5.4.2. Air Environment

344. The emission from CFCL expansion project shall be mainly from the three stacks, very limited fugitive emissions while handling product (as CFCL has urea dust collection and recovery system in bagging plant) or leakages in the plant and ammonia release while air stripping effluent water (near sump pits only in plant abnormal conditions).

- In order to mitigate the adverse environmental impact due to the operation at expanded / increased capacities following measures are recommended:
- Close watch and control are to be exercised over the quality of raw material {NG (S < 0.1 ppm) and Naphtha (S, 100-150 ppm).} being received. Increase in sulphur content will be reflected in increased SOx emission.
- The control measures (through proper up keep / maintenance) and good house keeping will considerably reduce the fugitive emission.
- Existing monitoring system of air pollutants SOx, NOx, ammonia and SPM shall be continued.
- Regular monitoring of shop floor environment is to be carried out to control the fugitive emission as well as shop floor safety.
- Leakages {of gases / liquids/ dust} shall be checked and promptly attended.

5.4.3. Noise Environment

345. The statutory national standards for noise levels at the plant boundary and at residential areas near the plant are being and are to be met. The following mitigation measures are proposed to meet the objectives:

- The selection of any new plant equipment is to be made with specification of low noise levels. Noise suppression measures such as acoustic enclosures / cabins, buffers and / or protective measures are be provided (wherever noise level is around +80 dB (A) and exposure limits to workers is more than 8 hours a day) to limit noise levels within occupational exposure limits. Areas with high noise levels are to be identified and segregated where possible and will include prominently displayed caution boards.
- However, in areas where noise levels are high and exposure time is less, employees will be provided with ear protection measures like earplugs or earmuffs. Earplug shall be provided to all workers where exposure level is > 85 dB (A). The exposure of employees working in the noisy area should be monitored regularly to ensure compliance with the regulatory requirements.
- The existing practice of regularly monitoring of noise levels is essential to assess the efficacy of maintenance schedules undertaken to reduce noise levels and noise protection measures.
- The green belt around the plant and township attenuate the noise level. Mixed plantation as well as variability in tree height and shape, to disperse the sound waves more efficiently shall be further strengthened.

5.4.4. Water Environment

346. CFCL plant has taken ample precautions to reduce water consumptions and tackle effluents problem. The philosophy of segregation of effluent streams and treatment near the source and recycle back to the system has helped in

reducing the water consumptions and effluent generation considerably. These efforts shall continue and now efforts shall be directed to:

- Increased use of treated effluents in horticulture and green belt developments.
- Recycle of treated effluents in the system as far as possible.
- The treated sewage shall be effectively utilized in the plant after further treating it through RO system (or for irrigation in green belt).
- The use of any chemical to check microbial activity shall be avoided, as it would harm the human health and fauna.
- Use of pesticide and herbicide shall be avoided as these can cause ground water contamination.
- Water is a precious commodity and it shall be further conserved.
- Rain water harvesting shall be taken up where ever possible.

5.4.5. Rsource Conservation Measures

347. Some of the key measures taken for natural resorce and energy conservation are as given below:

- Due to use of clean fuel and state of art technology, emissions are minimized.
- Proper schedule of preventive maintenance and centrifuging of oil on all critical machines is there to minimize used oil generation.
- Reduction of power consumption by optimum use of electrical lights in plants by installing timers.
- Ten nos. Solar street lights & Six nos. of Solar geysers (total capacity 2400 Liter/Day) have been installed.
- Due to Natural Draft Prilling Towers, emission of Urea dust is very low, which conserves the natural resource and increase the production.
- By proper collection of spilled urea & recycled back in process from different locations in Bagging plant.
- Running of Cooling towers on High cycle of concentration (COC ~ 10) and reducing of water losses through blow down.
- Rainwater harvesting project has been implemented phase vise for utilization of surface water during monsoon for recharging of ground water.
- Preparation of NADEP compost by recycling biodegradable horticulture waste.

348. Some of the measures are also applicable to proposed project (use of NG, CT with high COC and natural draft PT) also. Proposed project will have the advantage of latest energy efficient technology also.

5.4.6. Biological Environment

349. CFCL has developed green belt all around it and also along roads, as groves of fruit trees, as forest blocks, lawns and ornamental / flowering bushes. Mostly the trees have been planted in blocks of one particular plant – Albezzia Lebbecks, Dalbergia Sissoo, Pinnata, Termenalia Arjuna etc.

- Block plantation of same species of trees is restricted to only 10 to 15% of total population of trees.

- The trees, which have attained their age, shall be cut and new trees shall be planted.
- Proper maintenance shall be done for the avenue trees such as:
  - Avenue trees shall not block the view of road or building. This is necessary from safety and security point of view.
  - The distance of avenue trees shall not be less than 4 to 5 meters.
  - The road curbs should not have trees rather shrubs.

350. The prevailing wind direction at CFCL rotates from WNW to ESE (in Winter) and West to East (in Summer) sector most of the time with most influential zone being E and SE sector. Although wind rotates at all angles, the green belt is developed all around the industrial unit but more critically towards the windward side ESE. The fugitive emissions (if any) emitting from CFCL plant falls beyond 300 – 400 m from the source. Considering this the green belt of width 100 – 200 m in ESE direction is enough to attenuate pollutants. Thus scattered and fugitive emissions shall be taken care by the plantation inside the plant complex itself. Some of the cautions and guidelines for green belt at CFCL complex area:

- The high trees shall have ground vegetation in between to give good coverage and more attenuation area.
- The trees around the boundary walls of township and plant shall be fast growing and perennial trees.
- Block plantation shall be restricted. Mixed plantations are good for the plant growth. In the plant area more shrubs are needed close to the fugitive pollution sites.
- To maintain healthy life of the plant, diseased plants (herbs, shrubs, trees) shall be removed.

5.4.7. Land Environment

351. The expansion project will generate the solid wastes similar (in quality as well as increase in quantity) to the existing system and the existing handling system for the same is to continue. No additional measures are required.

5.4.8. Socio - economic Environment

- CFCL is carrying out various welfare programs in adjoining areas. The other agriculture related programs like horticulture, bio Fertilisers, compost from agriculture and domestic wastes through worm , bio-pesticides etc. shall be actively initiated with related agencies.
- As a good corporate citizen and major industry, CFCL may consider adopting few selected villages in developing them as model villages.
- More awareness program are to be initiated in immediate neighbouring villages about CFCL plant activities and the various EHS measures undertaken to make the plant safe and environment friendly.

5.4.9. Environment Management Cell

352. CFCL has an environment management cell headed by a senior executive supported by Dy.Manager (EQC) and other supporting staff. The plant also has well equipped quality and environmental control laboratory having sophisticated instruments including:

- Gas Chromatograph
- Water quality checker
- CO,CO_2 ppm analyser (Japan)
- BOD Incubator
- Colony Counter
- Spectrophotometer
- Naphalometer
- Atomic absorption Spectrophotometer(Hitachi Japan)
- Stack Monitoring Kits.
- Drager Pumps and tube kits
- pH Meter
- Gas Chromatograph for NG & other associated facilities.

353. A team of well trained and experienced staff carries out tests in the laboratory.

5.4.10. Post – Operational Monitoring Program

354. CFCL is carrying out environment monitoring and has necessary equipments and associated facilities. However monitoring plan proposed is as follows:

Discipline	Location	Parameter	Frequency	Remarks
Meteorology	One	Temp.{max.; min.}; Relative humidity; Rain fall; Wind speed and direction.	Daily	Being complied
Ambient Air Quality	Five	SPM,SOX, NOx, RPM and CO	Twice a week	Being complied
Stack Emission	All continuous stacks	SPM, NOx,SOx,NH_3 & CO (as applicable0	Once a week;	Being complied
Effluents	Final effluents discharge point	pH, Free NH3, TAN; TKN; NO_3;SS; PO_4, Oil-grease; COD; BOD	Once a day.	Being complied
	Sanitary	TSS; BOD	Weekly	Being complied
Ground Water Quality	{Wells / Hand pumps}	pH, NO_3, Floride,NH_3 & PO_4	Monthly	Being complied
Surface Water Quality (Up stream & Down stream) of Kali-Sindh River	Two (100 mt up & 100 mt down from discharge point)	pH, Nitrogen(Amm.; Nitrate, TKN); TSS; pH, NH_3, NO_3, PO_4, Oil-grease;	Weekly	Being complied
Noise	Plant area & periphery	Day & Night time noise level	Monthly	Being complied

Discipline	Location	Parameter	Frequency	Remarks
Health Check Up	All Plant Personnel	Disease of eyes, ears and chest	Annually	Being complied

6. HAZARD EVALUATION & RISK ANALYSIS

6.1. Introduction

355. Industrial plants deal with materials, which are generally hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of these. Fire, explosion, toxic release or combinations of these are the hazards associated with industrial plants using hazardous chemicals. More comprehensive, systematic and sophisticated methods of **Safety Engineering,** such as, **Hazard Analysis** and **Risk Assessment** have now been developed to improve upon the integrity, reliability and safety of industrial plants.

356. The primary emphasis in safety engineering is to reduce risk to human life, property and environment. Some of the more important methods used to achieve this are:

357. **Risk Analysis:** Provides a relative measure of the likelihood and severity of various possible hazardous events by critically examining the plant process and design.

358. **Work Safety Analysis:** The technique discerns whether the plant layout and operating procedures in practice have any inherent infirmities.

359. **Safety Audit:** Takes a careful look at plant operating conditions, work practices and work environments to detect unsafe conditions.

360. Together, these three broad tools attempt to minimize the chances of accidents occurring. Yet, there always exists, no matter how remote, probability of occurrence of a major accident. If the accident involves highly hazardous chemicals in sufficiently large quantities, the consequences may be serious to the plant, to surrounding areas and the populations residing therein.

361. To meet emergencies caused by such major accidents, planning response strategies are termed as **On-site Emergency Plan /Disaster Management Plan (DMP)**.

362. DMP cannot be considered in isolation or act as a substitute for maintaining good safety standards in a plant. The best way to protect against a major accident occurrence is by maintaining very high levels of safety standards.

6.2. Hazards Survey

363. Hazard identification and risk assessment studies can be performed at any stage, that is, at initial design stage or as on going operation in the system. Hazard survey is a formal systematized approach employed for hazard identification.

364. Appraisal of material characteristics from Material Safety Data Sheet for various materials and chemicals used or produced in the fertilizer plant of Chambal Fertilisers and Chemicals Limited (CFCL) indicates that some of the materials are highly inflammable/explosive (Natural Gas/Naphtha) and some are toxic (Ammonia / Chlorine etc.). In addition some of the intermediate materials produced in the process (hydrogen and carbon monoxide) are extremely dangerous considering the process conditions.

365. All process materials which are capable of producing accidents/hazards owing to their physical and chemical properties are identified and on the basis of material movement, hold ups are calculated. Quantities in the pipelines are also taken in to account. Large and sub-sequential inventories in storage or process are indicative of the potential hazards to the plant and its surroundings. Flammability and toxicity factors of these inventories can lead to the unpredictable incidents.

366. CFCL is producing urea for agriculture use. The major raw materials and other consumable used are given in **Table 6.1**. Most of the materials consumed (except Naphtha, Ammonia, Chlorine) are non hazardous in nature. However, the materials in the process i.e. NG, hydrogen, carbon monoxide and ammonia are highly hazardous. The consequence of hazards is enhanced considering the process conditions (high temperature and pressure). These materials need to be handled very carefully to ensure safety.

Table 6.1 : Important Materials Storages

Sr. No	Storage Tank		Capacity	Remarks
	Material	Location		
1.	Caustic Lye	DM-1	33.35 MT	Caustic Inventory ~ 40 MT (max.)
2.	Caustic Lye	DM-2	90.00 MT	
3.	Hydrochloric Acid	DM-1	118 MT	HCl Inventory ~90MT (max.)
4.	Hydrochloric Acid	DM-1	75 MT	
5.	Hydrochloric Acid	DM-2	70 MT	
6.	Ammonia Storage	Amm Storage Area	2X5000MT	Ammonia Inventory ~ 4000 MT (max.)
7.	Naphtha Storage(Old)	Naphtha Storage Area	2X3500 MT	Since April 2006 CFCL-Phase –II Plant has also started receiving R-LNG resulting in to substantial reduction of naphtha inventory only 5000KL (max.).
8.	Naphtha Storage(New)	Naphtha Storage Area	3X10000MT	
9.	Naphtha Day tank	SPG	420 MT	
10.	Naphtha Day tank	Amm-II	2234 KL	
11.	Naphtha Day tank	Amm-II	1745 KL	
12.	HSD	SPG	2X20 KL	
13.	HSD	Amm-II	20 KL	
14.	Sulphuric Acid	Phase –I Cooling Tower	90 MT	Sulphuric acid ~ 70 MT (max)
15.	Sulphuric Acid	Phase –II Cooling Tower	30 MT	

6.3. Hazard Evaluation

367. The evaluation phase determines the extent and degree of employee's exposure to toxicants and other physical hazards in the work place environment. In the case of major accident/breakdown occurrences, hazards exposure may cross plant boundary limit and persons/properties in the neighboring areas may be exposed. During the evaluation study, the likelihood of large and small leaks is also considered. Hazardous substances may be released as a result of leaks or catastrophic failures causing possible damage to the surrounding areas. The extent of damage will depend upon the nature of release. The release of flammable and toxic materials and subsequent ignition results in heat radiation, pressure wave or vapour cloud depending upon the flammability, toxicity and its physical state.

368. Sudden exposure to high concentrations of toxic chemicals via leaks or operational upsets (relief valve pop up) may lead to acute effects, such as, unconsciousness, burning eyes, fits of coughing, etc.

369. Chronic effect, however, arises by repeated exposure to toxic chemical concentrations mostly by small leak. Many fine toxic dusts or vapors are invisible, colorless and odorless (CO). Small leaks of these substances might not become obvious for months or even years.

6.4. Potential Hazards

370. Accidental release of flammable or toxic vapours can result in severe consequences. Delayed ignition of flammable vapours can result in blast overpressures covering large areas. This may lead to extensive loss of life and property. Toxic clouds may cover yet larger distances due to lower threshold values in relation to those in case of explosive clouds (the lower explosive limits).In contrast fires have localized consequences. Fires can be put out or contained in most cases; there are few mitigating actions one can take once vapour clouds get released. Therefore, major accident hazards occur upon release of ***flammable or toxic vapours or BLEVE*** in case of pressurized flammable liquefied gases.

6.4.1. Toxic Release

371. In CFCL complex some hazards arises due to production, transfer, storage, handling and processing of liquefied ammonia. In case of fully refrigerated liquid ammonia release, instantaneous flash due to adiabatic expansion is negligibly small. Evaporation due to aerosol formation also does not occur. Release of liquid ammonia at pressure (in ammonia plant synthesis section), gives rise to flash evaporation equivalent of the initial flash due to adiabatic expansion. In case of HP ammonia stored at near ambient temperature liquid released would completely vaporize with no pool formation. Ejection of high pressure ammonia appears to entrain 10 to 15 times of its own weight of air enough to evaporate nearly all the liquid. Thus if an HP release occurs unimpeded the ammonia entrains sufficient air to evaporate all the droplets carried out with flash.

6.4.2. Flammable Release

372. The flammable materials used at CFCL, involve natural gas used as feedstock, fuel gas and synthesis gas produced in ammonia plant upstream of Synthesis converter, and naphtha. The hydrogen rich synthesis gas or CO/ hydrogen rich gas on release under momentum would ignite due to reverse Joule Thompson effect that shall result in an increase in temperature to a value higher than the auto-ignition temperature. In certain section of the plant the operating temperature itself exceeds the auto-ignition temperature of hydrogen and carbon monoxide. In all such cases due to immediate ignition, a jet flame will result.

6.4.3. Jet Release

373. Generally when a gas flows out of an opening at high velocity a turbulent free jet invariably results. The out-flowing gas entrains a large quantity of the ambient air. The net results being the jet getting diluted to LEL within the short distance from the release point. If ignited the jet flame results, but if the released material does not get ignited immediately then the possibility of vapour cloud explosion on delayed ignition is very remote because by this time free jet has lost its momentum and the mass can begin to disperse due to environmental forces {the concentration of flammable material has already fallen below the LEL}.

374. No vapour cloud explosion has therefore been considered. Jet flames due to impingement on the adjoining important installations can lead to secondary effects (domino effect). In certain cases the domino effects could lead/ result in loss of containment of ammonia with serious consequences. The toxic effect of carbon -monoxide has also not been considered since any such release due to high system operating pressure (and consequent high momentum) will either get diluted to low concentrations within short distance from the source due to air entrainment or will get ignited and hence the consequence distance will be rather small.

6.5. Inventory Analysis

375. Inventory plays an important part in regard to the potential hazard. Larger the inventory of the vessel or a system, the larger the quantity of potential release. A practice commonly used to generate an incident list is to consider the potential leaks and major releases from fractures of pipelines and vessels containing sizable inventories. The potential vapour release (source strength) depends upon the quantity of liquid release, the property of the materials and the operating conditions (pressure). These when combined into matrix and vapour source strength computed for each release case, a ranking shall become a credible exercise. Plant inventory can get discharged to environment due to loss of containment.

376. From the preliminary risk assessment study carried out for each participating unit, some of the possible hazards have been identified. The likely accident scenarios considered are given below:

Table 6.2 : Likely Accident Scenario

Sl. No.	Scenario	Vulnerability Zone	Remarks
1.	Rupture in NG line	Area close to leak / release	Isolate the line / area; Cool / drench / dilute the source point to prevent ignition.
2.	Hole in Naphtha line / tank	Area adjoining leak / tank farm	Isolate the line / area; Cover the spillage with foam / reclaim if possible to prevent ignition.
3.	Ammonia line leakage and spillage	Surrounding Area	Isolate the line / area. Approach with gas mask / lifeline. Dissolve in water and store and treat the water gradually.
4.	Chlorine Tonner Leakage	Surrounding Area	Isolate the line / area. Approach with gas mask / lifeline. Cover the cylinder with hood, take a vent line from hood to caustic scrubber.

377. The above mentioned hazards scenarios can further aggravate into much more serious incidents if not intercepted in time. The fire in one tank of tank farm can spread to adjoining tanks and may result in explosions. The vulnerability zone will be considerably enlarged. The vapors of toxic fluids/dust if carried away by wind above TLV concentrations may further enlarge the vulnerability zone. Similarly, toxic fluid spillage and all wastes leaving the live processing zone if not decontaminated properly can cause serious health hazard to plant personnel and persons in nearby area.

6.6. Methodology, Approach and Damage Criteria for Risk assessment

378. Consequence analysis is that part of risk analysis, which considers individual failure cases, and the damage caused by the failure cases. It is done to predict the outcome of potentially serious hazardous accidents to man and material in and around the plant boundary limits. The advantages of carrying out consequence analysis are given below:

- To improve plant layout
- To meet statutory requirements
- Protection of public in the nearby areas
- Disaster management planning
- Training tool

379. The findings of a consequence analysis provide information about hazardous effects resulting from an accidental scenario. In addition, methods for dealing with possible catastrophic events are also provided.

6.6.1. Damage Criteria

380. In order to understand the damages produced by various scenarios, it is appropriate to discuss the physiological/physical effects of thermal radiation intensities. The thermal radiation due to tank fire usually results in burn on the human body. Furthermore, inanimate objects like equipment, piping, cables, etc. may also be affected and also need to be evaluated for damages. **Table - 6.2** and **Table -6.3** respectively give tolerable intensities of various objects and desirable escape time for thermal radiation.

Table 6.3 : Effects due to Incident Radiation Intensity

Incident Radiation kW/m^2	Damage Type
0.7	Equivalent to Solar Radiation
1.6	No discomfort on long duration
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burn are likely).
9.5	Pain threshold reached after 8 sec. Second degree burn after 20 sec.
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing etc.

Table 6.4 : Thermal Radiation Impact to Human

Exposure Duration (sec)	Radiation Energy {1% lethality; kW/m^2}	Radiation Energy for 2^{nd} degree burns; kW/m^2	Radiation Energy for 1st degree burns; kW/m^2
10	21.2	16	12.5
30	9.3	7.0	4.0

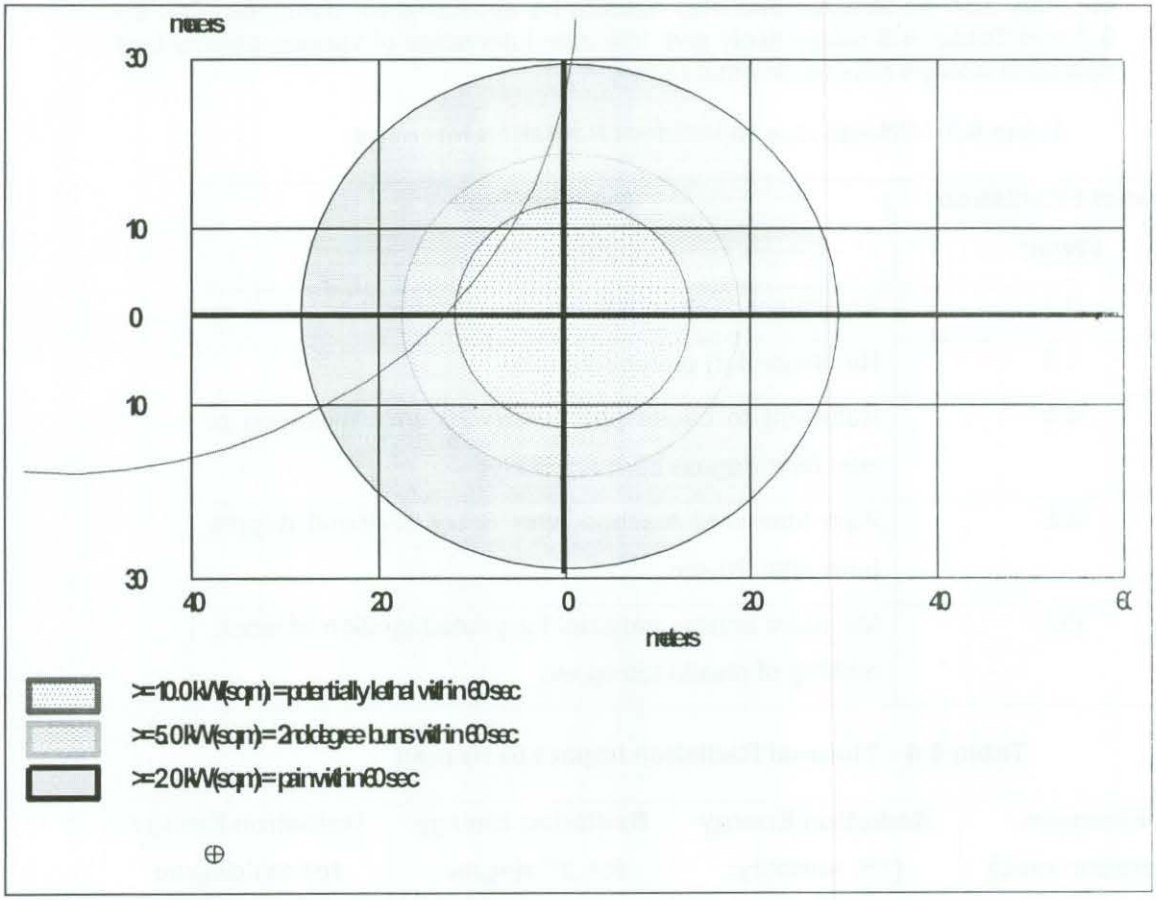
6.6.2. Selected Failure Cases

381. Few accidental scenarios have been considered and subjected to consequence analysis / damage zone.

6.6.2.1 Rupture in NG Line

382. NG consisting of 98 % methane is the main raw material (Balance higher hydro carbons and other gases) and is used to generate hydrogen to fix atmospheric nitrogen as ammonia. Any leakage in the pipe line {through flange joint / valve/ instrumentation fittings/ welding failure} would result in hazardous situation. NG will be released at pressure (+ 30 kg/cm2) and also at high temperature (depending upon the leakage point in the process).

- Ambient Temperature : 35^0 C
- Leak source size : ~ 50 mm
- Burning Rate : 577 kg / min.
- Incident : Flash fire



383. **Threat Zone**: Threat Modeled for the thermal radiation from jet fire.

- Red: 14 m --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- Orange: 19 m --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- Yellow: 30 m --- (2.0 kW/(sq m) = pain within 60 sec)

6.6.2.2 Hole in Naptha Line/ Tank

384. The two large naphtha storage tanks and transfer lines are the likely sources of leakages. The leaked naphtha will form a pool and incase of the naphtha catching fire, the radiation intensity / thermal load on the adjoining area / material has been assessed as below.

- Ambient Temperature : 30^0C
- Leaked Naphtha Pool Diameter : 20 m
- Intensity of Radiation : 71.6 kW / m^2