HAZARD IDENTIFICATION & RISK ASSESSMENT

Industrial activities, which produce, treat, store and handle hazardous substances, have a high hazard potential to safety of man and environment at work place and outside. Recognizing the need to control and minimize the risks posed by such activities, the Ministry of Environment & Forests have notified the "Manufacture Storage & Import of Hazardous Chemicals Rules" in the year 2008 (In super session of the Hazardous Wastes (Management and Handling Rules, 1989**)** and subsequently modified, inserted and added different clauses in the said rule to make it more stringent. For effective implementation of the rule, Ministry of Environment & Forests has provided a set of guidelines. The guidelines, in addition to other aspects, set out the duties required to be performed by the occupier along with the procedure. The rule also lists out the industrial activities and chemicals, which are required to be considered as hazardous.

During the process of manufacture and other associated materials hazardous wastes are generated which are stored and used within the plant process. The major chemicals handled / stored by the plant includes HSD, LDO etc. In view of this, proposed activities are being scrutinized in line of the above referred "manufacture, storage and import of hazardous chemicals rules" and observations / findings are presented in this chapter.

1.1 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Hazard is a source or situation that has the potential for harm in terms of human injury, ill health, damage to property or the environment, or a combination of these factors. It has got a short or a long term effect on the work environment with considerable human and economic costs. A hazard can have a potential to create an emergency like situation at the work place. Hazard is a potential cause to generate a disaster.

Hazards exist in every workplace in different forms and required to be identified, assessed and controlled regarding the work processes, plant or substances. They arise from (i) workplace environment, (ii) use of plant and equipment (iii) use of substances and materials, (iv) poor work and/or plant design, (v) inappropriate management systems and work procedures, and (vi) human behaviour.

Steel plant has many hazardous processes and operations which can cause considerable environmental, health and safety risk to the workforce. All the hazards cause potential risk to the work environment which include work force and work place and hence need proper assessment.

M/s Bravo Sponge Iron Pvt. Ltd. has planned for expansion of the Steel Plant by installation of Pellet Plant with Grinding Facility (2x0.85 MTPA), Sponge Iron Plant (1x350 TPD Kiln), Induction Furnaces (3x25 T), Capacity revision of Rolling Mill from approved 600 TPD to 1000 TPD along with 7 MW capacity Captive Power Plant (WHRB based, utilising waste heat from the proposed sponge iron plant) and Producer Gas Plant (12x4000 Nm^3/hr) at Village Mahuda, P.O. Rukni, P.S: Para, District: Purulia, West Bengal. The Plant has lower risk potential than those industries dealing with toxic and flammable chemicals. Off-site people are not exposed to any dangers, hence the societal risk is insignificant.

This is an early check of major hazards, which are of risk potential - including the potential for disastrous interactions of the various plant operational activities. This checklist, though not strictly speaking a Hazard and Operability Study (HAZOP) would considerably facilitate a full scale HAZOP Study for final drawing up of risk management measures when the 'design-freeze' stage commences. The identification of hazards anticipation for the proposed project activities are presented below in **Table-1.1**.

TABLE 1.1
HAZARD IDENTIFICATION OF THE PROJECT

Item	Nature of Hazard	Hazard Potential
Raw Material Handling:		
Iron Ore Fines, Limestone, Dolomite etc.	Dust	Minor
Coal	Heat, Fire & Dust	Moderate
HSD/ Lube Oils / Greases	Heat & Fire	Major
Production Units:		
Pellet Plant	Heat & Dust	Moderate
Sponge Iron Plant	Fire, Heat & Dust	Moderate
Steel Making Facilities - Induction Furnaces	Heat & Fire by Hot Metal & Slag Handling	Major
Hot Rolling Mill	Heat	Moderate
Captive Power Plant	Fire, Heat & Dust	Moderate
Producer Gas Plant	Heat & Dust	Moderate

Utilities:		
Fuel (Gas/Liquid)	Heat & Fire	Major
Electric Power Supply	Heat & Fire	Minor

The Brief about nature of various Hazards is given below,

Brief of Nature of Hazard in the Project

NATURE OF HAZARD	SOURCES
Fire Hazard	Release/leakage of waste gas from Sponge Iron plant and Hot Liquid metal. Fire in HSD storage.
Explosion Hazard	Release/leakage of waste gas from Sponge Iron plant.
Fire/Explosions due to Spillage of Liquid Metal	Spillage/Transfer of liquid metal, liquid steel and hot slag.
Heat Radiations due to Hot Metal Handling	Spillage of liquid metal, liquid steel and hot slag
Accidents due to Material Handling Equipment	Connected with all Material Handling Equipment

(a) Splashing of molten metal and solid waste : Sudden breaks out of molten metal and slag have been known to take place during furnace operation. The break out may take place from weak portions of hearth. The 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 will be limited to working personnel near the site of incident.

(b) Dust and fumes: Dust and fumes will be generated at many points in the steel plant.

Exposure to silica is a risk to workers engaged in lining, relining and repairing induction furnaces and vessels with refractory materials. Ladles are lined with fire-brick or bonded crushed silica and this lining requires frequent repair. The silica contained in refractory materials is partly in the form of silicates, which do not cause silicosis but rather pneumoconiosis. Workers are rarely exposed to heavy clouds of dust.

Alloy additions to furnaces making special steels sometimes bring potential exposure risks from chromium, manganese, lead and cadmium.

(c) Rolling Mill: Severe injuries may be sustained in hot rolling, if workers attempt to cross roller conveyors at unauthorized points. Looping and lashing may cause extensive injuries and burns, even severing of lower limbs. The use of large quantities of oils, rust inhibitors and so on, which are generally applied by spraying, is another hazard commonly encountered in rolling mills. Despite the protective measures taken to confine the sprayed products, they often collect on the floor and on communication ways, where they may cause slips and falls.

Even in automated works, accidents occur in conversion work while changing heavy rollers in the stands.

Tongs used to grip hot material may knock together; the square spanners used to move heavy rolled sections by hand may cause serious injuries to the head or upper torso by backlash. Many accidents may be caused by faulty lifting and handling and by defects in cranes and lifting tackle. Many accidents are caused through falls and stumbles or badly maintained floors, by badly stacked material, by protruding billet ends and cribbing rolls and so on.

In hot rolling, burns and eye injuries may be caused by flying mill scale; splash guards can effectively reduce the ejection of scale and hot water. Eye injuries may be caused by dust particles or by whipping of cable slings; eyes may also be affected by glare.

Considerable noise develops in the entire rolling zone from the gearbox of the rolls and straightening machines, from pressure water pumps, from shears and saws, from throwing finished products into a pit and from stopping movements of the material with metal plates.

Cleaning of the finished products with high-speed percussion tools may lead to arthritic changes of the elbows, shoulders, collarbone, distal ulna and radius joint, as well as lesions of the navicular and lunatum bone.

ASSIFICATION OF MAJOR HAZARDOUS SUBSTANCES

Hazardous substances may be classified into three main classes namely flammable substances, unstable substances and toxic substances. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345 M. The major hazardous materials to be stored, transported, handled and utilized within the facility have been summarized in the **Table-1.2**. The fuel storage details and properties are given in **Table-1.3** and **Table-1.4** respectively.

TABLE-1.2
CATEGORY WISE SCHEDULE OF STORAGE TANKS

Materials	Hazardous Properties
HSD	U 1202. Dangerous Goods Class 3 – Flammable Liquid

TABLE-1.3
HAZARDOUS MATERIALS STORED, TRANSPORTED AND HANDLED

A	Material	No. of Tank	Capacity (Storage Condition)
1	HSD	2	25 KL

TABLE-1.4
PROPERTIES OF FUELS USED IN THE PLANT

Chemical	Codes/Label	TLV	FBP	MP	FP	UEL	LEL
			^{0}C			%	
HSD	Flammable	-	371	-	54.4	6	0.7

TLV : Threshold Limit Value FBP : Final Boiling Point
MP : Melting Point FP : Flash Point
UEL : Upper Explosive Limit LEL : Lower Explosive Limit

1.1.1 IDENTIFICATION OF MAJOR HAZARD INSTALLATIONS BASED ON GOI RULES, 2008

Following accidents in the chemical industry in India over a few decades, a specific legislation covering major hazard activities has been enforced by Govt. of India in 2008 (In suppression of 1989) in conjunction with Environment Protection Act, 1986. This is referred here as GOI Rules 2008. For the purpose of identifying major hazard installations, the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

A systematic analysis of the fuels/chemicals and their quantities of storage has been carried out, to determine threshold quantities as notified by GOI Rules, 2008 and the applicable rules are identified. Applicability of storage rules are summarized in **Table-1.5**.

TABLE-1.5
APPLICABILITY OF GOI RULES TO FUEL STORAGE

Sr. No.	Chemical/Fuel	Listed in Schedule	Total Quantity	Threshold Quantity (T) for Application of Rules	
				4, 5, 7-9, 13-15	10-12
1	HSD	3(PART II)	2 x 25 KL	10,000 MT	10,000 MT

1.2 HAZARD ASSESSMENT AND EVALUATION

1.2.1 METHODOLOGY

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

In the proposed steel plant large amounts of material will be processed, transported and conveyed by massive equipment. The major chemicals handled / stored by the plant includes HSD, LDO etc. Due to massive equipment and movement of large masses of materials, workers will be exposed to the heat of molten metal and slag at temperatures up to 1,800°C, toxic or corrosive substances, respirable air-borne contaminants and noise.

Burns may occur at many points in the steel-making process: at the front of the furnace during tapping from molten metal or slag; from spills, spatters or eruptions of hot metal from ladles or vessels during processing, teeming (pouring) or transporting; and from contact with hot metal as it is being formed into a final product.

Water entrapped by molten metal or slag may generate explosive forces that launch hot metal or material over a wide area. Inserting a damp implement into molten metal may also cause violent eruptions.

Mechanical transport exposes workers to potential struck-by and caught- between hazards. Overhead travelling cranes are found in almost all areas of steel works. Most large works also rely heavily on the use of fixed-rail equipment and large industrial tractors for transporting materials.

Large quantities of greases, oils and lubricants are used and if spilled can easily become a slipping hazard on walking or working surfaces.

Sharp engines or burrs on steel products or metal bands pose laceration and puncture hazards to workers involved in finishing, shipping and scrap-handling operations.

Foreign-body eye hazards are prevalent in most areas, especially in raw material handling and steel finishing, where grinding, welding and burning are conducted.

1.2.2 PRELIMINARY HAZARD ANALYSIS (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally, the vulnerable zones are plotted for which risk reducing measures are deduced and implemented. Preliminary hazard analysis for fuel storage area and whole plant is given in **Table-1.6** and **Table-1.7**.

TABLE-1.6
PRELIMINARY HAZARD ANALYSIS FOR STORAGE AREAS

Unit	Capacity	Hazard Identified
HSD	2x25 KL	Pool fire

TABLE-1.7
PRELIMINARY HAZARD ANALYSIS FOR THE WHOLE PLANT IN GENERAL

PHA Category	Description of Plausible Hazard	Recommendation	Provision
Environmental factors	If there is any leakage and eventuality of source of ignition.	--	All electrical fittings and cables will be provided as per the specified standards. All motor starters will be flame proof.
	Highly inflammable nature of the liquid fuels may cause fire hazard in the storage facility	A well designed fire protection including foam, dry powder, and CO_2 extinguisher should be provided.	Fire extinguisher of small size and big size will be provided at all potential fire hazard places. In addition to the above, the Company has own firefighting equipment.

1.2.3 FIRE EXPLOSION AND TOXICITY INDEX (FE&TI) FOR STORAGE UNIT

Dow's Fire and Explosion Index (F and E) is a product of Material Factor (MF) and hazard factor (F3) while MF represents the flammability and reactivity of the substances, the hazard factor (F3), is itself a product of General Process Hazards (GPH) and Special Process Hazards (SPH). The application of FE & TI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information.

The degree of hazard potential is identified based on the numerical value of F&EI as per the criteria given below:

F&EI Range	Degree of Hazard
0-60	Light
61-96	Moderate
97-127	Intermediate
128-158	Heavy
159-up	Severe

By comparing the indices F&EI and TI, the unit in question is classified into one of the following three categories established for the purpose **(Table-1.8).**

TABLE-1.8
FIRE EXPLOSION AND TOXICITY INDEX

Category	Fire and Explosion Index (F&EI)	Toxicity Index (TI)
I	F&EI < 65	TI < 6
II	65 < or = F&EI < 95	6 < or = TI < 10
III	F&EI > or = 95	TI > or = 10

F&EI Index Range	Degree of Hazards
1 – 60	Light
61 – 96	Moderate
97 – 127	Intermediate
128 – 158	Heavy
159 – up	Severe

Certain basic minimum preventive and protective measures are recommended for the three hazard categories.

1.2.4 RESULTS OF FE AND TI FOR STORAGE UNIT

Based on the GOI Rules 2008, the hazardous fuel used by the proposed project is identified. Fire and explosion are the likely hazards, which may occur due to the fuel storage. Hence, fire and explosion index has been calculated for in plant storage.

The Health (N_h), Flammability (N_f), Reactivity (N_r), and MF (Material Factor) for all the materials under consideration was derived from NFPA (National Fire Protection Association) codes. The GPH (General Process Hazard Factor) and SPH (Specific Process Hazard Factor) was calculated accordingly. Based on F&EI (Fire and Explosion Index), the HSD will come in light degree of hazard and nil toxicity. Thus Risk Assessment and Hazard analysis has been carried out due to fire hazard for HSD tanks by carrying out MCA (Maximum Credible Accident) analysis for the same. Estimates of FE&TI are given in **Table-1.9**.

TABLE-1.9
FIRE EXPLOSION AND TOXICITY INDEX

Fuel	Total Capacity	NFPA Classification				GPH	SPH	F&EI	F & E Category	**TI	Toxicity Category
		N_h	N_f	N_r	MF						
HSD	2x25 KL	0	2	0	10	2	2.2	43.2	Light	NIL	-

Results of FE&TI analysis show that the storage of HSD falls into Light category of fire and explosion index.

Damage distance computations for MCA (Maximum Credible Accident) analysis

The major hazards scenarios identified for the possibility of occurrence are mainly concerned with HSD tanks.

A storage tanks of HSD with a capacity of 1x25 KL, Molecular Weight 135 kg/kg mol, Boiling Point 350°C, density 900 kg/m^3 is considered. Tank fire would occur if the radiation intensity is high on the peripheral surface of tanks leading to increase in internal tank pressure. Pool fire would occur when fuel oil collected in the dyke due to leakage gets ignited. As the tanks are provided within the dyke the fire will be confined within the dyke wall.

SOURCE STRENGTH:

Burning Puddle / Pool Fire
Puddle Diameter: 2.5 meters
Puddle Volume: 5 cubic meters
Flame Length: 8 meters

Burn Duration: ALOHA limited the duration to 1 hour
Burn Rate: 25.3 kilograms/min
Total Amount Burned: 1,516 kilograms

THREAT ZONE:

Sr. No.	Incident Radiation (kW/m^2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
1	37.5	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec
2	12.5	Minimum energy to ignite with a flame; melts plastic tubing	1% lethality in 1 min.
3	4.5		Causes pain if duration is longer than 20 sec, however blistering is un-likely (First degree burns)
4	2		Causes no discomfort on long exposures

Source: Techniques for Assessing Industrial Hazards by World Bank

The maximum capacity of storage of HSD is 25 KL. The most credible failure is the rupture/hole of the storage tank. As a worst case, it is assumed that the entire contents leak out into the dyke forming a pool, which may catch fire on finding a source of ignition. The radiation intensities for rupture of HSD storage tank is given in **Table-1.10**.

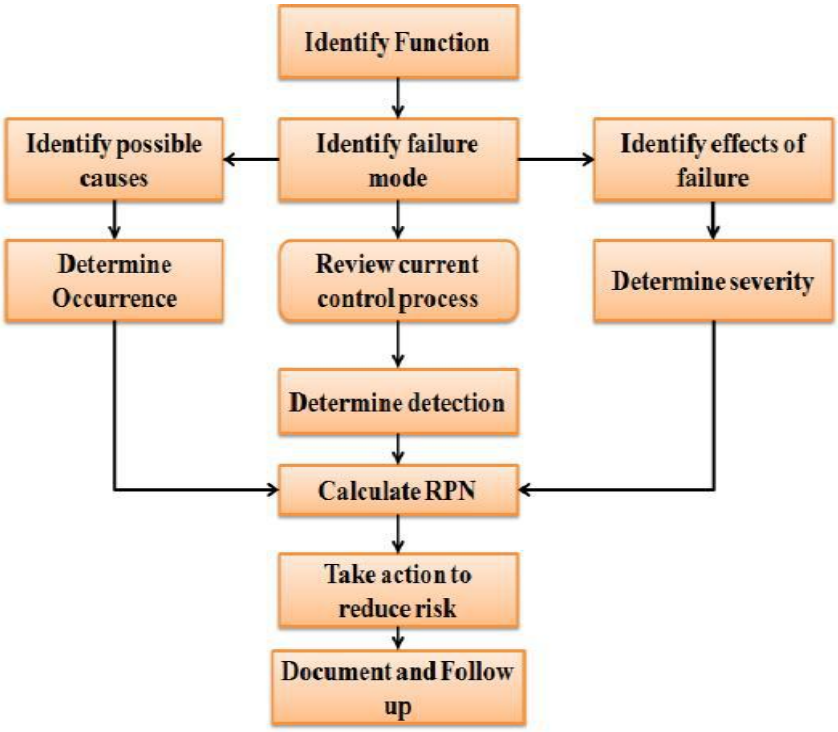
TABLE-1.10
THERMAL RADIATION DUE TO FAILURE OF HSD TANKS

Scenario	Thermal radiation kW/m^2 distance in m			
	37.5	**12.5**	**4.5**	**2.0**
Failure of HSD Storage tank	0.69	1.5	2.23	3.81

1.3 FAILURE MODE EFFECT ANALYSIS

Failure mode effects analysis (FMEA) is one of the most important and widely used tools for reliability analysis. FMEA identifies corrective actions required to reduce failures to assure the highest possible yield safety and reliability. Even though it is widely used reliability technique it has some limitation in prioritizing the failure modes and output may be large for even simple systems, may not easily deal with time sequence, environmental and maintenance aspects.

Figure – 1.1 : Steps in FMEA



1.3.1 RISK PRIORITY NUMBER

Risk priority number (RPN) methodology is a technique for analysing the risk associated with potential failures during a FMEA analyses. To calculate risk priority number severity, occurrence, and detection are the three factors need to determine.

Risk priority number (RPN) = Severity × Occurrence × Detection

1.3.2 SEVERITY (S)

Severity is the seriousness of the effect of potential failure modes. Severity rating with the higher number represents the higher seriousness or risk which could cause death.

Table-1.11: Example table of Severity

Rating	Detection	Detection by design control
10	Absolute uncertainty	Design control cannot detect failure mode
9	Very remote	Very remote chance the design control detect failure mode
8	Remote	Remote chance the design control detect failure mode
7	Very low	Very low chance the design control detect failure mode
6	low	Low chance the design control detect failure mode
5	Moderate	Moderate chance the design control detect failure mode
4	Moderately high	Moderately high chance the design control detect failure mode
3	High	High chance the design control detect failure mode
2	Very high	Very high chance the design control detect failure mode
1	Almost certain	Design will control detect failure mode

1.3.4 OCCURRENCE (O)

Occurrence ratings for FMEA are based upon the likelihood that a cause may occur based upon past failures and performance of similar system in similar activity. Occurrence values should have data to provide justification.

Table –1. 12: Example table of Occurrence

Rating	Classification	Example
10 9	Very high	Inevitable failures
8 7	High	Repeated failures
6 5	Moderate	Occasional failures
4 3	Low remote	Few failures
2 1	Remote	Failures unlikely

1.3.5 DETECTION (D)

Detection is an assessment of the likelihood that the current controls will detect the cause of failure mode.

Table – 1.13: Example table of Detection

Ranking	Effect	Severity effect
10	Hazardous without warning	Very high severity without warning
9	Hazardous with warning	Very high severity with warning
8	Very high	Destructive failure without safety
7	High	System inoperable Equipment damage
6	Moderate	System inoperable with Minor damage
5	low	System inoperable without damage
4	Very low	Degradation of performance
3	Minor	System operable with Some degradation in performance
2	Very minor	System operable with minimal interference
1	None	No effect

1.3.6 FMEA IMPLEMENTATION

Failure mode effect analysis is executed by a multidisciplinary team of experts with the help of process flow chart. Criteria of ranking of severity, occurrence and detection are selected suitably by analyzing the past failure records of the furnace. Using values of severity, occurrence and detection number risk priority number is calculated.

Table – 1.14: RPN for proposed expansion project & Propose Control Measures

Sponge Iron Plant									
Conveyor feed belt to DRI	Friction	Corrosion	Improper Maintenance	Belt Sway Switch	8	2	2	32	Lubricating the rotating parts regularly
Reducing Gas injection	Pipeline rupture	Process Failure in DRI Kiln	Over Pressure	Line Inspection	7	3	3	42	Regular inspection and Periodic maintenance
Cooler Discharged Gas	Pipeline rupture	Failure in After Burning Chamber	Excess Pressure	Line Inspection	5	3	2	30	Regular inspection and Periodic maintenance
Mag Pulley	Mechanical Failure	Waste Conveying	Improper Monitoring	Inspection	5	3	3	45	Periodic Maintenance

		System Failure							
Conveyor Belt to storage Bins	Friction	Waste Storage System Failure	Improper Maintenance	Belt Sway Switch	4	2	2	16	Lubricating the rotating parts regularly
SMS- INDUCTION FURNACE									
Flow monitoring switch	Failure to operate	Rupture in Current Flow	Switch broken	Reliable Supplier	7	2	3	42	Regular Inspection
DC Choke	Failure to operate	Rise of current to dangerous level	Electric Failure	Reliable Supplier	7	3	3	63	Regular Inspection
DM Water circulating unit	Failure to circulate de ionized water	Excessive Heat generation in solid state power supply unit	Electric Failure	Inspection	4	3	3	24	Regular inspection and Periodic maintenance
direction Control Valve	Failure to operate	furnace tilting control failure	Corrosion	Reliable Supplier	7	2	3	42	Periodic Maintenance
Furnace lamination packet	Electric/magnetic failure	Failure to provide a return path to the flux	Overheating of the structure	Inspection	7	3	2	42	Regular inspection and Periodic maintenance
Flow regulating valves in furnace	Failed to Operate	Excessive Temperature	Improper Maintenance	Indicator	8	3	4	96	Periodic Maintenance
Hot metal lifting by crane	Rope breakage	Hot Metal ladle down	Overloading	Safe working load are marked	9	3	2	54	interlocks with alarm
Hot metal transfer by trolley	Mechanical Failure (Gearbox, Axial, Wheel)	Spillage of hot metal	Improper Maintenance	ROW (3 m) marked, cover ladle, loading within Granted permissible limit	9	3	2	54	Regular inspection and Periodic maintenance
Ladle Refining Furnace									
Hot metal ladle transfer car	Friction	Fire	Improper Maintenance	Belt Sway Switch	8	2	2	32	Lubricating the rotating parts regularly
Continuous Casting Machine									
Ladle car	Friction	Fire	Improper Maintenance	Belt Sway Switch	8	2	2	32	Lubricating the rotating parts regularly
Stopper	Mechanical Failure	Fire & Explosion	Improper Maintenance	Indicator	7	2	2	28	Regular Inspection
Tundish	Failed to Operate	Spillage of Hot liquid metal	Mechanical Failure	Line inspection	7	2	2	28	Regular inspection and Periodic maintenance

Rolling Mill (Hot)									
Conveyor rollers to feed	Friction	Fire	Improper Maintenance	Belt Sway Switch	8	2	2	32	Lubricating the rotating parts regularly
Water cooling pump	Pump failure	Explosion	No power supply	Redundant power supply	10	3	2	60	Check the fuel level of diesel generator
Dolochar Coal Mix based CPP									
Air Supply Fluidized Bed	Flow Air Fuel Ratio	Operation Failure	Air Flow Below 30 %	Line inspection	5	3	5	75	Provide detectors with alarm system
Boiler	Corrosion Effect	Cooling of tube increases temperatur e	Creep Failure	Line inspection	4	4	5	80	Regular inspection
Boiler	Boiler Tube	Damage inside & outside the tube	Extremely combustion	Monitors	6	2	5	60	Periodic Maintenance
Boiler	Tube Alignment & Setting	Deformatio n of vibration Arrestor	Vibration increases	Inspection	6	2	4	48	Periodic Maintenance
Boiler	Incomplete Combustio n	Air Fuel Losses	Insufficient air supply to Furnace	Line inspection	5	2	5	50	Regular inspection
Turbine/ Steam Generator	Temp of Super Heater & Reheater	Failure of turbine blades	Changing the plant load	Line inspection	5	2	6	60	Periodic Maintenance
Turbine/ Steam Generator	Loss of fuel	Abnormal Combustio n	Improper air fuel mixture	Monitors	4	3	4	48	Check the level for every 5 minutes
water Tank	Water Level of Drum	Excess Steam Pressure	Failure of Indicators	Monitor	6	3	2	36	Regular inspection
Producer Gas Plant									
Air Injection	Pipeline rupture	Operation failure	Improper Maintenance	Detectors	7	3	2	42	Provide detectors with alarm system
Turbine	Temp of Super Heater & Reheater	Failure of turbine blades	Changing the plant load	Line inspection	5	2	6	60	Periodic Maintenance

1.3.7 RESULT OF FEMA FOR PROCESS UNIT

- In SMS, highest value of risk priority number is obtained . However,periodic maintenance shall minimize the risk probability.
- The hot metal from Induction Furnace will be transported by crane / trolley which carry moderate risk priority number. This will be

well equipped with the interlocking facility with alarm in case of any overloading. Moreover, proper marking with ROW of 3 m will be in place along with all safe guards to ensure the absence of water throughout the hot metal transfer route.

1.4 RISK REDUCTION OPPORTUNITIES

The following opportunities will be considered as a potential means of reducing identified risks during the detailed design phase:

- Safety organization is of prime importance in the iron and steel industry, where safety depends so much on workers' reaction to potential hazards. The first responsibility for management is to provide the safest possible physical conditions, Accident-prevention committees, workers' safety delegates, safety incentives, competitions, suggestion schemes, slogans and warning notices can all play an important part in safety programmes.
- Provision for adequate water capacity to supply fire protection systems and critical process water;
- Isolate people from load carrying/mechanical handling systems, vehicle traffic and storage and stacking locations;
- Installation of fit-for-purpose access ways and fall protection systems to facilitate safe access to fixed and mobile plant;
- Provision and integrity of process tanks, waste holding tanks and bunded areas as per relevant standards;
- Arrange display signs for material strictly prohibited inside any work premises like inflammable materials, firearms, weapons & ammunitions, etc.
- Developing 'Dos' & 'Don'ts' during various types of works like working at heights, etc.
- Ensure that emergency control mechanisms like switch, valve and emergency lamp are covered with shield, water & shock resistance cover during rain etc. and peddle switch for bigger rotating machinery mixer etc. There should be no temporary cable joints and open air working switch yard at enriched level.
- In addition to the yard fire hydrant system, each individual shop would be provided with fire and smoke detection alarm system. Fire detection system would be interlocked with automated water sprinklers.
- Security of facility to prevent unauthorized access to plant, introduction of prohibited items, and control of onsite traffic; and

- Development of emergency response management systems commensurate.

Overall, an integrated approach combining good engineering and maintenance practices, safe job procedures, worker training and use of personal protective equipment (PPE) is required to control hazards.