RISK ASSESSMENT

INTRODUCTION

Risk analysis deals with the identification and quantification of risks, the plant equipment's and personnel are exposed to, due to accidents resulting from the hazards present in the factory. Hazard analysis involves the identification and quantification of the various hazards that are likely to occur in the industry.

Both hazard and risk analysis are very extensive studies, and require a very detailed design and engineering information.

The various hazard analysis techniques that may be applied are Hazard and Operability (HAZOP) studies, Fault - Tree Analysis (FTA), event –tree analysis and, failure and effects mode analysis.

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a through knowledge of failure probability, credible accident scenario, vulnerability of populations etc. Much of these information's are difficult to get or generate. Consequently, the risk analysis is oftenly confined to maximum creditable accident studies.

SCOPE OF THE STUDY

The scope of study includes the study of proposed operations, storage and handling of raw materials with respect to Hazard Identification. Risk Assessment and preparation of Disaster Management plan. Based on the Hazard Identification and analysis, the major disaster scenarios would be worked out to estimate the consequence of failure. A Disaster Management Plan (DMP) would also be evolved to meet the emergency situation including the occupational health and safety.

FIRE PROTECTION SYSTEM

The following Fire Protection system will be provided in the plant.

- Hydrant system covering the entire plant including all important auxiliaries and buildings. The system will be complete with piping, valves, instrumentation, hoses, nozzles and hydrants, etc.
- Sprinkler system for cable galleries / vaults / spreader room etc.
- High velocity water system for FO storage tanks.
- Portable fire extinguishers such as pressurized water type, carbon dioxide type and foam type will be located at strategic locations throughout the plant.

- Modular type carbon dioxide panel injection fire extinguishing system will be provided in control equipment room, cable space below control room and at other unmanned electrical and electronic equipment room.

The following pumps will be provided in the fire protection system.

Fire water pumps:

(Fire water reservoir is part of the main water reservoir)

a) AC motor driven fire water pumps for hydrant, medium velocity water spray system and foam system.

b) AC motor driven fire water pumps for high velocity water spray system.

c) Diesel engine driven pump as stand by for the above.

d) AC motor driven Jackey pump 1 No. for maintaining pressure.

Suitable number of electric motor driven and diesel engine operated hydrant and spray pumps with automatic starting will be provided for the above systems. The fire water pumps will take suction from the fire water reservoir to be created in the plant area.

METHODOLOGY OF MCA ANALYSIS

The MCA Analysis involved ordering and ranking of various sections in terms of potential vulnerability. The following steps were involved in MCA Analysis.

- Preparation of an inventory of major storages and rank them on the basis of their hazardous properties.
- Identification of potentially hazardous storage sections and representative failure cases from the vessels and the pipelines.
- Visualization of chemical release scenarios.
- Effect and damage calculation from the release cases through mathematical modeling.
- Inventory Analysis and Fire & Explosion and Toxicity Index (FETI) are the two techniques employed for hazard identification process.

FIRE & EXPLOSION AND TOXICITY INDEX

The role of Fire & Explosion Index (FEI) aids quantitative hazard identification. The FEI is calculated by evaluating the loss potential of all the units in the storage area and the hazardous areas are classified accordingly. The FEI plays an important role in

- Identification of the equipment/areas that could likely contribute to the creation or escalation of incident and relative ranking of the incidents.

- Quantification of the expected damage of potential fire and explosion incidents.
- Preparation of guidelines for mitigating fire hazards.

The loss potential which could actually be experienced under the most adverse operating conditions is quantitatively evaluated. The FEI is used for any operation in which a flammable, combustible or reactive material is stored, handled or processed.

FEI = MF * GPH * SPH

Where MF : Material factor

GPH : General Process Hazard

SPH : Special Process Hazard

TOXICITY INDEX

The Toxicity Index is calculated using the the following formula.

$$TI = \frac{(Nh + Ts) * (1 + GPH + SPH)}{100}$$

Where Nh:

Ts:

GPH: General Process Hazard

SPH: Special Process Hazard

ASSESSMENT OF RISK AT ANIMESH ISPAT PRIVATE LIMITED

Based on the storage inventory the following areas are identified as potential safety risk areas, shown in Table No. 7.3.1

TABLE No. 7.3.1 : POSSIBLE RISKS FROM THE STEEL PLANT

Equipment	Process	Potential Hazard	Provision
DRI PLANT			
Sponge Iron Kiln	Reduction of Iron Ore	Falling of Hot Mass & Dust	• Ensuring before opening the kiln bottom door, first clean the inner surface of the stack cap, such that the dust particle and hard clinkers which deposited in the cap is fallen into the DSC. • Ensure before opening the DSC bottom door to check the DSC bar position and condition and to clean if big block of castables or any hard clinkers which is blocking the dust flow passage to wet scrapper chute. • Ensure to clean the dust by opening the man hole provided in the chute and check the spiking rods and the screen. In built safety

Equipment	Process	Potential Hazard	Provision
			system is provided in the construction of furnace with suitable refractory walls. • Allow the wet scrapper to run to remove the sludge, then open the drain pipe of the wet scrapper, which is located at bottom on either side, pour sufficient water to clean the sludge and the slurry dust to flow through drain pipe. • Ensure to stop the wet scrapper and open the top plate to check the alignment, weak and tear of the plates and take necessary precaution against the excessive worn out plate.
Sponge Iron Kiln	Reduction of Iron Ore	Air emission	• Adequately designed ESP and other Air Pollution control systems will be provided with internal lock to the kiln feeding system in order to prevent by passing of emissions through safety cap and also during non-operation of ESP or any other pollution control devices.
POWER PLANT			
Turbine	Convert pressure in the flue gas into Mechanical Energy	Mechanical & Fire Hazards Noise	• Layout of Equipment / Machinery will be in accordance to factory and electrical inspectorate. • Acoustic enclosure to Turbine
Generator	Convert Mechanical energy into electrical energy	Mechanical & Fire Hazards a) Lube Oil System b) Cable galleries c) Short circuits	• Layout of Equipment / Machinery will be in accordance to factory and electrical inspectorate.
		Noise	• Acoustic enclosure • Isolated panel rooms • Special foundation with vibration absorbers
Power Transformers	50,000 KVA capacity	Fire and explosion	Automatic fire fighting system will be provided. Isolated with fencing and restricted entry.
Switch Yard	transformer	Fire	All electrical fittings and cables are provided as per the specified standards.
Switch Yard control room		Fire in cable galleries and switch	
Coal storage shed	Storage of coal for 10 days requirement.	Fire and spontaneous combustion	Coal storage yard will be continuously sprinkled with water with garden type sprinklers.

Equipment	Process	Potential Hazard	Provision
Coal handling bunkers	----	Fire and dust explosions	Continuous water sprinkling
Compressor House	Plant operation	Governor failure due to the failure of pins and springs leading to opening of safety valves	The design precautions of safety will be followed in manufacture and erection of compressors.
Coal storage yard	Coal dust is combustible	Explosion Hazard	• Coal storage shall be minimized • Coal piles shall not be located above heat sources such as steam lines. • motors. • All mechanical & electrical equipment inside the coal storage area shall be approved for use in hazardous locations and provided with spark proof
STG, draft fans, soot blowing from boiler, ventilation pipes	Noise generated due to operation of STG, working of fans, ventilation system,	Noise hazard	• Acoustic enclosures will be provided to STG. • Enclose fans, insulating ventilation pipes • use of dampeners.
Failure of APCS	Dust / Smoke	Air emission	• Interlocking system will be provided and whenever APCS is not working, then raw material feed will be stopped. Consequently, there will be no production in the unit till APCS is rectified. • The unit cannot be stopped immediately and it will take some time to stop. During this period release of particulate matter will take place, hence mobile dust suppression system will be provided to suppress the particulate matter immediately to mitigate the impact of PM on surroundings. • Depending upon the wind direction at the time of emergency, Mobile dust suppression equipments will be provided to suppress the dust within the plant and also outside the plant to reduce the impact on habitation, water body, crops etc. • Immediately upon failure of any APCS, emergency siren will be blown to inform the

Equipment	Process	Potential Hazard	Provision
			employees and nearby villagers about the emergency. • Dust masks will be provided to the employees and nearby villagers. Immediately upon hearing siren, every employee and villager must wear the dust mask. • Mock drills will be conducted in the nearby villages for the emergency preparedness.

Coal Handling Plant - Dust Explosion

Coal dust when dispersed in air can explode if it gets ignition source. Crusher houses and conveyor systems are most susceptible to this hazard. The minimum of explosive concentration of coal dust (33% volatiles) is 50 grams/m^3. Failure of dust extraction & suppression systems may lead to abnormal conditions and may increase the concentration of coal dust upto the explosive limits. The sources of ignition are incandescent bulbs, electric equipment & cables, friction & spontaneous combustion in accumulated dust. Dust explosion may occur at any time without any warning with maximum explosion pressure of 6.4 bars. Another dangerous characteristic of dust explosion is that it sets off secondary explosions after the occurrence of initial dust explosion.

Stock pile area shall be provided with automatic garden type sprinklers for dust suppression as well as to reduce spontaneous ignition/combustion in coal stock piles. Necessary water distribution network will be provided for distributing water at all transfer points, crusher house, control room, etc.

A centralized control room with microprocessor-based control system has been envisaged for operation of the coal handling plant. Except locally controlled equipment like travelling tripper, dust extraction / dust suppression / ventilation equipment, sump pumps, water distribution system all other equipment's will have provision for local control as well.

Control Measures for Coal Storage Yard

The entire quantity of coal will be stored in separate stack piles, with proper drains around to collect washouts during the monsoon. Water sprinkling system will be installed in and around the stocks of pile to prevent spontaneous combustion and consequent fire hazards. The stack geometry will be adopted to maintain minimum exposure of stock pile areas towards predominant wind direction. Temperature will be monitored regularly to detect any abnormal rise in temperature inside the stock pile to be enabled to control the same.

POSSIBLE RISKS FROM THE FERRO ALLOYS UNIT

S.No.	AREA OF	OCCUPATIONAL & SAFETY HAZARDS AND CAUSES	THEIR IMPACT	ACTIONS TAKEN TO ELIMINATE THE IMPACT / HEALTH AND SAFETY HAZARDS
1	Raw Material Areas	• Exposure To Dust • Working In Open Areas	• Dust allergy, • Fatigue due to physical activity	• Providing protective and safety appliances • Rotation of workers
2	Raw Material Feeding Systems Ferro Alloys	• Exposure To Dust While Handling Raw Materials In Yards • Exposure To Dust At Transfer Towers • Noise Levels Due To Impact At Batching System, EMV Feeders	• Dust allergy, Lung disorders, respiratory problems and effect to skin • Fatigue due to physical activity • Scope of accidents / injuries due to improper maintenance practices. • Hearing impairment, sleep disturbance, hypertension	• All conveyors covered • Dust suppression systems at transfer towers to eliminate dust • Providing proper protective and safety appliances • Standing instructions and standard operating procedures • Providing ear plugs
3	Furnace Area Ferro Alloys	• Exposure To Heat At Furnace • Exposure To Dust At Furnace • Charging & Stroking System At Furnace • Suffocation At Operating Floor Level 1st Floor	• Dehydration and cardio vascular disease. • Dust allergy, Lung disorders, respiratory problems and effect to skin • Metallic dust exposure • Scope of burns and injuries and effect to eyes • Scope of injury due to spillage of hot charge mix at furnace operating floor	• Low hood design of furnace smoke hood eliminates exposure to dust and fumes • Providing safety and protective appliances • Proper design of hood top for extraction of fumes to eliminate suffocation at operating floor due to fugitive emission • Face marks, shoes, helmets at operating floor eliminates injuries
4	Process Ferro Alloys	• Fluctuations Due To Metallurgical Aspects • Furnace Eruptions • Variations In Process Parameters	• Burns and injuries due to furnace erruptions due to metallurgical disturbances in process • Exessive heat / radiation and effect due to hold up of slag / metal in the furnace due to process variations	• Proper selection of raw materials and quality control of inputs eliminates process variations and related hazards. • Provision of proper safety and protective equipment eliminates injuries / burns

S.No.	AREA OF	OCCUPATIONAL & SAFETY HAZARDS AND CAUSES	THEIR IMPACT	ACTIONS TAKEN TO ELIMINATE THE IMPACT / HEALTH AND SAFETY HAZARDS
5	Hot Metal Handling Areas	• Tapping Area Hot Liquid Metal Handling And Spillages • Exposure To Heat • Continuous Casting Machine Process	• Scope of burns due to liquid metal spillages • Accidents due to Break down / failure of tools and tackles used in hot metal handling equipment • Burns due to Liquid metal spillages during process of pouring • Burns due to water ingress to hot metal areas	• SOPs and proper maintenance of cranes / tools & tackles eliminate accidents • Proper layout and free spaces for movement in hot metal handling areas eliminate scope of injuries in abnormal conditions. • Providing proper safety and protective equipment eliminate scope of injuries
6	Product Handling Ferro Alloys	• Hot Metal & Slag Cakes Handling • Product Sizing Process • Product Loading Process	• Scope of burns due to hot metal cakes handling • Metallic dust exposure • Scope of injuries during sizing process of metal and slag • Failure of lifting tools & tackles and equipment	• Providing proper safety and protective equipment to eliminate scope of injuries • SOPs and proper maintenance and testing of lifting equipment to eliminate scope of injuries.
7	Equipment Ferro Alloys	• Break Down Of Cranes • Break Down Of Water Cooling Pumps • Break Down Of Blowers In Furnace Area • Break Down Of Hydraullic Systems	• Crane break down cause scope of lining failures and there by scope of injuries / burns • Scope of steam generation in the water cooling circuit and failure of water hoses due to steaming and scope of burns • Break down of blowers scope of suffocation in 2nd floor	• Proper SOPs for O & M and proper maintenance schedules and equipment testing schedules eliminate scope of accidents related to these failures. • Proper ventilation in the plant building eliminates scope of suffocation.
8	Furnace Transformers	• Possibilities Of Fire • Possibilities Of Electrical Failures	• Injuries / burns due to fire at transformer • Electrical short circuits causing transformer failure and scope of catching fire	• Proper fire fighting equipment and nitrogen purging eliminates fire accidents in transformers

S.No.	AREA OF	OCCUPATIONAL & SAFETY HAZARDS AND CAUSES	THEIR IMPACT	ACTIONS TAKEN TO ELIMINATE THE IMPACT / HEALTH AND SAFETY HAZARDS
				• Proper protection scheme and isolation of furnace from source eliminate any scope of accidents due to failure of transformer
9	Hydraullic Systems	• Failure Of Hydraullic Hoses • Possibilities Of Fire Of Hydraullic Oil	• Failure of hydraulic hoses due to electrical short circuits may cause accidents • Possibility of fire accident due to oil catching fire	• Proper SOPs for O & M eliminate failures • Using carbon free high pressure hoses eliminate hose failure accidents. • Separate enclosed room for hydraulic room reduces scope of high temperature and eliminate fire accidents
10	Pollution Control Systems Ferro Alloys	• Sparks Causing Burning Of Bags In Bag Filters • Possibilities Of Sudden Surges In Furnace	• Fire accidents at Bag house • Excessive emissions due to failure of bags • Structural failures due to this fire accident	• To avoid scope of bags catching fire, baffles in the ducting to arrest sparks, water cooled hood top, duct length of about 40 metres between hood & bag filter, providing heat exchanger and dilution dampers for fresh air completely eliminate this scope of fire accident • PLC based Interlocking system w.ill be provided and acts in such a way that whenever bagfilters fail, then furnace will be shutdown
11	Refining Process Areas	• Liquid Metal Handling Scope Of Burns • Break Down Of Cranes	• Scope of burns due to liquid metal spillages • Accidents due to Break down / failure of tools and tackles used in hot metal handling equipment • Burns due to Liquid metal spillages during process of pouring	• SOPs and proper maintenance of cranes / tools & tackles eliminate accidents • Proper layout and free spaces for movement in hot metal handling areas eliminate scope of injuries in abnormal conditions.

S.No.	AREA OF	OCCUPATIONAL & SAFETY HAZARDS AND CAUSES	THEIR IMPACT	ACTIONS TAKEN TO ELIMINATE THE IMPACT / HEALTH AND SAFETY HAZARDS
				• Providing proper safety and protective equipment eliminate scope of injuries
12	Testing Areas	• Hazards Due To Chemicals • Exposure To Reaction Fumes / Gasses	• Scope of burns and skin damages • Scope of lung disorders	• Proper safety precautions and protective equipments to eliminate these hazards
13	Electrical Systems	• Exposure To Electrical Shocks • Scope Of Fire Due To Electrical Short Circuits • Exposure To Burns Due To Electrical Systems	• Burns due to electrical accidents • Shocks due to electrical accidents • Damages to skin due to electrical fire accidents • Neurological problems due to electrical shocks	• Proper SOPs for O & M teams will eliminate scope of these hazards • Proper fire fighting scheme for electrical failures eliminate these Hazards • Proper design of electrical equipment and proper isolation eliminate these Hazards
14	Noise Related Hazards	• Exposure To Noise Of Various Equipment • Working At Furnace Areas	• Damage to ears and neurological systems • Lung disorders • Skin diseases and effect to skin	• Proper ventilation eliminates heat • Proper measure to reduce noise levels and keep noise levels within permissible • Proper safety and protective equipment
15	Fire Hazards Areas	• All Hot Metal Areas • Furnace Transformers • Furnace Operating Floor	• Scope of fire accidents and burns • Scope of damage to skin	• Proper SOPs for O & M and good fire fighting scheme eliminate these Hazards • Proper safety and protective equipments eliminate impact of these Hazards
16	Safety Related Areas	• Tools And Tackels Used In Handling Areas • Furnace Working Areas • Vehicular Movement At Rm Yards	• Scope of mechanical related accidents causing injuries • Exposure to dust causing dust allergy	• Proper SOPs for testing of toold and tackles and lifting equipment and proper maintenance schedules eliminate the scope of these accidents and hazards • Proper layout design eliminates accidents due to vehicular movement in project

S.No.	AREA OF	OCCUPATIONAL & SAFETY HAZARDS AND CAUSES	THEIR IMPACT	ACTIONS TAKEN TO ELIMINATE THE IMPACT / HEALTH AND SAFETY HAZARDS
17	Continuous Process Industry	• Fatigue Due To Long Working Hours • Age Related Constraints	• Absentism causes long working hours and fatigue • Incapability in some working areas beyond certain age limit	• Keeping some additional manpower in summers eliminate fatigue • Relocation / rotation of working area will eliminate age related constraints
18	Seasonal Related Issues	• Exposure To Heat In Summers • Furnace Process Fluctuations During Monsoon Season • High Moisture Levels In Raw Materials	• Dehydration during summers at furnace areas • Excess moistures cause improper porosity in the furnace causing eruptions and burning • Chocking of charging systems and spillages due to excess moisture during monsoon causing work load fatigue to maintenance teams	• Proper ventilation, providing additional manpower during summers eliminate the scope of impact due to these hazards. • Proper selection of raw materials during monsoon, storage of raw material in covered sheds, maintaining proper preventive maintenance schedules and additional manpower during mansoon eliminates these Hazards
19.	LDO / FO Storage Area	MS Tanks (1 X 25 KL)	• Fire & explosion	Precautions as per TAC and OISD will be implemented.
20.	Failure of APCS	Dust / Smoke	• Air emission	• Emergency alarm to be given to Villagers. • Water sprinkling arrangements

RISK & CONSEQUENCE ANALYSIS OF FIRE

The principle objective of this study is to identify the potential hazards, estimate the effects of hazards to people both within and outside the plant premises.

- Identification of possible failure cases of the facilities, which might affect the population and property within the plant boundary.
- Assessment of consequential effect on surrounding population, property etc., due to onset of such failures.
- Suggest recommendations based on consequence analysis relevant to the situations.

METHODOLOGY

The hazards expected from this plant include the pool fire situation due to the leakage of HFO, LDO & FO from the storage tanks. There will be two Nos. of FO storage tanks each of 25 m^3 capacity, one No. of storage tank for HFO with a capacity of 25 m^3 & one No. of storage tank for LDO with a capacity of 25 m^3. The tanks, made of Mild steel, will be provided with dyke. The most credible failure is due to the rupture of the pipe connecting the storage tank. The worst case can be assumed as when the entire contents leak out into the dyke forming a pool, which may catch fire after getting source of ignition.

HFO, LDO & FO STORAGE TANK - POOL FIRE SCENARIO

The maximum quantity of HFO, LDO & FO stored at site will be 1 x 25 $m^{3,}$ 1 x 25 m^3 & 2 x 25 m^3 capacity respectively. In the event of oil spillage through a small leakage or due to rupture of pipeline connecting the tank fire will follow after getting ignition source. As the tanks are provided with dyke, the fire will be confined within the dyke. Threshold limit for first degree burns is 4.5 kw/m^2. Based on these results it may be concluded that the vulnerable zone in which the thermal fluxes above the threshold limit for first degree burns (4.5 kw/m^2) is restricted to 19 m.

The hazard distances for various radiation intensities are shown in Table No. 7.3.3

TABLE No. 7.3.3

HAZARD DISTANCES (Four Tanks on fire - scenario)

HFO Quantity : 1 x 25 m^3

LDO Quantity : 1 x 25 m^3

FO Quantity : 2 x 25 m^3

Radiation intensity		**Hazard Distances**
37.5 kw/m^2	(100% lethality)	2 m
25.0 kw/m^2	(50% lethality)	7 m
12.5 kw/m^2	(1% lethality)	12 m
4.5 kw/m^2	(1^{st} degree burns)	19 m

The hazard distances for Thermal radiation are confined to the plant premises only. Hence there will not be any thermal radiation impact on outside the population due to the pool fire scenario. The thick green belt to be developed will help to further mitigate the radiation intensity level outside plant boundary.