Risk Analysis

For hazard identification, maximum credible accident (MCA) scenarios have been assessed. The maximum credible accident has been characterized as an accident with a maximum damage potential and the occurrence of which is most probable. Based on MCA scenario, the following hazards were identified from this project.

a) Fire in 2 x 150 KL Fuel Tanks: Light Diesel Oil is viscous mixture of aromatic hydrocarbons with flash point and auto ignition point higher than naphtha and petrol. It is flammable and needs source of ignition to catch fire. Its vapour pressure is also higher than its other counterparts. Hence, fire risk due to storage and handling of LDO is less compared to naphtha, petrol. LDO have boiling point above the ambient temperature and therefore stored in tanks under normal atmospheric pressure and temperature. Continuous release of such non-boiling liquids from vessels due to leaks will form a contained pool inside the dyke area of the Tank. Upon ignition the liquid pool will result in pool fire. In case of ignition of the hydrocarbon vapour-air mixture present near rim seals and rim vents of storage tanks, tank fire will occur.

Pool fire and Tank fire falls under MCA scenario. The heat radiation effect distances for the largest tank combination are described below.

1st degree burn - 4.0 KW/m^2
1% fatality - 12.7 KW/m^2 for 20 seconds exposure [EIA manual of MOEF prescribes thermal limit of 12.7 for 20 seconds exposure]
50% fatality - 25.0 KW/m^2
99%fatality - 37.5 KW/m^2

The following assumptions have been considered during modeling:
Steady state burning has been assumed.
A surface radiation flux of 120 KW/m^2
The flame is cylindrical in shape with the diameter based on the hydraulic diameter of the spillage area.
The flames maintain a constant and uniform surface heat flux. No account is made for the pulsation effects.
The effect of wind speed on the flame length is considered insignificant.

Computer Aided Management of Emergency Operations (CAMEO) and USEPA guidelines (Central Federal Register - CFR 40, Part 68, 1998 titled “Chemical Accident Prevention Provision”) have been followed for risk assessment. Wind speed affects the flame parameters in two ways, namely flame length and flame tilt. At a low wind speed, the flame length is more, which reduces with increase in wind speed, whereas the tilting of the flame in the direction of wind increases with higher wind speed. Hence a largely tilted flame intensifies radiation at any point in the direction of wind and on the contrary large flame length poses greater threat at any point from radiation point of view. For similar fire sizes the effect distances under 3 m/s wind speed is significantly larger than those distances under 1.5 m/s wind speed. This is due to tilting of flame under higher wind speeds (21 to 47 degrees tilt). For 1.5 m/s stable atmosphere (F class stability), 5 degree tilt has been considered in the cases of pool fire.

Consequence of Fire: The summary of the consequence modeling results for Pool fire is shown below:

Endpoint distance [1% fatality – 8.3 KW/m^2 for 20 seconds exposure]

In case of pool fire, the thermal damage for 1% fatality under 3 m/s wind speed, B class stability is 8.8 m. In case of pool fire, the thermal damage for 1% fatality under 1.5 m/s wind speed, E class stability is 5.5 m.

b) BF Gas Leakage: The blast furnace gas will be collected and transported through a pipeline network to the various reuse points. Any leakage of the gas and subsequent ignition may cause explosion / fire. Inhalation to the gas may also result in fatality. By adopting good engineering design, quality equipment and regular maintenance, risks due to such incidents can be minimised. CO detectors will be installed at strategic locations and any leakage of the gas will be detected through the electrochemical sensors of the CO detector probes. In the event of CO detection, the relevant hooter will hoot. The plant personal working in these areas will be evacuated immediately by the emergency response team and medical aid provided to employee exposed to the gas.

The Blast Furnace gas is odorless, poisonous and inflammable because of large amount of carbon monoxide. The gas will be handled, stored and reused for various purposes within the steel plant. Necessary risk mitigation measures will be provided. In case a person inhales CO, he would be removed to fresh air and kept calm and given mediated oxygen through a mask for 30 minutes and if required cardiopulmonary resuscitation would be performed. Thereafter, supportive treatment will be given in the hospital.

c) Fire in coal yard: This is the most common accident known to occur in any plant storing and handling coal. Since such incident takes sufficient time to get widespread, enough response time is available for plant personnel to get away to safer distance. An elaborate fire hydrant network and fire fighting system comprising of trained crew and facilities will mitigate the risk of such incidents. In case of bunkers / tunnel, alarm system and smoke detectors should be installed.

d) Handling of hot metal and slag: Sudden break out of molten metal and slag has been known to take place during furnace operation. The break out may take place from weak portions of furnace. Spillage of hot metal or slag can cause severe burn injuries and fires. Explosions may also occur due to hot metal or slag falling in a pool of water resulting in injuries and fire due to flying hot splinters and splashing of hot metal or slag. The spillage of hot metal can also be due to hearth breakage, mould breakage and during transportation. The accidents can occur due to failure of water-cooled panels, puncture in water-cooled lances, leakage of water from the walls of mould. Through regular checks and proper upkeep of furnace refractory and cooling panels such incidents can be avoided. The consequences will result in death (extreme case), severe burn and mechanical injury and limited to working personnel near the site of incident. By adopting good engineering design and quality equipment and regular maintenance, risks due to such incidents can be minimised.

e) Leakage and spill of chemicals: Chemicals like sodium hydroxide and hydrochloric acid will be stored for use in the DM plant. Handling of these chemicals is risky for plant personnel. Other water treatment chemicals like flocculent, polyelectrolyte, lime, etc do not posses any risk. Caustic and acid are corrosive and contact due to their spill will cause burn injury to plant personnel. Personnel involved in handling of these chemicals will be properly trained and made aware of the safety data and related first-aid measures. Water tap/jet will be installed near the DM plant so that the affected personnel can thoroughly wash in case of acid / base contact incident. Therefore accidental risk due to spill of chemicals can be minimised.

f) Mechanical injury to body parts: In a steel plant there are several palaces where workers are likely to be involved with accidents resulting in injury to body parts. The places are workshop, during mechanical repair work in different units, during construction work, road accidents due to vehicular movement, etc, etc. Workers exposed to mechanical accident-prone areas will be given personal protective equipment. The non-respiratory PPE includes tight rubber goggles, safety helmets, welders hand shields and welding helmets, plastic face shields, ear plugs, ear muffs, rubber aprons, rubber gloves, shoes with non-skid soles, gum boots, safety shoe with toe protection.

The likelihood of accidents and hazards has been assessed. The assessment of the potential likelihood of each scenario concluded that three of the scenarios pose a likelihood of ‘low’, and the three scenarios pose a likelihood of ‘medium’. This was primarily as a result of following considerations:

- The chemical or material released not reaching an off-site receptor, due to the nature of the chemical or some form of on-site containment;
- The chemical not being sufficiently toxic, or present at a particular environmental receptor for a sufficient period of time, or at a sufficient level, to have an adverse effect on that receptor; and
- The absence of any significant environmental receptors in the vicinity of the site that could be affected by a release of any of the chemicals and materials released.

Risk Mitigation Measures

1. Appropriate storage facilities shall be provided for special requirements such as for substances that are flammable and incompatible by-product and waste types shall be kept separate.
2. After constructing the plant and based on actual inventorization of hazardous chemicals that are stored inside the premises, their exact location and appointment of O&M staff, JSL project management team shall carry out a detailed hazard analysis. The existing On-site and Off-site Disaster Management Plan shall be then upgraded. Name and contact numbers of plant personal, concerned government officials, police station, fire station, ambulance, district hospital staff should be updated in the plan.
3. Passive mitigation measures that shall be considered are dyke walls around the liquid fuel storage tanks, enclosures, drains, sumps, fire walls, etc, wherever necessary. Adequate capacity dyke wall around the tank to contain the entire volume of tank in case of spill should be made.
4. Fuel tanks and LPG Bullets shall be located at least 50 m away from the plant boundary so that societal risk is avoided.
5. Active mitigation measures that shall be considered are water sprinkler system, water curtain, flares, scrubbers, emergency shut down system, etc.
6. In case of spill or leaks in storage tanks leading to containment of flammable liquid, vaporisation should be avoided by placing fume suppression chemicals over the surface of liquid [they provide a curtain over relevant sections]. Water spray systems or foaming systems should be used over storage tanks, and storage vessels.
7. Emergency isolation valves at critical locations on equipments / pipings shall be placed to isolate high inventory of hydrocarbons.
8. Nitrogen / steam purging facilities shall be provided on critical equipment / system for driving out hydrocarbons.
9. Non-essential plant personnel (office staff, administration and accounts staff) shall be located away from the storage area outside the zone of 4 KW/m^2 radiation intensity.
10. All hazardous storage systems shall be designed with safety features as appropriate and recommended to enhance the safety against design failure.
11. Pumps of reliable quality shall be installed. Arrangements should be made around the pumps so that leaks from glands, valves or joints can be contained locally.
12. Earthing of road tankers carrying flammable chemicals shall be made before unloading to eliminate possibility of static sparks.
13. All lighting and electrical equipment in the unloading area and flammable chemicals storage area shall be suitable to the area classification approved by Competent Authority.
14. Safety showers and eyewash fountains shall be provided in section where caustic soda, acid and other corrosive or reactive chemicals are handled.
15. Pressure detectors shall be installed for oil & gas transportation pipelines, the indication of which shall be seen in the control room. This would enable the control room to detect any leakage in the pipelines forwarding fuels / products.

16. Hydrocarbon detectors shall be provided at strategic locations.
17. Minor leaks could occur in routine operations, like pump seal failure, flange leak, sample point valve left open or drain valve left open. These shall be checked regularly by a preventive maintenance program and rectified immediately.
18. Corrosion protection methods for pipelines shall be done. All locations where the above ground pipelines are close to traffic movement, protection like crash guards shall be provided.
19. For containment of fire and preventing it from spreading in cable galleries, section wise fire barriers with self-closing fire resistant doors will be provided. The ventilation systems provided in cable galleries will be interlocked with the fire alarm system, so that in the event of a fire, the ventilation system gets automatically switched off. In order to avoid spreading of fire, all cable entries/openings in cable galleries, tunnels, channels, floors, barriers etc. will be sealed with non-inflammable/fire resistant sealing materials.
20. Fire hydrant points will be provided throughout the steel plant premises. Medium velocity spray system will be provided for protection of transformers, cable galleries, fuel oil and turbine oil storage tanks and coal conveyor galleries. Water for hydrant, spray and sprinkler systems will be supplied from the fire water pumps located in fire water pump house adjacent to cooling water pond. The hydrant system is designed as an ordinary hazard class. Portable fire extinguishers are provided at strategic locations throughout the plant. Fire detection and alarm system will be provided to detect fire/smoke in vulnerable areas of the plant through smoke / heat detectors.
21. Existing DMP will be upgraded to meet the new requirement of the proposed plant.

Risk Mititgation Measures in Existing Pellet Plant

Fire Fighting System: Effective measures have been implemented to minimise fire hazard. Fire protection through hydrant and sprinkler system has been designed as per the recommendation of Tariff Advisory Committee of Insurance Association of India. The following areas in the plant are taken care:

Electrical switchgear / MCC room.
Coal handling area
Transformers

All safety and health codes prescribed by the BIS have been implemented in the existing Pellet Plant. Safety data sheets of the hazardous chemicals are displayed at specific locations. Fire hydrants are located at all convenient and strategic points along the major drains and checked for water availability on regular basis. Fire extinguishing equipment, sand buckets, water sprinklers and water hoses are provided at all convenient point. Fire, heat, smoke and hydrocarbon detection alarms will be installed.

On-site disaster management plan has been prepared. The plan contains the name and contact number of plant personnel, district officials, police station, fire station, and hospitals.

Disaster Management Plan

The quantum of risk posed by an industry depends not only on the hazardous chemicals being used, stored, handled or manufactured, but also on the industry management, level of safety awareness among employees and the safe practices and preventive measures followed while handling these chemicals. The main areas considered for management capability are as follows:

Compliance with existing Rules and Regulations: The following statutory provisions to be complied by JSL:

The MSIHC Rules, 1989/2000 notified under the Environment Protection Act, 1986.
Rules on Emergency planning, Preparedness and Response for Chemical Accidents.
Hazardous Wastes (Management and Handling Rules) 2000
Factories Act, 1987 (Amended)
Public Liability Insurance Act, 1991
Air Act, 1981 and Water Act, 1974

Engineering Aspects: This includes the factory layout and following general features of the facility.

1. Demarcation with proper boundary wall
2. Green belt and buffer zone
3. Segregation of process and utility blocks
4. Access for emergency vehicle movement
5. Adequacy of exit and entry points
6. Ventilation of process area
7. Dyking of hazardous material storage tanks
8. Source of process knowhow and documentation
9. Use of codes and standards
10. Third party inspection

Process Aspects: This include the process safety angle like reaction characterization (is the reaction well characterized in terms of runaway potential, exotherms, heat of reaction, etc.), existence of high temperature pressure alarms, back up indicators, annunciate panel, etc. and existence of process control through PLC, single loop controls, interlocks, etc.

Emergency response: It includes the emergency preparedness of the installation like

1. Working on-site emergency plan
2. Fire protection system in terms of fire water storage, hydrant, sprinkler, foam, fire alarms, smoke detectors and gas detectors
3. Emergency power
4. First aid, emergency vehicle and medical provisions
5. Back-up communication
6. Training and mock drill
7. Personnel Protective Equipment and Self contained breathing apparatus

Management System**:** It includes the management commitment within the organisation.

Existence of professionals in key factory positions
Safety, health and environment function
ISO 14001, ISO 18001 and ISO 9001 certification, safety and environment policy
System for recording near miss and accident investigation
Workers awareness of hazards involved

Operation and Maintenance System: This includes
Existence of SOP for all critical operations
Inerting systems used for reactors, tanks, pipelines, etc.

Earthing system
Preventive maintenance system
System for implementing plant modifications

The aim of hazard control and disaster management is concerned with preventing accidents through standard design and efficient operation, preventive maintenance, inspection and proper usage of safety measures by which it is possible to reduce the risk of an accident. JSL will coordinate with the District Administration and adopt all measures to minimize the effect of disaster. The objective should be to localize the emergency and, if possible, eliminate it and minimize the effects of the disaster on workforce and surrounding community. This EMP formulates a procedure for controlling disaster with minimum damage to men, material and machines, evacuating the victims to safer places, rescuing the victims and providing them medical treatment, rehabilitating the affected areas, delegating specific tasks to staff (avoid overlapping of activities within various groups) and preserving relevant records as evidence in any subsequent inquiry.

1. Elimination of hazards will require prompt action by operators and emergency staff and mobilizing fire-fighting equipment, emergency shut-off valves and water sprays. To minimize the effects of a disaster, prompt operation for providing rescue, first aid, evacuation, rehabilitation and right information to people living in nearby areas is necessary.
2. Emergency team leader is called site main controller (SMC) who should be the plant manager. He should lead the emergency response team. In his absence the senior most person available at plant should act as emergency team leader. Besides the top officials described above, rest of the employees should be divided into three action teams namely A, B, C. Action team A consists of staff of section in which accident has occurred. Action team B consists of staff of non-affected section and maintenance department. Action team C consists of supporting staff i.e. security supervisor, shift supervisor and ancillary people comprising of contractor, labour.
3. Team A will initiate action in case of an emergency. Team B will help team A by remaining in their respective sections and preparing to comply with specific instructions of SMC. Team C consisting of supporting staff will help Team A as and when required and receive direction from Team B to act. Team C will help in evacuating the affected personal to safer place, under the supervision of Team B. A multi-channel communication network will connect Site Emergency Control Room (SECR) to control rooms of various other departments and the nearest fire station, medical centre and district hospital.
4. The onsite emergency will in all probability commence with fire or burns and the victims will be the members of operational staff on duty. In case a staff member on duty spots the emergency, he (as per site emergency procedure of which he is adequately briefed) should go to nearest emergency (fire) alarm location. He should try his best to inform the exact location and nature of emergency to the fire fighting station. In accordance with work emergency procedure, the following key activities should immediately take place to control the emergency.
5. On site crew should arrive at the site of incident with fire extinguishers and necessary equipment.
6. Emergency security controller should commence his role from main gate office.

7. Incident controller should arrive at SECR with members of his advisory and communication team and assume absolute control of the site. He should receive information continuously from incident controller and give decisions and directions to the following:
   a) Incident controller
   b) Plant control rooms
   c) Emergency security officer
   d) Site or shift medical officer
8. After all the key emergency personnel have taken up their respective positions, the incident controller should use communication system to convey and receive the messages. At the site of incident the incident controller should directly handle the emergency with the help of specific support group such as Team C and fire fighting personnel. At the main gate, the Emergency Security Controller and Personnel Manager will contact external agencies. At the site medical center / first aid center, the Medical Officer will take control of medical support services. Site Main Controller should direct and decide all issues and direct the following aspects:
   a. Whether the incident controller requires reinforcement of manpower and facilities.
   b. Whether the plant operation should be shut down or kept in running condition.
   c. Whether the staff in other locations should be kept indoors or evacuated and assembled at predefined safe areas.
   d. Whether the missing staff members should be searched or rescued.
   e. Whether off-site emergency plan should be activated and message to that effect should be sent to the District Headquarter / Administration.
   f. Whether and when outside emergency services should be called.
   g. Respond to any large size complaints from outside public and to assess an off-site impact arising out of the on-site emergency.
9. On receiving the message of Disaster from site main controller (SMC), fire control room attendant should sound siren ‘wailing type’ for 5 minutes. Incident controller should arrange to broadcast disaster message through public address system. On receiving the message of ‘Emergency Over’ from incident controller the fire control room attendant should sound alarm ‘All Clear Signal’ straight for two minutes. The features of alarm system will be explained to one and all to avoid panic or misunderstanding during disaster.
10. On receiving the signal following actions will be taken:
    a. All the members of advisory committee, personnel manager, security controller, etc. shall reach the SECR.
    b. The process unit persons will remain ready in their respective units for crash shutdown on the instruction from SECR.
    c. The persons from other sections will report to their respective officer.
11. The concerned section will take immediate action to remove contractor’s personnel outside the plant gate.When the incident has eventually been brought under control as declared by the incident controller, the SMC will send two members of his advisory team as incident site for the following purpose:

a. To conduct an on-the-spot assessment of total damage and prevalent condition with particular attention to possibility of recurrence of the emergency situation, this may be temporarily under control.

b. To inspect other parts of site which might has been affected by impact of incident.

c. To inspect the personnel collection centers and roll call centers, to check if all persons on duty have been accounted for.

d. To inspect all the control rooms of the plant in order to assess and record the status of respective plants and to supervise any residual action that is deemed necessary.

12. Once the emergency situation comes under control, the advisory team should return to SECR with their observations, report and submit the findings in writing to SMC. Based on the reports, SMC should communicate further directives to all emergency management sub-centers and finally declare and communicate termination of emergency and authorize step by step restoration of normal operation of the affected plant. Emergency security controller and personnel manager should deal with all the members of public and other local bodies from the main gate office. During the entire period of emergency, the site should remain out of bounds to external visitors except for the following officials:

a. District fire personnel

b. District hospital ambulance staff

c. Civil/ Defence personnel

d. District administration

e. Factory Inspectorate Officers and Labour Commissioner

f. Officers of State Pollution Control Board

g. Insurance authorities.

13. Effective working of rescue team is essential during the disaster. In order to make the services of rescue team more effective following equipment will be provided to the team.

a. Chemical cartridge type gas mask (self-contained breathing apparatus)
b. Self rescue type gas filters (with oxygen cylinder or compressed air)
c. Mechanical filters
d. Fire proximity suits, asbestos aprons or aluminized asbestos suits)
e. Safety helmets
f. Face shields (Asbestos or PVC)
g. Petromax lamp/Torches
h. Axes/hand saw
i. Fire entry suits
j. Fire blankets
k. Gloves (PVC, asbestos, special rubber make)
l. Ropes
m. Ladders
n. Rubber glove (tested upto 25000 volt.)
o. Blanket
p. Rubber sole shoes and gum boots
q. Safety shoes with toe protection
r. Shoes with non-skid soles
s. Safety belt with life line (leather, hard rubber or neoprene)

14. In view of vulnerability to fire, effective measures have been considered to minimize fire hazard. Fire protection is envisaged through hydrant and sprinkler system, designed as per the recommendation of Tariff Advisory Committee of Insurance Association of India / Loss Prevention Association of India.

15. For detection and protection of the plant against fire hazard, any one or a combination of the following systems will protect susceptible areas:

a. Hydrant system
b. Medium velocity spray system
c. Portable fire extinguishers
d. Fire alarm system

16. Fire hydrant points shall be provided at all necessary places. Medium velocity spray system shall be provided for protection of transformers, cable galleries and coal storage areas. Water for hydrant, spray and sprinkler systems shall be supplied from the fire-water pumps located in water pump house. The hydrant system should be designed as an ordinary hazard class. Adequate number of portable and mobile chemical fire extinguishers (Carbon dioxide, dry chemical powder, foam types) shall be provided at strategic locations throughout the plant. Fire detection, heat detection, hydrocarbon detection and alarm system should be provided to detect fire/ heat/ smoke/ hydrocarbons in vulnerable areas of the plant.