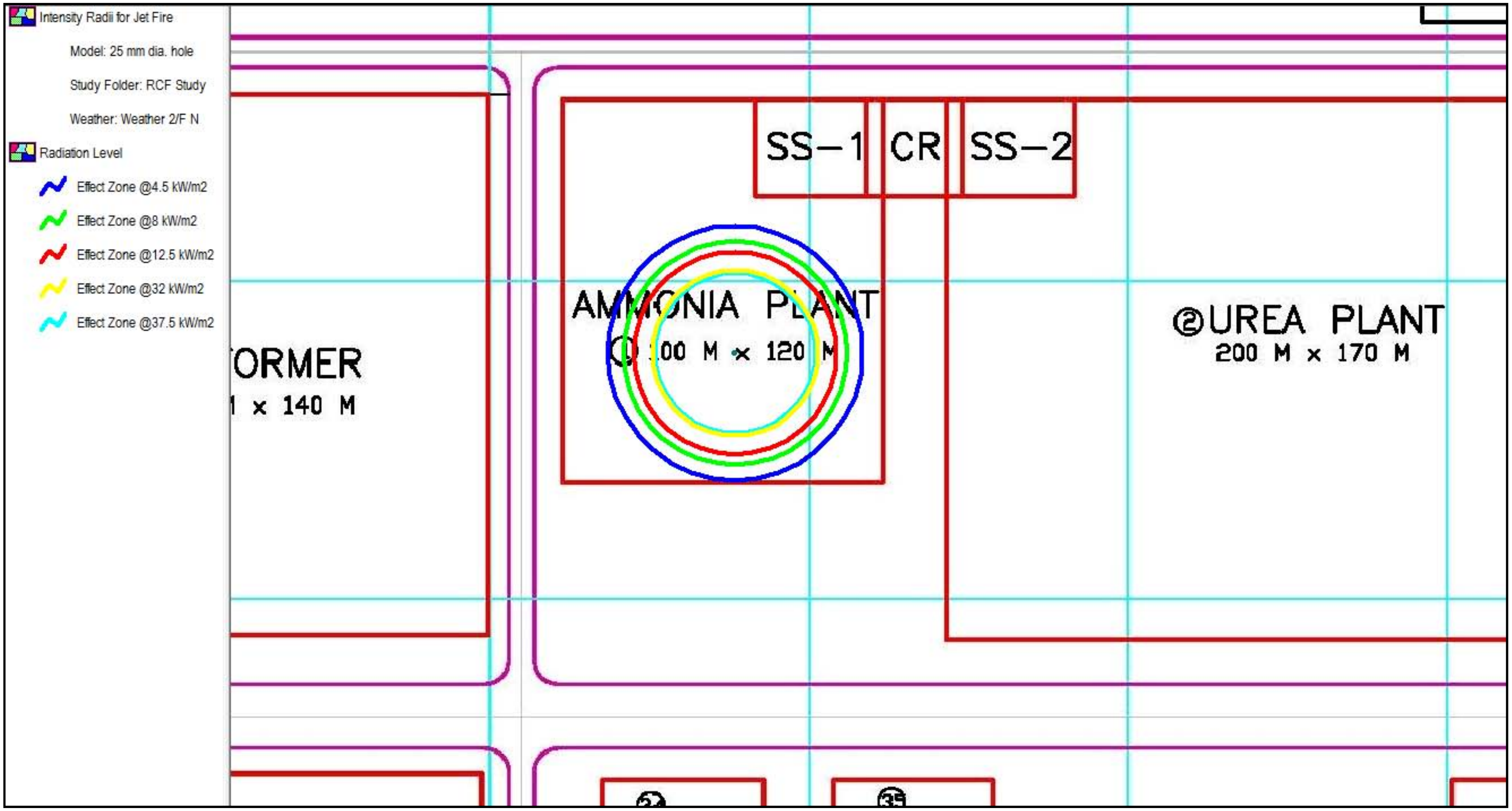
Drg. No. 3 (F/N Curve Iso-Risk Contour for Coal based New Ammonia (2200 MTPD) & Urea (3850 MTPD) Fertilizer Project of M/s TFL at closed unit of FCIL, Talcher)



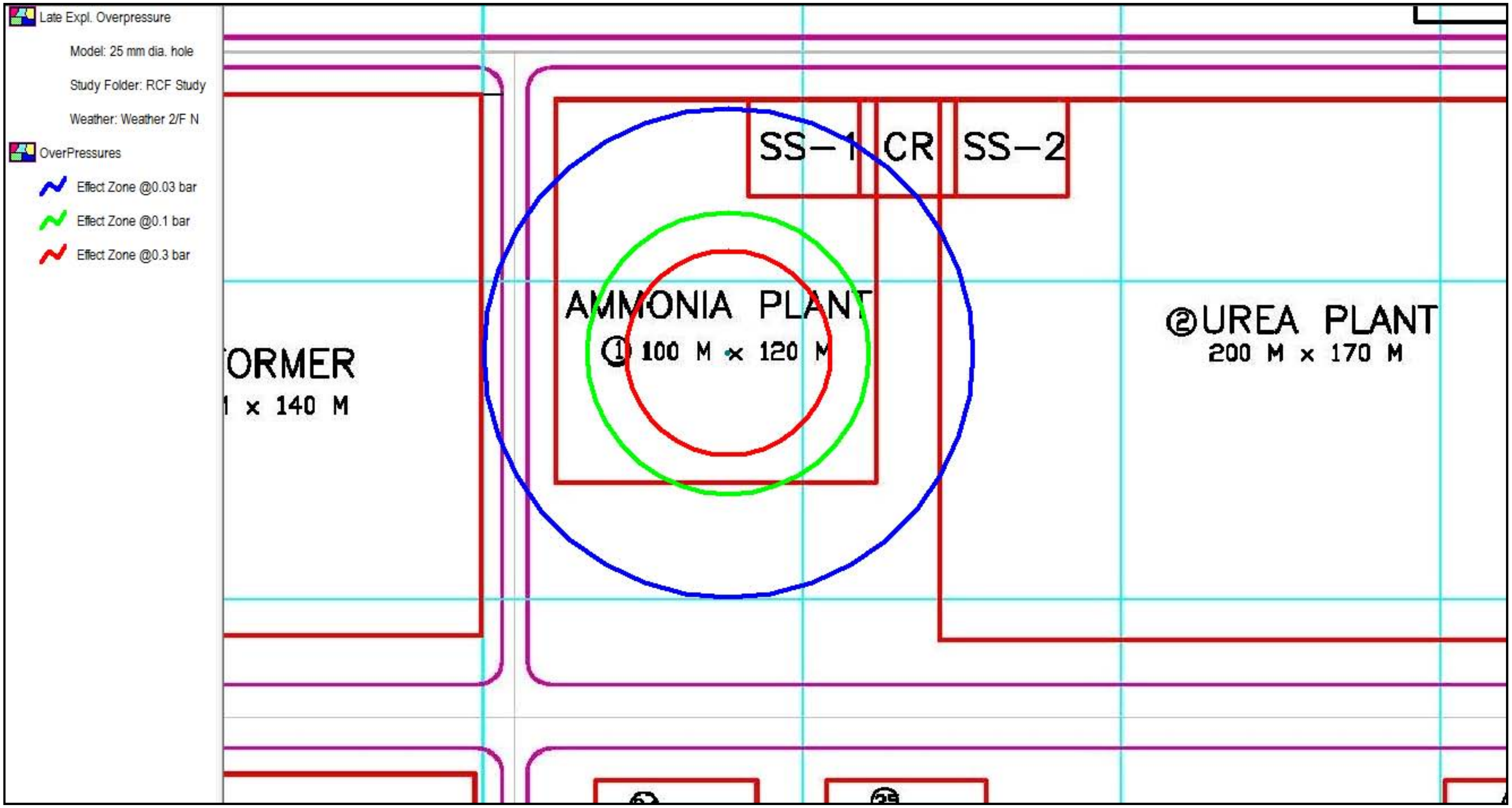
Drg. No. 04 (Thermal Radiation due to Jet Fire for Make-up Synthesis Gas to Ammonia Synthesis Section Line 25 % Gasket Failure)



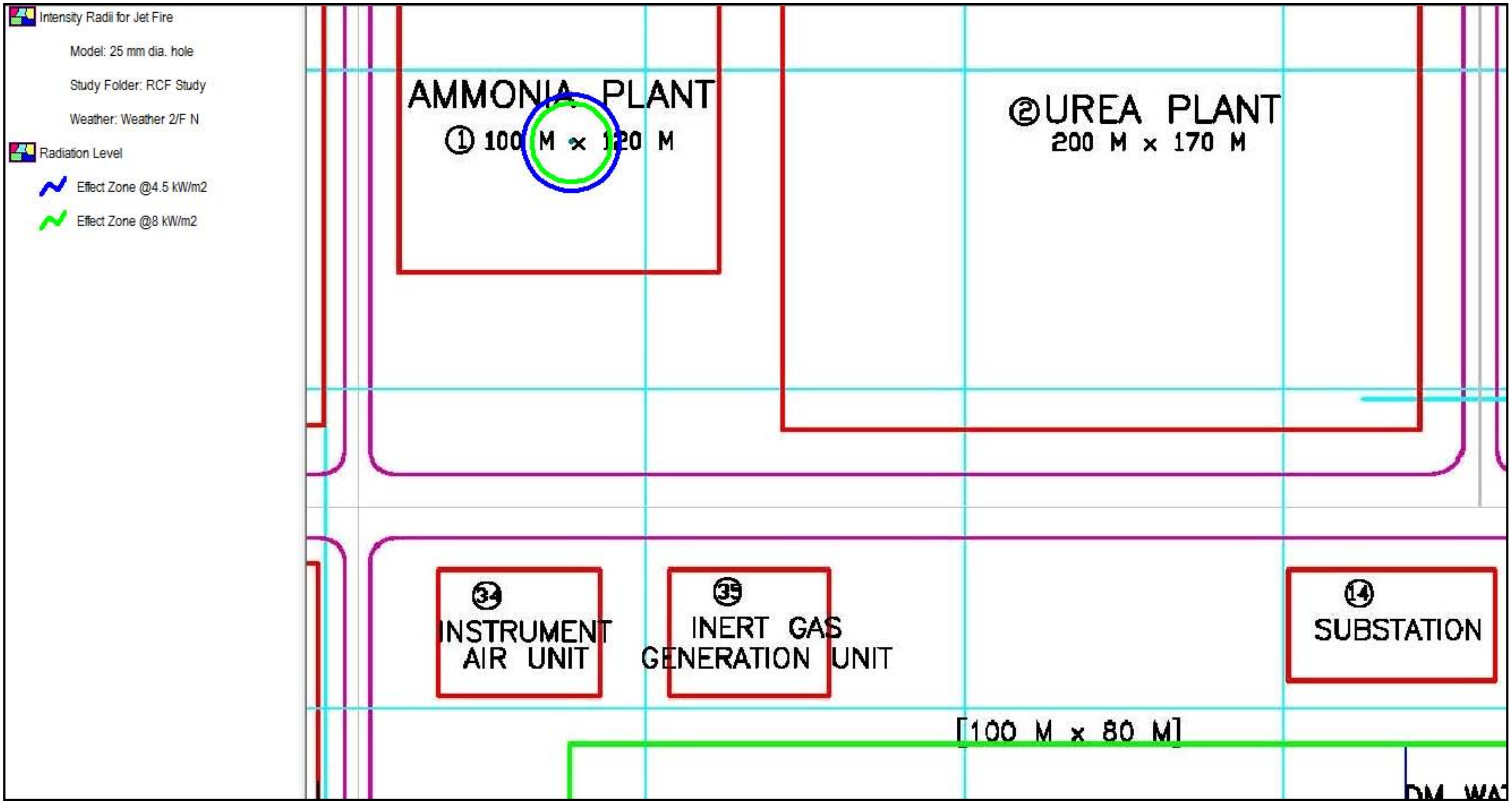
Drg. No. 05 (Overpressure distance due to UVCE for Make-up Synthesis Gas to Ammonia Synthesis Section Line 25 % Gasket Failure)



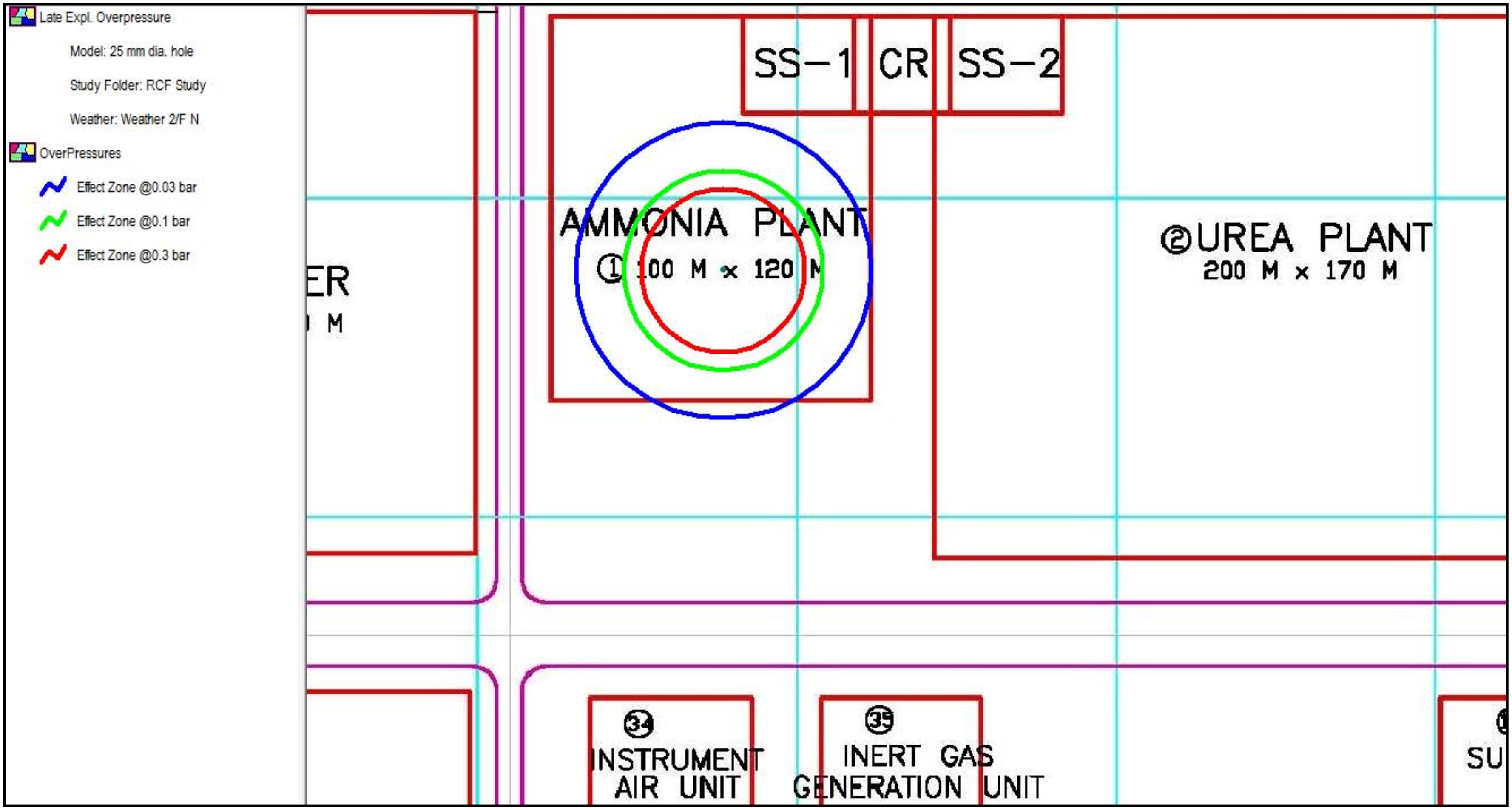
Drg. No. 06 (Thermal Radiation due to Jet Fire for Ammonia Converter Outlet Line 25 mm dia. hole)



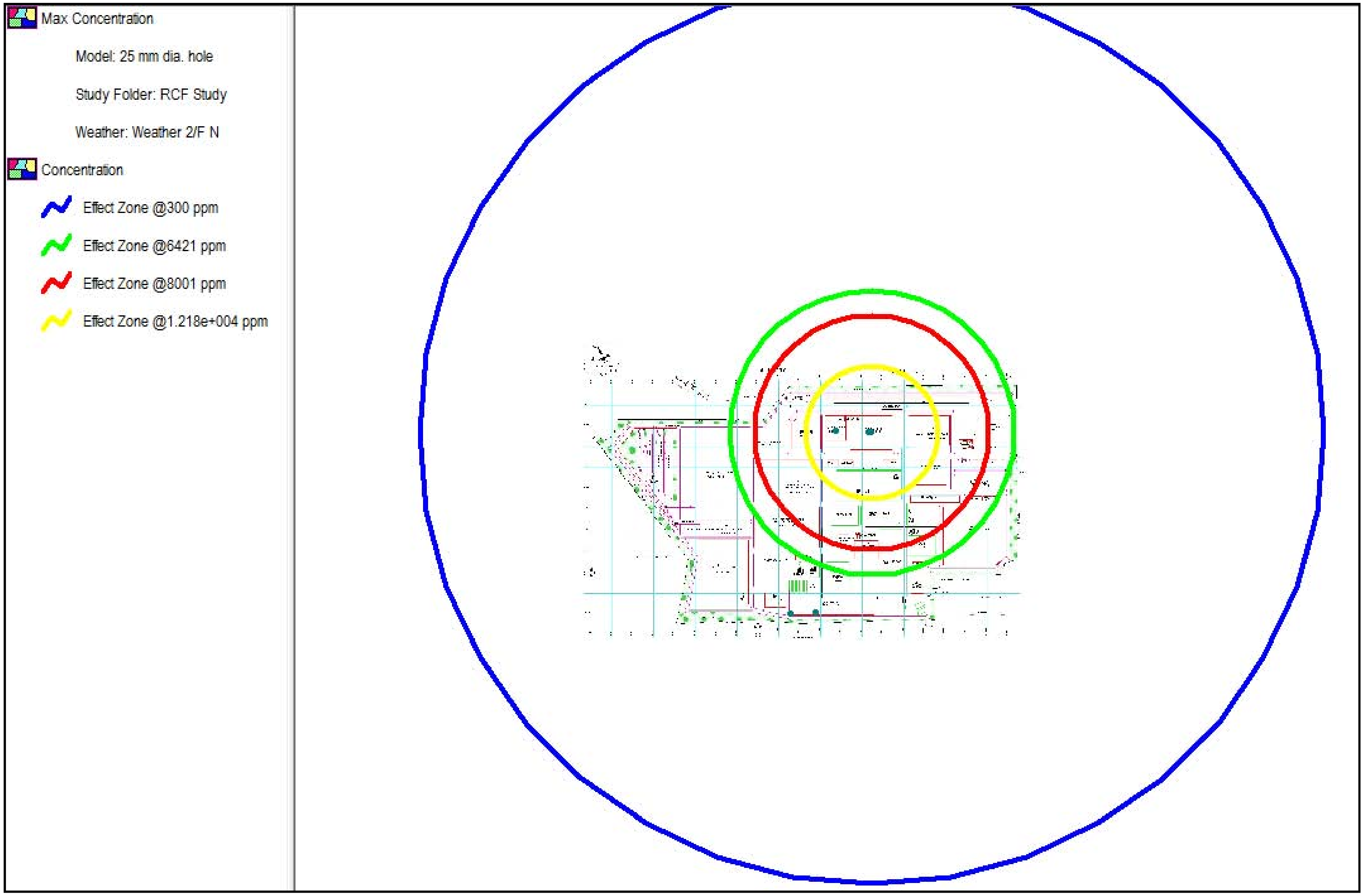
Drg. No. 07 (Overpressure distance due to UVCE for Ammonia Converter Outlet Line 25 mm dia. hole)



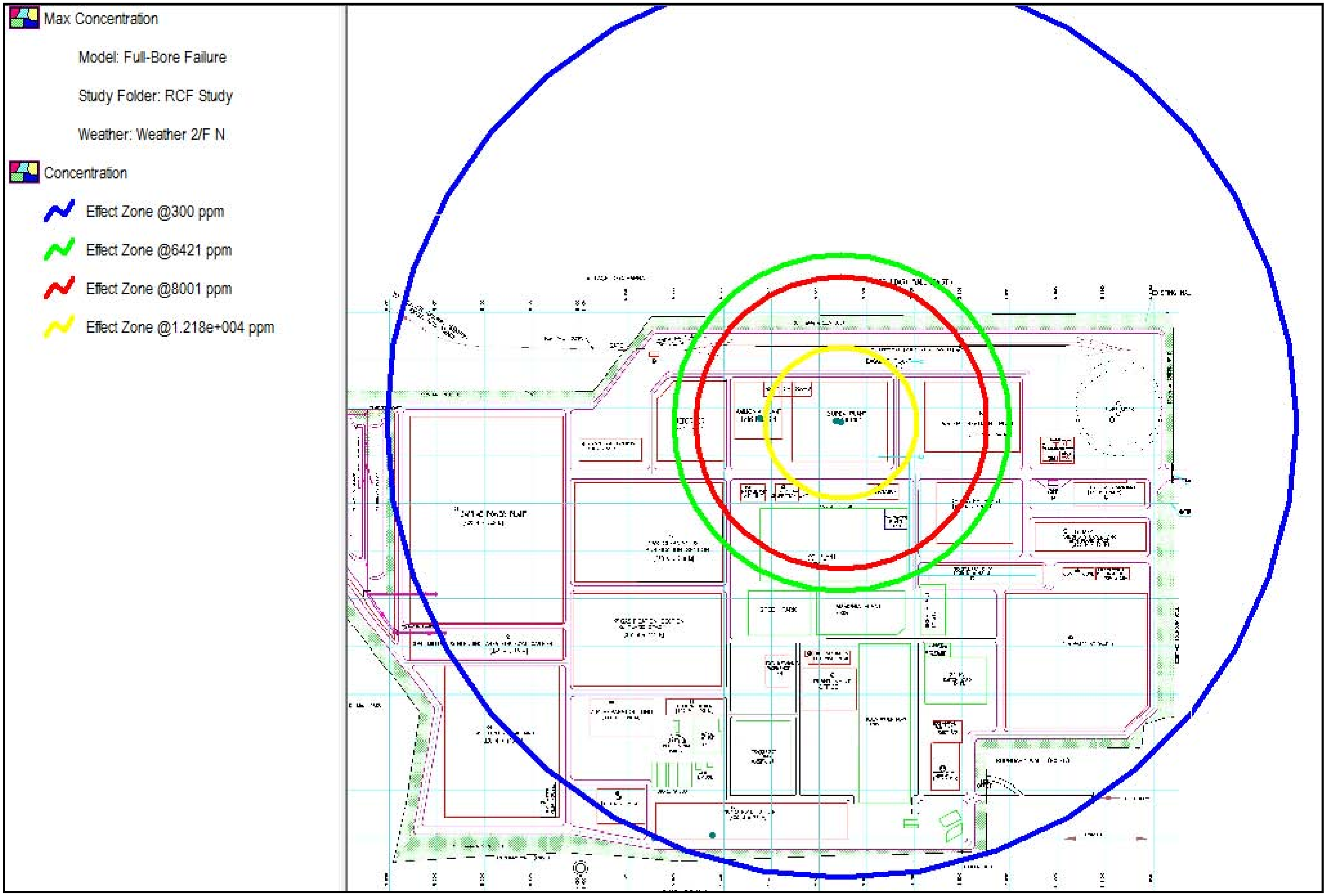
Drg. No. 08 (Thermal Radiation due to Jet Fire for Ammonia Recirculator Outlet Line 25 mm dia. hole)



Drg. No. 09 (Overpressure distance due to UVCE for Ammonia Recirculator Outlet Line 25 mm dia. hole)



Drg. No. 10 (Maxm. Concentration due to dispersion for 25 mm dia. hole in HP Liquid Ammonia Pump Outlet Line to Ejector)



Drg. No. 11 (Maxm. Concentration due to dispersion for Liquid NH3 from NH3 Reservoir to Liquid NH3 Booster Pump Line Pressure Gauge Nozzle Failure)