7.3 RISK ASSESSMENT

7.3.1 INTRODUCTION

Risk analysis deals with the identification and quantification of risks, the plant equipments 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 often confined to maximum creditable accident studies.

7.3.2 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.

7.3.3 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 through out 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.

7.3.4 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.

7.3.5 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

7.3.6 ASSESSMENT OF RISK AT M/s. SHYAM STEEL MANUFACTURING LTD.

[Std.ToR # 3 (v) & (ix)]

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

TABLE 7.3.1: TYPE OF HAZARDOUS IDENTIFIED DURING STORAGE & HANDLING

S.No.	Area	Capacity / quantity	Hazards identified
1.	Steam turbine generator building	10 MW + 7.0 MW + 4 x 9 MW + 18 MW	Fires in a) Lube oil system b) Short circuit in control room / switch gears

			c) Cable galleries d) Fire in oil drum storage
2.	Transformer	-	Explosion & fire
3.	Boilers	8 Nos. WHRB & 2 nos. FBC	Fire (mainly near oil burners) steam explosion, fuel explosion
4.	Coal handling plant	-	Fire and or dust explosion
5.	Coal storage	38,000 tones	Fire, spontaneous combustion
6.	LDO / LSHS tank farm	3 x 50 m^3	Fire
7.	HFO tank farm	1 x 25 m^3	Fire

The degree of hazard is identified based on FEI & TI range as per the criteria given below.

FEI RANGE	**DEGREE OF HAZARD**
0 – 60	LIGHT
61 - 96	MODERATE
97 - 127	INTERMEDIATE
128 - 158	HEAVY
159 & Above	SEVERE

TI RANGE	**DEGREE OF HAZARD**
0 – 5	LIGHT
5 - 10	MODERATE
> 10	SEVERE

Fire and Explosion are the likely hazards which may occur due to the fuel storage. Hence F&EI has been calculated for storage capacities of fuels in the plant and are shown in Table 7.2.

TABLE 7.3.2: FIRE & EXPLOSION AND TOXICITY INDEX FOR STORAGE FACILITIES

Fuel	Total quantity of storage	F& EI	Category	TI	Category
LDO / LSHS	3 x 50 m^3	1.5	Light	--	--
HFO	1x25 m^3	1.5	Light	--	--

TABLE No. 7.3.3: POSSIBLE RISKS FROM THE STEEL PLANT & PROPOSED MITIGATION MEASURES

Equipment	Process	Potential Hazard	Mitigation
Pellet Plant			

Equipment	Process	Potential Hazard	Mitigation
Raw material storage	Spillage of wet bentonite may lead to slip	Head injury / Broken bones	• Immediate barrier will be placed and warning signage around spillage area • Training to the workers
Balling & Mixing	Dust generation during running of loading circuit	Lung disorders	• Personal respiratory equipments will be provided to the workers at work place. • Exhaust ventilation system will be provided
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 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 interlock 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

Equipment	Process	Potential Hazard	Mitigation
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	----	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.
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 minimised • 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.
LDO / FO storage area	MS tanks HFO: 1 x 25 m^3 LDO /LSHS: 3 x 50 m^3	Fire & explosion	Precautions as per TAC and OISD will be implemented.
Failure of APCS	DUST / SMOKE	Air emission	• Emergency alarm to be given to Villagers. • Interlocking system will be provide to APCS.

Equipment	Process	Potential Hazard	Mitigation
			• Water sprinkling arrangements

TABLE NO. 7.3.4: PROCESS HAZARD ANALYSIS RELATED TO INDUCTION FURNACE & NECESSARY RISK CONTROL MEASURES

S.No	Area/Section	Hazards	Risk Control Measures
A)	**ELECTRIC INDUCTION FURNACE**		
1)	IF proper	Explosion hazard due to Water Leakage from coil, Water Cooled panel or power cables.	• Stop operation. • Stop tilting or stop any Furnace movement • Identify the leakage point • Develop and Follow SOP
		Metal splash or explosion due to water coming into contact with molten metal. (Water may be present in scrap material or from leaks in the furnace cooling systems)	• Stop operation. • Ensure use of PPEs • Proper protection system like Ground Leak Detector (GLD) etc. in place • Ensure No unauthorized person on furnace platform • Ensure no wet scrap and leakage of water
		Metal splash or explosion due to improper scrap charging / wet scrap / chemicals in scrap	• Stop operation • Proper Segregation of scrap • Inspection of scrap and approval • process for worthiness. • Safe scrap charging through cranes/vibrators charging trolley • Use of Hydraulic pusher for melting
		Injury from Material Handling like DRI, Pig Iron, Scrap shifting to furnace floor	• Regular Maintenance of EOT cranes in respect of wire ropes, brakes, lifting hook, rails/wheels, electrical system/motors etc. • Provision of proper limit switches • Emergency main switch of cranes to be provided near platform or at an easily accessible place. • Bell/Siren is to be provided in the cabin for crane operator • Annual inspection of Cranes/Lifting tackles/Magnets by competent person every year as per factory act • Display of safe working load on each crane • Proper Guarding of all stairs and crane's CT Trolley
		Explosion due to high temperature/thinning of refractory with improper Melting system protection	• Water Temperature & flow sensors • Ground leak detector • Circuit breakers and tripping mechanism • Frequency monitoring • Lining conditions of crucibles & ladle etc.

		Additionally-Bridging in IF: Leading to superheating of furnace bottom and erosion of ramming mass and rupture of cooling water tubes and subsequent explosion.	• Develop and follow SOP
2)	IF turnaround activity	Burn Injury due to splashing slag	• Proper PPE and visor. • Covering of all exposed area with cloth
		Injury from Pressurized Vessels	• Air compressors/pressure vessels should be checked regularly for proper working of Pressure switches, safety valves and Pressure gauges. • Auto drain valve is to be provided on each pressure vessel • Six monthly testing of PV Thickness and hydraulic testing every four years by competent person as per the factory act.
		Person hit by moving machines	• Siren, gong bell during movement machines. • Auto announcement during any operation. • Permit to work prior to undertaking any maintenance job
3)	Electrical system	Electrical failures and shock	• Proper Earthing pits • Earthing of all electrical motors/gadgets • Work permit system • Transformer testing (dielectric strength and dehydration of Transformer oil)

TABLE NO. 7.3.5: PROCESS HAZARD ANALYSIS RELATED TO ROLLING MILLS & NECESSARY RISK CONTROL MEASURES

Sl. No	Area/Section	Hazards	Risk Control Measures
A.	**Raw material section**	Injury in grinding operation	• Wear goggles for all grinding machine operations. • Operate grinding wheels at recommended speed with recommended depth of cut. • Use proper wheel guards on all grinding machines. • Use PPEs. • Develop and Follow SOPs
		Hazards due to conveyors	• Avoid sitting, standing, or walking on conveyors. • All conveyor to be provided with proper guards.

			• Never perform maintenance while a conveyor is in operation. • Ensure correct operation of conveyor controls. • Avoid loose clothing, long hair, jewellery and other loose items near conveyor • Emergency "shut-off" devices to be provided • Follow lock-out / tag-out procedures for maintenance • Only authorized / trained personnel to operate or maintain the conveyor.
		Hazards in Material handling & stacking area	• Maintained floors in proper condition • Stacked the material properly without any billet ends protruding out • Clearly defined walkways, proper stacking of material. • Regular clearance of debris. • Develop and Follow SOP
B.	**Reheating Furnace**	Gas poisoning due to leakage of gas	• All the gas line to be insulated from circuit by "U" seal and also fill up water in water seal and ensure overflow of water to drain. • Blanking of gas line to be done before Removal of valves or flanges. • Proper packing to be provided in fixing of valves or flanges. • Regular inspection of gas lines to detect leakage if any. • Use Portable “CO” monitors to detect gas leakage. • Ensure the closure of main valve to cut off supply • Check all the flange/ welded joints for gas leakage. • Purge the gas pipe line with nitrogen in small segments by opening the bleeder valve • Develop and Follow SOP
		Fire hazards	• Give clearance for cutting / welding etc. after ensuring that there is no leakage of gas • Keep the Portable fire extinguishers ready for any hazards • While lighting up or off of the furnace, laid down procedures are to be followed strictly. • Develop and Follow SOP
		Burn injury hazards, Exposed to hot flames and hot billets / ingots	• Use personal protection equipment. • Keep the first aid kit having burn injury medicine on standby

			• Develop and Follow SOP
		Hazards associated with re-lining of furnace with refractory bricks	• Work permit system to be followed. • Monitor the temperature of area before starting work • Hand held 24 V bulb to be used during repairs in furnace • Detail job safety protocol may be prepared to undertake the job, if job is irregular. • Develop and Follow SOP
		Hazard due to mechanical & Electrical Maintenance	• All electrical equipment/ machines to be earthed properly • Use electrical PPEs • Develop and Follow SOP
C)	**Rolling Mill**	Injury from Moving roller table	• Shutdown / permit to work with electrical isolation. • No work to be done on conveyor in running condition. • Local emergency switch to be operated for approaching conveyor. • Availability of Pull chord. • Siren system prior to restarting conveyor. • Loose cloths prohibited. • Area barricading if material is removed from height. • Develop and Follow SOP
		Injury from Rotating machineries	• Coupling guards to be in place. • Loose cloths to prohibited • Develop and Follow SOP
		Injury during Working on mill stands	• "Permit to work" practice to be followed strictly. • Display of “Men at Work” board is to be done at Operator Control Panel • Develop and Follow SOP
		Injury during Roll Change	• During Roll Change, Rolls to be cooled with water spray before work to avoid burn injury. • Ensure to take Power Shutdown for Roller Table and connected drive. • Ensure written Work Clearance to be given to concerned personnel for doing the work. • Cleanliness of area with respect to presence of oil, grease, jute and other inflammable materials before gas cutting/ welding job. • Availability of fire hydrant to be ensured if job involves gas cutting etc. • Display “Men at Work” board at Operator Control Panel.

			• Place a plate on rollers table for smooth entry of personnel. • Use required PPE when changing roll and after completion of jobs, ensure that men and materials are removed from site. • Ensure that "Job completion Report" is given in writing and then cancel "Power Shutdown," remove "Caution Tags" and give clearance for operation. • Develop and Follow SOP
		Electric shock	• Ensures safety precautions like "Power Shutdown", work clearance before stating the job • Displaying of "Men at Work" at HT switching on panel. • Proper earthing of brush holder arm etc. • Checking protection and safety devices may expose the maintainer to risks in the event that the devices are not functional. For this reason, the machines must be isolated from their main power sources (electrical switchboards, main delivery valves, etc.) under the supervision of the Manager of the plant, using established SOP's and written permissions. • Develop and Follow SOP
		Entanglement/ injury at Gear box/ coupling	• For working in gear box / coupling, take power shut-down for connected drive. • Display "Men at Work tag". • Develop and Follow SOP
		Injury while Working on EOT Cranes	• For safe working, ensure" power Shut down" Work clearance Men at work tag. • Watch by additional person to observe movement of nearby crane etc. • Stoppers are to be welded on both sides of crane on LT rails. • Submit job completion report after repair. • All the lifting tools and tackles to be checked every year as per statutory requirement. • Develop and Follow SOP
		Injury in Motors with belt/chain drives	• Provide guards on all the motors having belt / chain type transmission mechanism. • Develop and Follow SOP
		Injury with Flywheel	• Flywheel to run below safe speed limits. • Appropriate guard to be provided around flywheel.

			• Develop and Follow SOP
		Person hit by rolling hot material during looping and play	• Auto Announcement during • Proper guards to be provided to avoid material coming in the way of workmen. • Proper pathways to be provided for safe movement. • Use of appropriate PPE hand gloves, gum boots, Face shield, dust mask, goggles by persons working on stands and handling hot materials. • Proper leg / arms guards / safety goggles to be provided to tongs men • Permit to work prior to undertaking any maintenance job. • Develop and Follow SOP
		Injury from Cooling Fans	• Appropriate guards to be provided around fan blades. • Proper stand to be provided. • Earthing to be provided. • Develop and Follow SOP
		Injury from Manual Handling of Heavy loads	• Use appropriate lifting tackles like chain pulley block, hoist etc to lift heavy parts • Develop and Follow SOP
		Injury from Handling of stock at stands	• All hand tools to be well designed, frequently inspected and well maintained. • Rivets of tongs used at mills to be renewed frequently. • Develop and Follow SOP
		Injury during Mill maintenance	• Ring spanners and impact wrenches should be provided for roll changing crews; • Bent-out, open-ended spanners not be used. • Adequate training to be given to fitters in the use of all hand tools. • Develop and Follow SOP
		Injury from Capital Repair Job in Rolling Mill (Semi Automatic)	• All the power shutdowns of the required system to be taken as per the dully filled work permit form and necessary clearance from concerned operation and electrical area. • Using required PPE as per requirement. • Ensure that all lifting tools & tackles (winches, Hug-zugs, Chain Pulley Blocks etc.), mobile cranes are tested by a competent person and test certificates are submitted. • For working at height, a “Work at heights pass” to be obtained from safety department and use of appropriate safety belts.

			• All portable electrical equipment, welding machines to be earthed effectively (body earthing). • Before any heavy structural member is gas cut, it is to be supported by ropes, chains or any other means to prevent its dropping or swinging. • Suitable fire extinguisher in working condition must be kept close to all welding and gas cutting operations. • Rolling of gas cylinders to be avoided and transferred / shifted by proper trolleys. • • Proper protection to be provided to conveyor and electrical cables to prevent fall of sparks from welding/ gas cutting. • Isolation of electrical power and written clearance to be obtained from electrical section before start of dismantling operation. • Area of work to be illuminated, before starting the job. • Movement of the employees to be restricted to working area only. • Mono rail hoist/EOT crane, to be operated with in safe working load (SWL) of the equipment. • All the openings created during dismantling to be immediately covered/ barricaded. • Compressed air vessels and pipelines to be de-pressurized before dismantling. • Combustible / Inflammable materials such as coal powders, oil spillages etc. are to be removed from the place where gas cutting/ welding jobs are to be carried out. • A charged water hose pipe may be kept near the place of work. • People involved in hazardous area to be imparted first aid & fire fighting training. • Prior to actuation it must be ensured that no persons are in the active area of the dangerous energy (mechanical, electrical, hydraulic, pneumatic, etc.). • Only the hydraulic / pneumatic specialist is allowed to perform switching operations on hydraulic / pneumatic valves,

			provided the following conditions are fulfilled: • personnel involved in plant start-up and control must be warned of any operations that are to be carried out in the enclosed area before starting the machine • No persons must be present in the danger zone, • Voice contact must be established with a responsible person at the workplace in charge of monitoring the sequence of functions. • Develop and Follow SOP
D)	**General safety norms for rolling mills (Semi Automatic) I**		• All required PPEs are to be used while working • Use properly maintained tools & tackles. • Hand tools to be checked in every six months. • All the lifting tools and tackles to be every year as per statutory requirement. • Permit-to-work to be filled up before taking any job. • Before starting any job compliance to be proper safety isolation procedure to be ensured by concerned agencies. • Compliance of special measures to be undertaken such as cooling of rolls in hot areas, use of supports, use of stoppers, closing of valves, housekeeping in the area, availability of fire hose / extinguishers. • Standard Operation Practices (SOPs) and Standard Maintenance Practices (SMPs) are to be followed strictly.
			• All the mechanical moving equipments are to be barricaded / guarded properly. • All electrical equipments to be earthed properly. • All high- pressure vessels are to be tested as per statutory requirements. • Oil Cellar to be checked every month for leakages. • Proper loading / unloading procedure for raw materials / finished products to be prepared and followed. • Ensure the availability of firefighting equipment. • Ensure proper illumination

			• Proper housekeeping to be done. • Before restoration of power of the equipment, it is to be ensured that men, materials including tools and tackles, supports, scaffolding etc. are removed. • Develop and Follow SOP
			• Safety signs are intended to ensure the safety of personnel at their workplace. Depending on the kind of hazard, the following signs must be placed: ✓ Prohibitive signs ✓ Warning signs ✓ Mandatory signs ✓ Rescue signs ✓ Informative signs ✓ Signs identifying permanent danger areas • Signs for operating areas requiring individual safeguarding • In operating and danger areas of the plant/machine, it is necessary to place the signs listed above before equipment is put into operation. • Before commencing their activities, all personnel must be instructed as to the significance of the safety signs, and renewed instruction must be given at appropriate intervals, but at least once per year.
			• In addition to the signs listed above, the user of the equipment shall clearly and distinctly indicate and place signs for the following: • Escape routes/emergency exits • First-aid stations • Places where stretchers are available • Emergency showers/eye washing facilities
			• The operational reliability and the safe use of the plant /machine are ensured (among other things) by electrical and mechanical interlock devices. These must be inspected at regular maintenance intervals. ❖ Emergency push buttons / switches to be checked for their functioning at regular intervals. ❖ All fixed guards, when removed for any work on the machine, must be correctly replaced and secured at the end of the work.

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 explosions 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 net work 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 equipments 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.

7.3.7 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.

7.3.7.1 METHODOLOGY

The hazards expected from this plant include the pool fire situation due to the leakage of HFO & LDO/ LSHS from the storage tanks. 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/ LSHS stored at site will be 1 x 25 m^3 & 3 x 50 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 25 m.

The hazard distances for various radiation intensities are shown in Table No. 7.3.6

TABLE No. 7.3.6

HAZARD DISTANCES (Four Tanks on fire - scenario)

HFO : 1 x 25 m^3

LDO /LSHS : 3 x 50 m^3

Radiation intensity		Hazard Distances
37.5 kw/m^2	(100% lethality)	5 m
25.0 kw/m^2	(50% lethality)	10 m
12.5 kw/m^2	(1% lethality)	15 m
4.5 kw/m^2	(1^{st} degree burns)	20 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.