7.0 ADDITIONAL STUDIES

7.1 RISK ASSESSMENT[1]

7.1.1 Introduction

The present proposal of JSWSL for expansion will create additional energy requirements, which will be catered to by in-plant generation of COG, BFG, BOFG and/or Mixed Gas. For functioning of the plant, it is required to handle and/or store all of these hazardous materials.

In Risk assessment studies the first step would be the Hazard Identification & quantification. This involves Hazard analysis which essentially is identification and quantification of the various hazards that are likely to occur in the industry as well as quantification of the consequences due to a particular hazard. The risk analysis estimates the probability as well as severity of a particular hazard over an exposed group of people, plant equipment or both.

Hazard identification and Risk assessment (HIRA) assists in identifying the most likely hazards which can have significant impact on workplace safety in an industry. It helps in devising effective management measures as well as engineering measures for both preventive as well as post-disaster management.

7.1.2 Scope of the Study

The scope of this study includes the assessment of proposed operations, storage and handling of hazardous materials with respect to associated hazards, the risks involved and updation of existing Disaster Management plan (DMP). Based on the Hazard Identification and analysis, the major disaster scenarios would be worked out to estimate the consequence of failure. JSW Steel, Toranagallu (JSWSL) is an existing plant and already has a comprehensive Disaster Management plan (DMP) which would be updated to meet the emergency situations due to the envisaged facilities of the proposed expansion project.

The present study includes hazard identification and consequence analysis for the new projects included in the proposed expansion of JSWSL.

The primary potential hazards due to the proposed units are identified based on a detailed Primary Hazard analysis (PHA) along with consequence analysis for the risk assessment. The same has been elaborated hereunder.

Hazards and risks for existing facilities has already been assessed by JSWSL and the same have been incorporated in their existing Onsite emergency plan. The brief details of the same are also reproduced in this chapter.

1 *Standard TOR point 3(x)*

7.1.3 Proposed project

The proposed expansion project of JSWSL from 16 MTPA to 18 MTPA primarily involves installation of a new Blast furnace (BF-5) of 4.5 MTPA capacity instead of earlier envisaged 3.0 MTPA blast furnace. Also, SMS-3 (EAF) will be augmented by installing 1x1.5 MTPA ZPF instead of earlier envisaged 1x1.2 MTPA EAF as well as SMS-4 (BOF) will expand by installation of 2x350 T BOF Converter in place of 2 x 200 T BOF Converter. Other facilities proposed to be revised in the proposed expansion project is elaborated in Chapter-2 of this EIA-EMP report.

The enhanced BF-5 of 4.5 MTPA capacity as well as higher capacity 2x350 T BOF converters will lead to increase in the total BF gas generation as well as BOF gas generation. The increased quantities of BFG and BOF G at 18 MTPA stage are the additional hazardous gases that will be required to be stored after expansion of JSWSL to 18.0 MTPA stage. A new BOF gas holder as well as a new BF gas holder of 1,00,000 m^3 capacity each is also envisaged to store these increased gases. Additionally, about 3.3 km of associated new pipelines are also envisaged from these storages to connect the existing gas network to these storages.

The major substances to be additionally handled/stored by JSWSL includes Blast furnace gas (primarily CO) and BOF Gas (primarily CO, N_2 & CO_2), etc.

In view of the above, JSWSL's proposed activities are scrutinized in line of the "Manufacture, Storage and Import of Hazardous Chemicals Rules" and the observations / findings are presented in this chapter.

An elaborate and well-documented Disaster Management Plan covering all substances/gases handled by JSWSL for their existing plant is already in place. The same shall be upgraded and extended to the proposed units under the expansion programme of JSWSL.

The assessment has been made in a systematic manner covering the requirements of the abovementioned rules. Accordingly, subsequent sections have been divided as follows:

- Brief Process description
- Applicability of the MSIHC Rules
- Hazard Identification
- Fire explosion & Toxicity Index (FETI) Approach for macro level risk assessment
- Consequence analysis for fire & explosion as well as toxicity hazards (with MCAA)
- Domino effects
- Failure frequency analysis
- Risk estimation
- Hazard events with greatest contribution to fatality (i.e. Risk ranking)
- Summary & Conclusions of Risk Assessment
- Recommended Risk reduction & Mitigation measures
- Offsite & onsite Disaster Management & Emergency Plan

7.1.4 Brief Process Description

JSWSL is producing steel products via BF (Blast furnace)/COREX –BOF (Basic Oxygen Furnace) and DRI – EAF (Electric Arc Furnace)/ ZPF (Zero pollution Furnace) routes for steel making. Iron ore lumps, sinter and coke (made from coking coal) and fluxes such as limestone, dolomite are the major raw materials. The major steps in the manufacturing process are as follows:

- Coke making - coal carbonisation
- Sintering
- Hot metal production (blast furnace and COREX)
- Steel production (basic oxygen furnace and DRI-EAF)
- Continuous casting

The above processes require considerable thermal energy, which is supplied through fuel gasses generated in the plant e.g. Coke oven gas (COG), Blast Furnace gas (BFG), BOF gas etc.

The present proposal of JSWSL for expansion will create additional energy requirements, which will be catered to by in-plant generation of COG, BFG, BOFG and/or Mixed Gas. Therefore to run the plant, it is required to handle and/or store all of these fuel gases.

As detailed in previous paragraphs, the proposed expansion project of JSWSL entails primarily an increase in BF gas generation due to installation of higher capacity Blast furnace, BF-5 of 4.5 MTPA capacity instead of earlier envisaged 3.0 MTPA Blast furnace as well as an increase in BOF gas due to installation of higher capacity 2x350 T BOF converters instead of earlier 2x200 T converters. Consequently, a new BF gas holder and a new BOF gas holder is also envisaged to store these gases.

The major additional hazardous materials to be stored, transported, handled and utilized within the facility have been summarized in **Table 7.1**:

Table 7.1 - List of additional Major Hazardous Substances to be Stored /Handled

Sn.	Additional Hazardous substance handled	Quantity handled	Type of vessel used for handling / storage	Nature of hazard associated
1.	Blast Furnace Gas[1#]	**109+31=140 T** stored in 01 BF Gas holder of 1 lakh m^3 capacity and handled via associated new pipelines	Stored in steel Cylindrical shaped gas holder with Dry seal and handled via In-plant Steel pipelines	Flammable gas
2.	BOF gas[2#]	**128+2.5=130.5 T** stored in 01 BOF Gas holder 1 lakh m^3 capacity and handled via associated new pipelines	Stored in steel Cylindrical shaped gas holder with Dry seal and handled via In-plant Steel pipelines	Flammable gas
Note: *[1]Blast Furnace Gas density 1.25 kg/m^3 at 0°C, 1 atm pressure conditions considering tentative gas mixture composition* *[2]BOF Gas quantity computed considering density as 1.37 kg/Nm^3* *[#]Total Quantity of gas handled includes amount of gas stored in holders along with gas in associated new pipelines*				
Source: • *SMS Gas holder capacity as per Pre-Feasibility Report furnished by JSWSL.* • *BF Gas Holder capacities as per Technical details furnished by JSWSL to IMD section of MECON.* • *Details of pipelines as per P&ID of existing Interplant Gas pipeline network, furnished by JSWSL's Energy Management Dept.*				

7.1.5 Applicability of the MSIHC Rules

As per MSIHC Rules, 1989 with subsequent amendments, the steel production process is classified as an "industrial activity" handling hazardous substances.

To decide whether the above mentioned industrial activities/substances are likely to come within the scope of the above mentioned "Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 & subsequent amendments", the threshold quantities mentioned in the rules are used for comparison, as given in **Table 7.2**.

Table 7.2 - Threshold Quantity & Identified Hazardous Substances to be handled as per MSIHC Rules, 1989 & subsequent amendments

Sn	Hazardous substance stored/ handled	Max. Quantity stored/ handled	Whether Included in The List of Hazardous & Toxic Chemicals	Type of vessel used for storage	Lower Threshold Qty. (In Tonne) *[For rules 5,7 to 9 & 13 to 15]*	Upper Threshold Qty. (In Tonne) *[For rules 10 to 12]*	Remarks
1.	Blast Furnace Gas	**109 T**	**Yes**, As per Sch. 3(i)	Steel Cylindrical shaped gas holder (Capacity: 1,00,000 m^3)	15	200	***Exceeds lower but within upper threshold limit.*** *Consequence analysis required to be carried out.*
		31 T	**Yes**, As per Sch. 3(i)	In-plant Steel pipelines (2277.8 m of 4000 mm ø pipes)	15	200	***Exceeds lower but within upper threshold limit.*** *Consequence analysis required to be carried out.*
2.	BOF gas	**128 T**	**Yes**, As per Sch. 3(i)	Steel Cylindrical shaped gas holder (Capacity: 1,00,000 m^3)	15	200	***Exceeds lower but within upper threshold limit.*** *Consequence analysis required to be carried out.*
		2.5 T	**Yes**, As per Sch. 3(i)	In-plant Steel pipelines (969 m of 1600 mm ø pipes)	15	200	***Exceeds lower but within upper threshold limit.*** *Consequence analysis required to be carried out.*

Sources:
- *SMS Gas holder capacity as per Pre-Feasibility Report furnished by JSWSL.*
- *BF Gas Holder capacities as per Technical details furnished by JSWSL to IMD section of MECON.*
- *Details of pipelines as per P&ID of existing Interplant Gas pipeline network, furnished by JSWSL's Energy Management Dept.*

The comparison of the above identified hazardous substances to be handled and stored at JSWSL with their corresponding threshold quantities, it can be noticed that BF gas and BOF gas exceed the lower threshold limits and come under the purview of MSIHC Rules, 1989 amended in 2000. Accordingly, Rule-7 i.e. notification of site requires submission of a written report containing consequence analysis among other information.

Further, rule 17 i.e. preparation and maintenance of material safety data sheets are also required for both the substances.

Owing to the hazardous nature of BF and BOF gas, consequence analysis of the facility has been done, taking in consideration all hazardous substances identified at **Table 7.2** above. MCAA (maximum credible accident analysis) approach has been used to identify plausible worst case scenarios for hazard identification and risk assessment.

7.1.6 Hazard Identification

Hazards associated with the identified hazardous chemicals based on NFPA (National Fire Protection Association) ratings as well as other parameters are presented in **Table 7.3.**

Table 7.3 - Type of Hazards Associated With Identified Hazardous Chemicals

Name of Chemical		Type of Hazard	*NFPA Hazard Rating*			IDLH Value	Flash point (°C)	Flammability range (for gases)	Remarks
			Health	*Flammability*	*Reactivity*				
*Constituents of **BFG/ BOFG***	Hydrogen	1,6,9	*0*	*4*	*0*	-	-	LEL = 4% (<13%)	All gases transported directly through pipelines. *Release: Leak/rupture* *LD gas stored in Steel Gas holders. Release: Leak/ Rupture*
	Methane	1,6,9	*2*	*4*	*0*	-	-	LEL = 4.4% (<13%)	
	Carbon monoxide	1,3,9	*3*	*4*	*0*	1200 ppm	-	LEL = 12% (<13%)	
	Ammonia(NH_3)	4,8	*3*	*1*	*0*	300 ppm	-	LEL = 16% UEL = 25%	
	Naphthalene	1,7,8	*2*	*2*	*0*	250 ppm	79°	LEL = 0.9% UEL = 5.9%	

Note: IDLH: Immediately Dangerous to Life or Health

Type of Hazard :

1 Flammable substance	*6 Gas or vapour not dangerous other than displacing air*
2 Oxidising substance, reacts with reducing agents	*7 Causes skin irritation or burns*
3 Emits a toxic gas or vapour	*8 Toxic substance*
4 Emits an irritating gas or vapour	*9 Explosive material under certain conditions*
5 Emits a narcotic gas or vapour	

NFPA HAZARD Rating

a) HEALTH

1 - None	2 - Minor	3 - Moderate, could cause temporary incapacitation or injury	4 - Severe, short exposure may cause serious injury	5 - Extreme, short exposure may cause death

b) FLAMMABILITY

1-None, Material does not burn	2- Minor, material must be preheated to ignite	3- Moderate, moderate heating is required for ignition and volatile vapours are released	4- Severe, material ignites at normal temperature	5- Extreme, very flammable substance that readily forms explosive mixtures

c) REACTIVITY

1-None, stable when exposed to fire	2-Minor, unstable at high temp. or press and may react with water	3-Moderate, unstable but does not explode, may form explosive mixture with water	4-Severe, Explodes if heated or water added	5-Extreme, readily explosives under normal condition

Source:

- *MSDS of chemicals as per published literature and/or furnished by JSWSL*
- *Onsite Emergency Plan of JSWSL*
- *Published literature for properties of chemicals at https://www.nfpa.org*

From the above table it can be observed that BF gas and BOF gas both are the hazardous materials of concern for the proposed project.

The catastrophic potential of a hazardous substance depends on its flammability, toxicity and volatility. The ambient temperature and vapour pressure of a substance is used as a measure of the ability to become air borne. Both BF and BOF gas are proposed to be stored in the plant, hence the fire hazards associated have been quantified owing to its toxic as well as high flammable nature.

The primary potential hazards due to the identified hazardous facilities is summarised in **Table-7.4** as below.

Table 7.4 - Primary Hazard Analysis of Proposed facilities

Unit/ facility	Hazardous activity	Failure Scenario	Nature of Potential Hazard	Control measures
Blast Furnace, BF5	Storage of BF gas (in new gas holder)	Failed tank or associated fittings, pump or pipework or operator error or mechanical damage	• Fire and explosion • Toxic cloud dispersion	• Design of storage structures / tanks to relevant standards and legislations. • Regular inspections and maintenance. • Operator induction and ongoing training. • Operational procedures. • Material safety data sheet (MSDS) register and MSDSs kept on-site at different locations in form of signage etc. • Hazard Signage. • Design of storage structures / tanks to relevant standards and legislations. • Appropriate storage of all chemicals, fuel and dangerous substances in accordance with relevant Hazardous Chemical Rules, 2000 with subsequent amendments and associated legislations. • Housekeeping activities – site would be kept clean and tidy and fire hazards removed where practicable. • Availability of firefighting equipment, such as overhead water spray system, mounted on top of gas holders. • Regular inspections and maintenance of firefighting equipment and storage areas, where required. • Site policies, management plans and procedures. • Protection of storage facilities (e.g. bollards). • Operator induction and ongoing training. • Location of explosive storage should be such that it has minimum interaction with people and property.
SMS-4	Storage of BOF gas (in new gas holder)	Failed tank or associated fittings, pump or pipework or operator error or mechanical damage	• Fire and explosion • Toxic cloud dispersion	

Unit/ facility	Hazardous activity	Failure Scenario	Nature of Potential Hazard	Control measures
Gas distribution network	Transport of BF & BOF Gas via associated new pipelines	Failure of pipeline, bursting of pipeline due to Corrosion, Vibration, external loading, Operation error, Over pressure, Maintenance failure, or Sabotage	• Fire and explosion • Toxic cloud dispersion	• Design of pipelines (i.e. wall thickness and stress relief), well sites, Central Processing Facility and related infrastructure to relevant standards and legislation. • Installation of pressure monitoring systems. • Conduct regular inspections, maintenance and testing of equipment. • Site policies, management plans and procedures. • Operator induction and ongoing training. • Maintenance of fire breaks to slow the progress of bushfires. • Routine hazard reduction burns. • Fire-fighting equipment and spill kits located in on-site vehicles and infrastructure (where appropriate). • Restriction of access to storage areas, including securing storage facilities. • Provision of adequate lighting around storage facilities. • Signage (i.e. unauthorized entry warning and information signs). • Police would be notified as soon as possible in case of a suspected breach. • Material safety data sheet (MSDS) register and MSDSs kept on-site at different locations in form of signage etc.
Source: • *Existing Emergency Plan of JSWSL.* • *Accident history of similar facilities for plant facilities.* • *EGIG and OISD manuals on pipeline and storage vessel failures.*				

7.1.7 Fire Explosion and Toxicity Index (FE&TI) Approach for macro level risk assessment

Dow's Fire Explosion Index (F&EI) and Mond's Toxicity Index (TI), together called as Fire Explosion and Toxicity Index (FETI), is one of the most widely used relative ranking hazard index. It is a quantitative risk analysis method used for hazard identification at plant level as well as estimation of the total risk due to a given process.

The application of FETI would help to make a quick assessment of the nature and quantification of the hazard in a plant facility on an overall plant scale. F&EI is a product of Material Factor (MF) and Hazard Factor. While MF represents the flammability and reactivity of the substances, hazard factor is itself a product of General Process Hazard (GPH) and Special Process Hazard (SPH).

As per *Dow's Fire & Explosion Index Hazard Classification Guide, Seventh Edition, 1994, by American Institute of Chemical Engineers,* the degree of hazard potential is identified based on the numerical value of Dow's F&EI. Similarly, the degree of hazard potential based on the numerical value of Mond's Toxicity Index as per *Mond's Index Manual, 1993 by Imperial Chemical Industries (ICI)* is identified as per the criteria given below:

Table 7.5 - Degree of Hazard for F&EI and TI

Dow's F&EI index range	Mond's Toxicity Index range	Degree of Hazard
0-60	1 – 6	Light
61-96	6 – 10	Moderate
97-127	> 10	Intermediate
128-158	> 10	Heavy
159-up	> 10	Severe

Source:
- *Dow's Fire & Explosion Index Hazard Classification Guide, Seventh Edition, 1994, by American Institute of Chemical Engineers (AICHE)*
- *Mond's Index Manual, 1993 by Imperial Chemical Industries (ICI)*

By comparing the indices of F&EI and TI given in above table, the unit under analysis is classified into one of the following categories established for this purpose.

Table 7.6 - Categories of substances based on F&EI and TI

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

Source:
- *Dow's Fire & Explosion Index Hazard Classification Guide, Seventh Edition, 1994, by AICHE*
- *Mond's Index Manual, 1993 by ICI*

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

Results of FE and TI for Storage/Process Units

Based on the methodologies for calculation of FE & TI, the hazardous BF gas and BOF gas storages proposed by JSWSL have been evaluated for the likely fire and explosion as well as toxic hazards. The estimates for F&E and TI are given below:

The maximum exposure allowed by OSHA in the workplace over an eight hour period for Carbon monoxide is 35 ppm and the NFPA codes (704, 325M or 49) indicates a health rank of 3 for CO. The same have been used to calculate Mond's Toxicity Index (TI).

Table 7.7 - Fire explosion & Toxicity Index assessment

Sl. No.	Chemical/Fuel	Storage capacity	F&EI	Degree of Hazard	TI	Category
1.	Carbon Monoxide (major component of BF Gas and BOF gas)	1,00,000 m^3	108.86	Intermediate	6.7	Moderate

Source:
- *Calculations as per methodologies defined by Dow's F&EI Hazard Classification Guide, 7th Ed., 1994, by AICHE & Mond's Index Manual, 1993 of ICI*

Dow's F&E Index value is calculated to be 108.86 for BFG/BOF gases (having Carbon Monoxide as the major component), implying intermediate degree of fire and explosion hazard. The radius of exposure, accordingly is calculated to be 91.4 ft. (i.e. 27.9 m). Thus any equipment/facility/person within 27.9 m of these storages will be at risk to be exposed to a fire & explosion hazard.

The degree of toxic hazard due to these gases is estimated to be moderate, indicated by a Mond's Toxicity index value of 6.7.

7.1.8 Consequence Analysis for fire and explosion as well as toxic hazards

Subsequent to the accidental release of hazardous chemicals, the consequence depends on various factors e.g. type and inventory of released hazardous materials, presence and location of an ignition source, meteorological conditions, etc.

DNV's PHAST, which is a consequence and risk assessment software for calculation of physical effects (fire, explosion, atmospheric dispersion) of the escape of hazardous materials has been used to perform the consequence calculations. The software allows detailed modelling and quantitative assessment of release of pure chemicals as well as mixtures from different scenarios.

Consequence analysis quantifies vulnerable zone for a conceived incident and once the vulnerable zone is identified for an incident, measures can be proposed to eliminate damage to plant and potential injury to personnel.

Consequence analysis for additional BF Gas and BOF Gas proposed to be handled via pipelines at JSWSL after implementation of the expansion project has been carried out.

For the purpose of consequence modelling, Maximum Credible Accident Analysis (MCAA) approach has been used to select worst-case credible scenarios. The same is detailed in subsequent paragraphs

a) Scenario selection based on Maximum Credible Accident Analysis (MCAA)

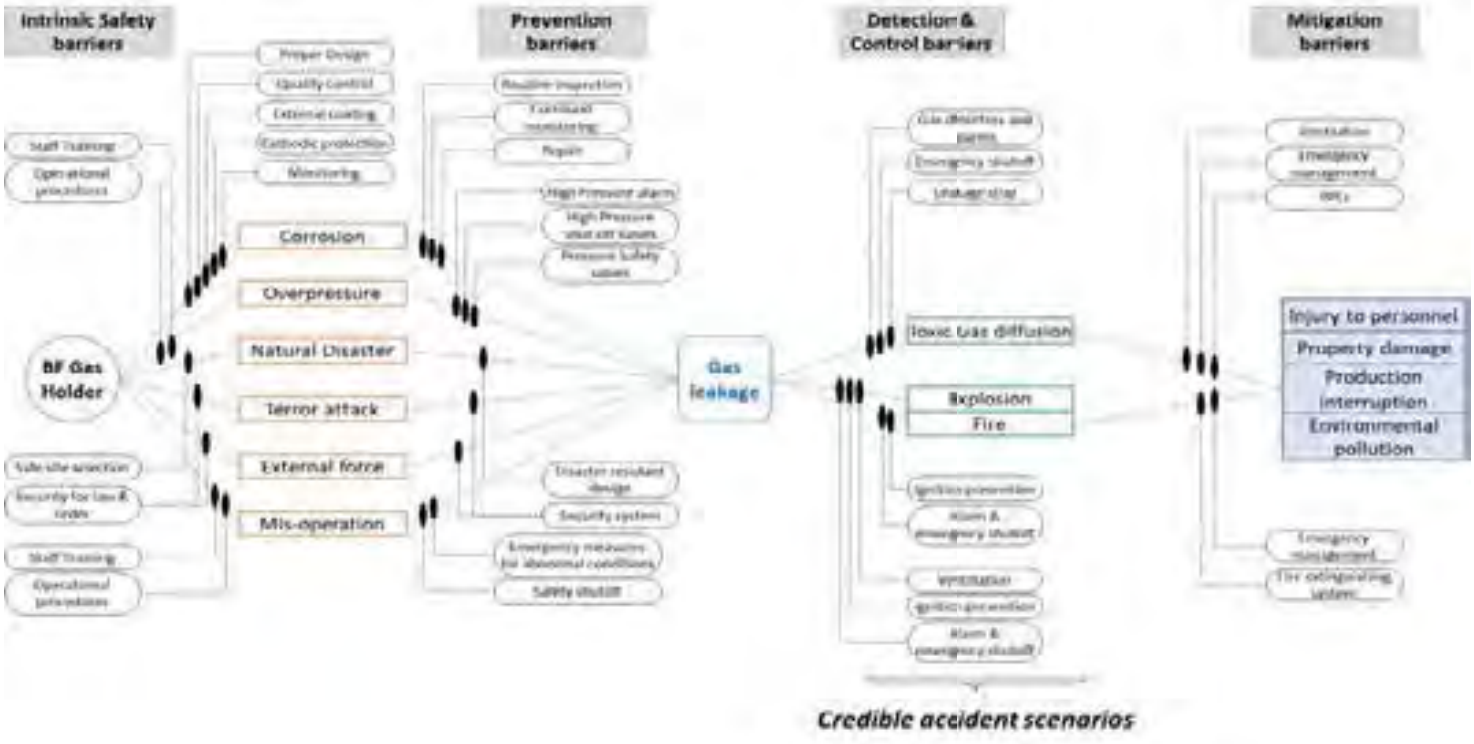
A Maximum Credible Accident (MCA) can be characterized, as an accident with a maximum damage potential, and yet is still highly probable. The selection of accident scenarios representative for a MCA-Analysis has been done on the basis of engineering judgment and expertise in the field of risk analysis studies, especially accident analysis.

MCA Analysis assists in identifying the potential major accidents arising due to flammable and/or toxic storages or handling facilities and estimate the maximum consequent effects on the surrounding environment in terms of damage distances of heat, radiation, toxic release, vapor cloud explosion etc. depending upon the effective hazardous attributes and the impact of the event, in the worst possible hazard situations.

The visualization of MCA scenarios for the present proposal has been done considering the chemical inventory being handled at the proposed plant, various loss of containment scenarios and subsequent accident scenarios and analysis of incident history of similar nature to establish credibility of the identified accident scenarios.

Credible scenarios were identified using Bow-tie diagram as shown in figure below.

Fig.7.1.: Bow-Tie diagram for identification of credible accident scenarios



Based on the above, the most credible release scenarios and associated hazards which would lead to maximum damage to human life as well as property, also identified as Worst Maximum Credible Accident Scenarios (WMCAS) are listed below in **Table 7.8**.

Table 7.8 - Probable Release & Accident Scenarios Identified as per MCAA

Sn.	Hazardous subs.	Accident Scenario	Likely consequence	Credibility for consequence analysis as per MCAA
1.	BF Gas	BF Gas pipeline leak from hole (100mm dia. hole)	Jet fire, Flash fire, Vapour cloud explosion, toxic exposure	Credible (non-worst case)
		BF gas pipeline catastrophic failure	Fireball, Flash fire, Vapour Cloud explosion, Toxic Cloud dispersion	**Credible (worst case)**
		BF gas holder catastrophic failure	Fireball, Flash fire, Vapour Cloud explosion, Toxic Cloud dispersion	**Credible (worst case)**
2.	BOF gas	BOF Gas pipeline leak from hole (100mm dia. hole)	Jet fire, Flash fire, Vapour cloud explosion, toxic exposure	Credible (non-worst case)
		BOF gas pipeline catastrophic failure	Fireball, Flash fire, Vapour Cloud explosion, Toxic Cloud dispersion	**Credible (worst case)**
		BOF gas holder catastrophic failure	Fireball, Flash fire, Vapour Cloud explosion, Toxic Cloud dispersion	**Credible (worst case)**
Reference: *Incident history of similar plants and engineering judgement for similar activities handling/storing similar substances.*				

The worst case credible scenarios have been considered for consequence assessment with a conservative approach, owing to the severity of damage possible due to those scenarios.

b) Consequence modelling

Consequence analysis for the selected accident scenarios has been carried to estimate the vulnerable zones. The prevalent meteorological conditions as well as probable inventory susceptible to release in case of loss of containment.

Consequence Model / Software Used

DNV's PHAST (Version 6.4) software, which is a consequence and risk assessment software for calculation of physical effects (fire, explosion, atmospheric dispersion) of the escape of hazardous materials has been used to perform the consequence calculations. The software allows detailed modeling and quantitative assessment of release of pure chemicals as well as mixtures from different scenarios.

Meteorological Conditions Considered

Minimum wind speed of 1.0 m/s and stable as well as neutral atmospheric stability conditions have been assumed to model fire effects in a worst case scenario having low chance of dilution of flammable substance concentration in the atmosphere and a higher damage effect. An average Wind speed of 3.0 m/s based on maximum of mean

monthly climatological trend of wind speeds at Bellary as collected from Climatological Normals (1981-2010) issued by IMD, GoI with neutral atmospheric stability conditions has been assumed to predict maximum extent of dispersion of toxic components of the identified hazardous substances during a release.

Damage Criteria Considered in the Model

In order to apprehend the damage produced by various scenarios, it is appropriate to discuss the physiological/physical effects of thermal radiation intensities due to fire accidents and overpressure effects of explosions. The thermal radiation due to pool fire or jet fires usually results in burn on the human body. Furthermore, inanimate objects like equipment, piping, cable, etc. may also be affected and also need to be evaluated for damages. The effect of overpressure due to blast effect and the effect of thermal radiation due to fire on unprotected skin, as per **Indian Standard IS 15656 : 2006** ***HAZARD IDENTIFICATION AND RISK ANALYSIS — CODE OF PRACTICE*** is presented below in **Tables 7.9** and **7.10**, respectively**.**

Table 7.9 - Effect of Different Over-Pressures on Human Life & Property

Overpressure (bar)	Type of Damage on structure	Type of Damage on Human life
0.02	Typical window glass breakage	-
0.14	Partial collapse of buildings	Personnel knocked down
0.21	Steel framed buildings get distorted and uprooted from their foundations	Ear drum rupture (beginning of serious injury to human life)

Source: *Indian Standard IS 15656 : 2006 - HAZARD IDENTIFICATION AND RISK ANALYSIS — CODE OF PRACTICE*

Table 7.10 - Relation Between Heat Radiation Intensity, Time & Effect on Man

Heat Radiation Level (Kw/m^2)	Duration (Secs)	Effect on Humans	Effect on property
4 -6	20	Sufficient to cause pain to personnel	Impairment of escape routes
12.5	5-20	Extreme pain within 20s (1% lethality in 1 minute)	Provides minimum energy required for piloted ignition of wood and melting of plastic
37.5	10	Immediate fatality (100% lethality in 1 minute)	Sufficient to cause severe damage to process equipment

Source: *Indian Standard IS 15656 : 2006 - HAZARD IDENTIFICATION AND RISK ANALYSIS — CODE OF PRACTICE*

The results of consequence analysis are summarized in the succeeding **Table 7.11** below.

Table 7.11 - Results of Consequence Analysis

Plant Unit	Hazardous Substance Handled/ Stored	Credible failure scenario and Failure size (mm)	Hazard effects	End Point Criteria	Hazard extent(m) Atmospheric Conditions		
					1.5F	1.5D	3D
BFG PIPELINE	BFG	Rupture (FBR)	Fire Ball *[Max Fireball radius= 91m]*	4.0 kW/m^2	187	187	187
				12.5 kW/m^2	85	85	85
				37.5 kW/m^2	-	-	-
			Flash Fire *[½ LFL conc: 162338 ppm]*	½ LFL	29	28	31
				LFL	24	21	21
			Vapour Cloud Explosion *[Distance of ignition: 40m]*	0.21 bar	85	85	85
				0.14 bar	104	104	104
				0.02 bar	345	344	344
			Toxic Dispersion distance	Probability of lethality = 0	30	25	25
				Probability of lethality >0 & ≤1.0	0	0	0
BOF PIPELINE	BOF gas	Rupture (FBR)	Fire Ball *[Max Fireball radius= 39m]*	4.0 kW/m^2	118	118	118
				12.5 kW/m^2	62	62	62
				37.5 kW/m^2	22	22	22
			Flash Fire *[½ LFL conc: 110644 ppm]*	½ LFL	1238	1250	1200
				LFL	1238	1250	1200
			Vapour Cloud Explosion *[Distance of ignition: 40m]*	0.21 bar	47	47	47
				0.14 bar	58	58	58
				0.02 bar	196	196	196
			Toxic Dispersion distance	Probability of lethality = 0	25	25	25
				Probability of lethality >0 & ≤1.0	0	0	0
BF GAS HOLDER	BF Gas	Rupture (FBR)	Fire Ball *[Max Fireball radius= 138m]*	4.0 kW/m^2	306	306	306
				12.5 kW/m^2	145	145	145
				37.5 kW/m^2	-	-	-
			Flash Fire *[½ LFL conc: 162338 ppm]*	½ LFL	46	43	51
				LFL	33	32	51
			Vapour Cloud Explosion *[Distance of ignition: 40m]*	0.21 bar	125	125	125
				0.14 bar	161	161	161
				0.02 bar	623	623	623
			Toxic Dispersion distance	Probability of lethality = 0	51	25	25
				Probability of lethality >0 & ≤1.0	0	0	*0*

Plant Unit	Hazardous Substance Handled/ Stored	Credible failure scenario and Failure size (mm)	Hazard effects	End Point Criteria	Hazard extent(m) Atmospheric Conditions		
					1.5F	1.5D	3D
BOF GAS HOLDER	BOF Gas	Rupture (FBR)	Fire Ball *[Max Fireball radius= 146m]*	4.0 kW/m^2	449	449	449
				12.5 kW/m^2	240	240	240
				37.5 kW/m^2	95	95	95
			Flash Fire *[½ LFL conc: 110644 ppm]*	½ LFL	1568	1412	1017
				LFL	1568	1412	1017
			Vapour Cloud Explosion *[Distance of ignition: 40m]*	0.21 bar	178	177	178
				0.14 bar	217	217	217
				0.02 bar	725	724	724
			Toxic Dispersion distance	Probability of lethality = 0	87	60	62
				Probability of lethality >0 & ≤1.0	0	30	31

Source: *Results obtained from DNV's PHAST ver. 6.4 for consequence modelling for proposed projects.*

The above table makes evident that the majority of the hazardous consequence have highest hazard extents in the atmospheric stability class D with wind speed of 3 m/s or in the stability class F with wind speeds of 1.5 m/s.

These worst case results for the different releases enumerated above have been summarized in **Table 7.12**. For assessing maximum damage from most credible scenarios, results have been shown for end point criteria corresponding to maximum observed damage due to a particular hazard effect.

Table 7.12 - Worst Case Credible Hazard Extents for Identified Hazardous Facilities

Plant Unit	Failure size	Nature of hazard	Hazard effects	Worst case Hazard extent (m)
BF GAS PIPELINES	Catastrophic Rupture	*Fire & Explosion*	Fireball	*85m* @12.5 kW/m^2
			Flash Fire	*24m* @LFL
			Vapour Cloud Explosion	*85m* @0.21 bar(g)
		Toxic effect	Toxic effect safe distance	*≥30m @ no probability of fatality*
BOF GAS PIPELINES	Catastrophic Rupture	*Fire & Explosion*	Fireball	*22m* @37.5 kW/m^2
			Flash Fire	*1250m* @LFL
			Vapour Cloud Explosion	*47m* @0.21 bar(g)
		Toxic effect	Toxic effect safe distance	*≥ 25m @ no probability of fatality*
BF Gas Holder	Catastrophic Rupture	*Fire & explosion*	Fireball	*145m @12.5 kW/m^2*
			Flash Fire	*51m @LFL*
			Vapour Cloud Explosion	*125m @ 0.21 bar(g)*
		Toxic effect	Toxic effect safe distance	*≥51m @ no probability of fatality*
BOF gas holder	Catastrophic Rupture	*Fire & explosion*	Fireball	*95m @ 37.5kW/m^2*
			Flash Fire	*1568m @LFL*
			Vapour Cloud Explosion	*178m @ 0.21 bar(g)*
		Toxic effect	Toxic effect safe distance	*≥87m @ no probability of fatality*

Source: *Results obtained from DNV's PHAST ver. 6.4 for consequence modelling for proposed projects.*

The worst case Hazard extents of all identified major hazardous units is shown in figures below

Fig.7.2.: Major Hazard Extents for Thermal Fire Effects (BOF gas holder)

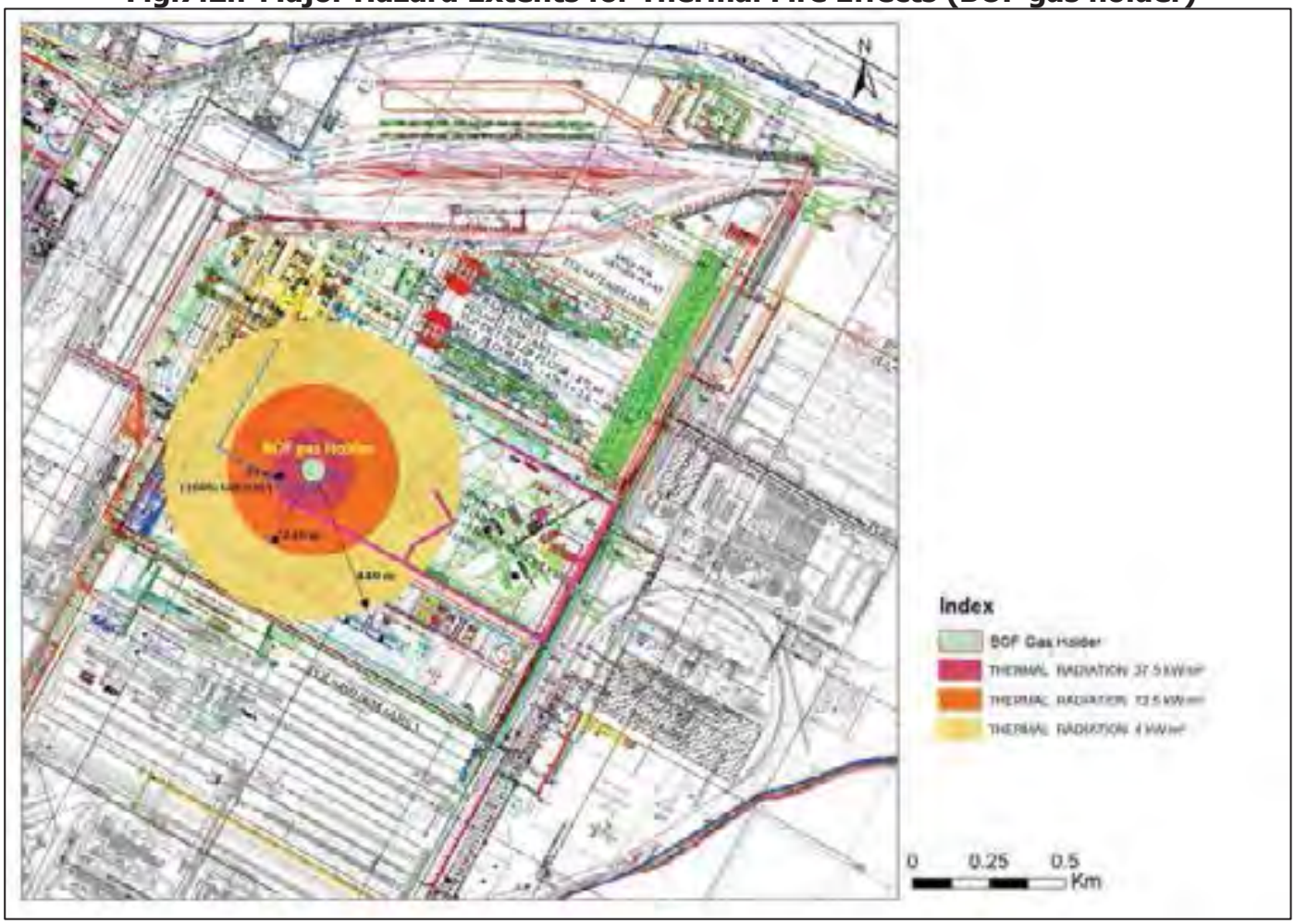


Fig.7.3.: Major Hazard Extents for Flash Fires (BF gas holder)

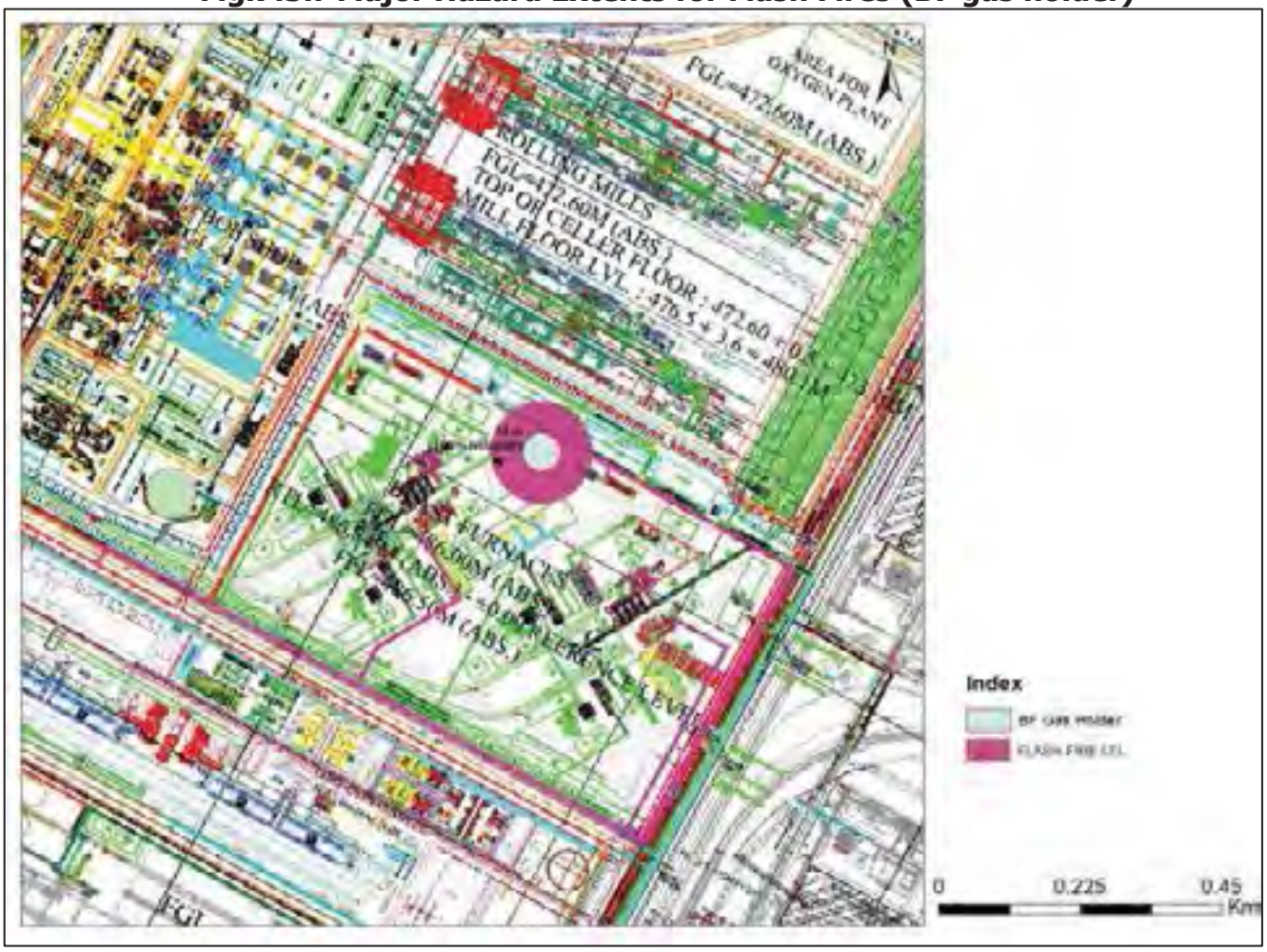


Fig.7.4.: Hazard Extent for Vapour Cloud Explosion Effects (BOF Gas holder)

Fig.7.5.: Hazard Extent for Vapour Cloud Explosion Effects (BF Gas line)

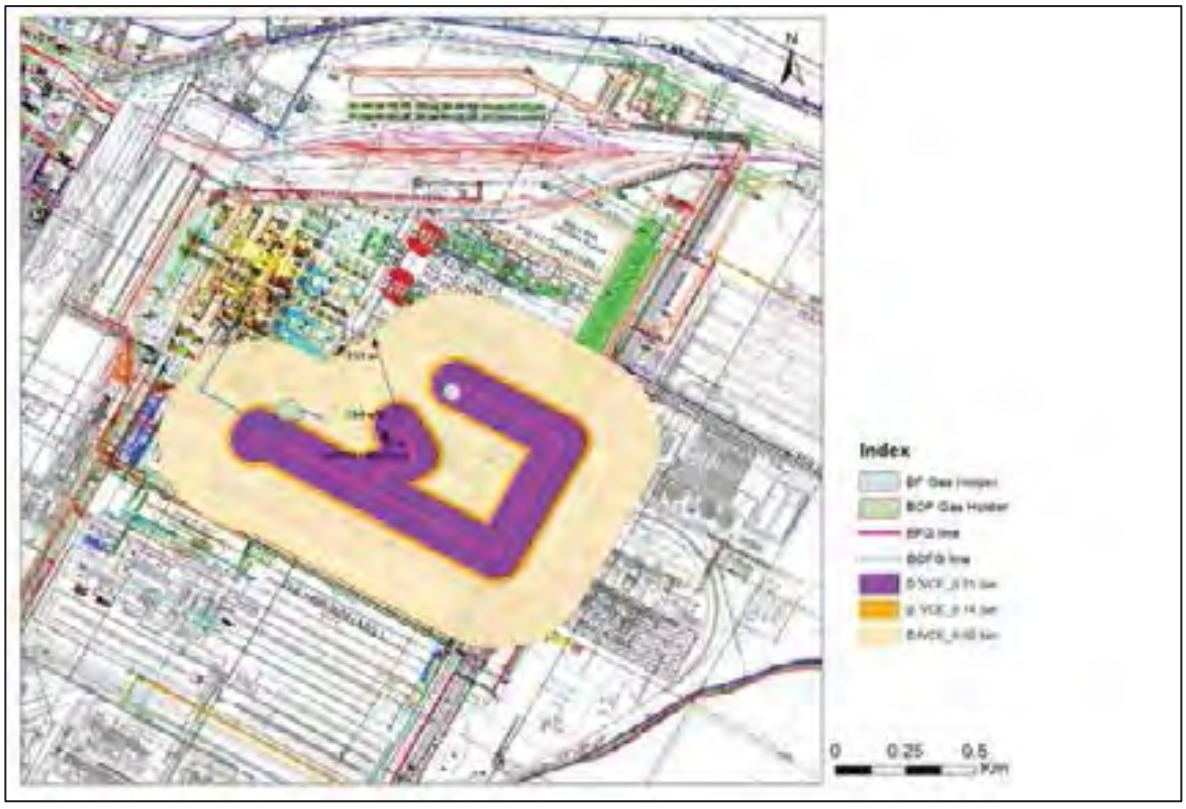
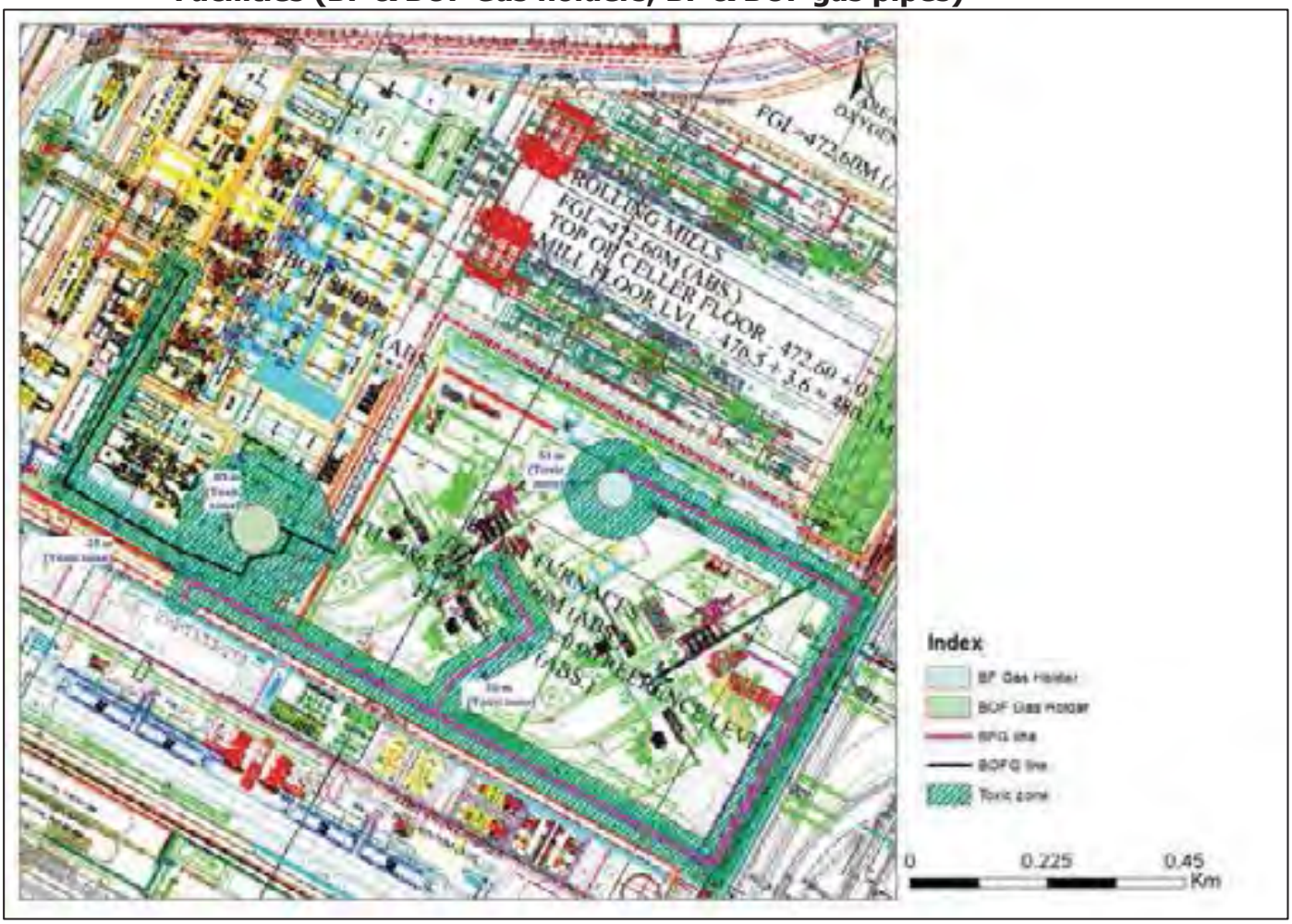


Fig.7.6.: Hazard Extents for Toxic Cloud Dispersion Effects in Identified Hazardous Facilities (BF & BOF Gas holders, BF & BOF gas pipes)



The nearest habitations to the JSWSL plant which could possibly be affected by an accident caused due to hazardous facilities within the plant as well as their proximity to the nearest hazardous facility is shown in **Table 7.13**.

Table 7.13 - Proximity of nearby habitations to proposed hazardous facilities of JSWSL

Hazardous Facility	Distances in km											
	N-NE Quadrant		NE-SE Quadrant		SE-W Quadrant		W-N Quadrant					
	BTPS Township	Toranagallu	Sunrise colony	Yerabanahalli	Nagalapur	Vidyanagar township	Hill view Township	Vaddu	Basapur	VV Nagar colony	Shankar Guda colony	Kurekuppa
BOF Gas Holder	3.5	1.4	4.0	3.7	7.5	4.8	7.2	5.1	5.0	2.9	1.8	4.3
BF Gas holder	4.0	1.4	4.7	4.2	6.9	4.3	6.6	4.6	4.5	2.7	1.4	4.0

Source: *Plant Layout of JSWSL, Google Earth*

To verify if any nearby habitation is within the effect radius of the proposed gas holders, they were plotted together with each of the gas holders and their distance to each of the gas holders was compared with the minimum safe distance from the gas holders for fire, explosion as well as toxic effects. The same have been illustrated in figures below.

Fig.7.7.: Safe Distances from Hazardous Installations of JSWSL to Nearest Habitations (Fire effects)

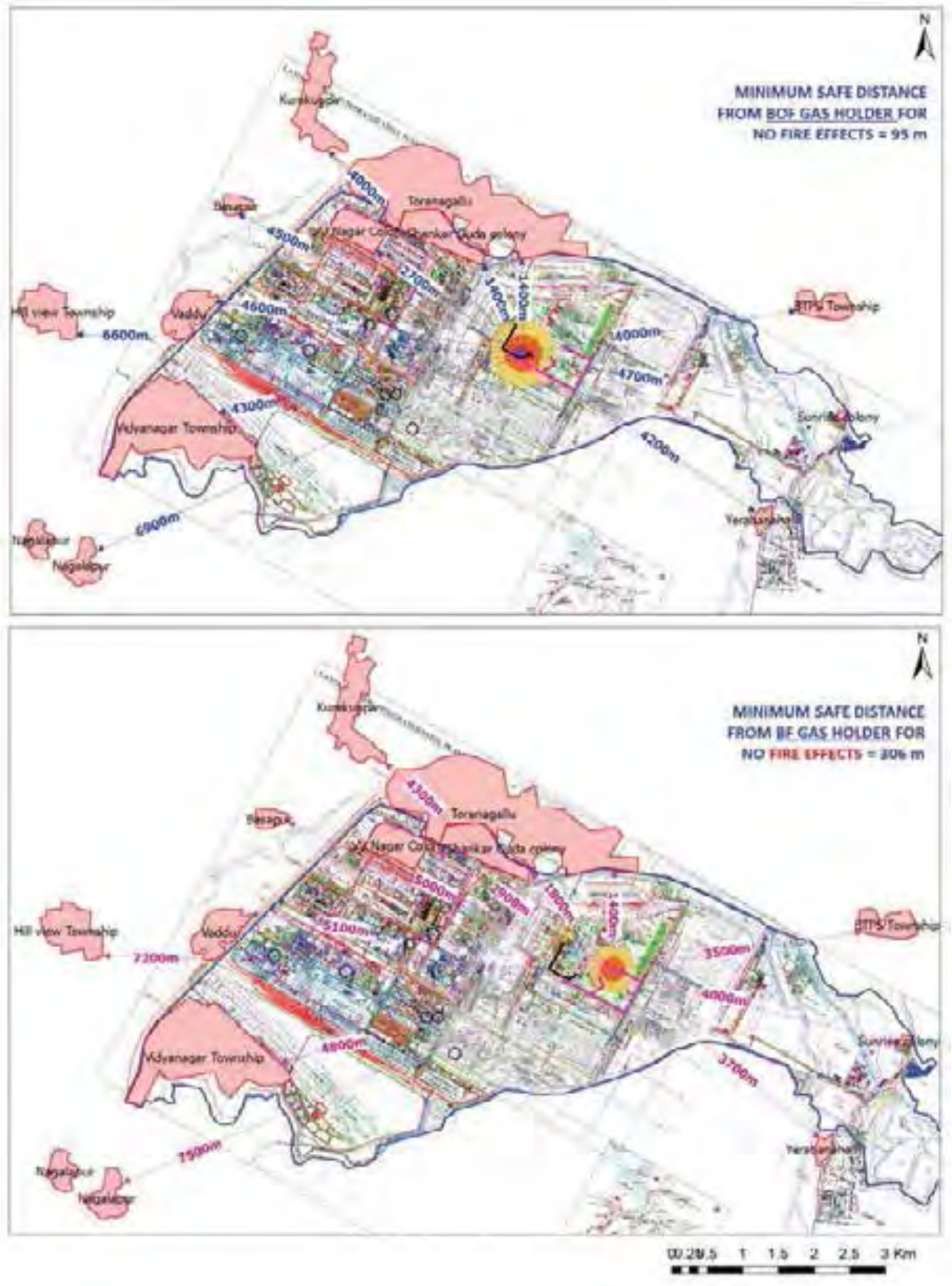


Fig.7.8.: Safe Distances from Hazardous Installations of JSWSL to Nearest Habitations (Explosion effects)

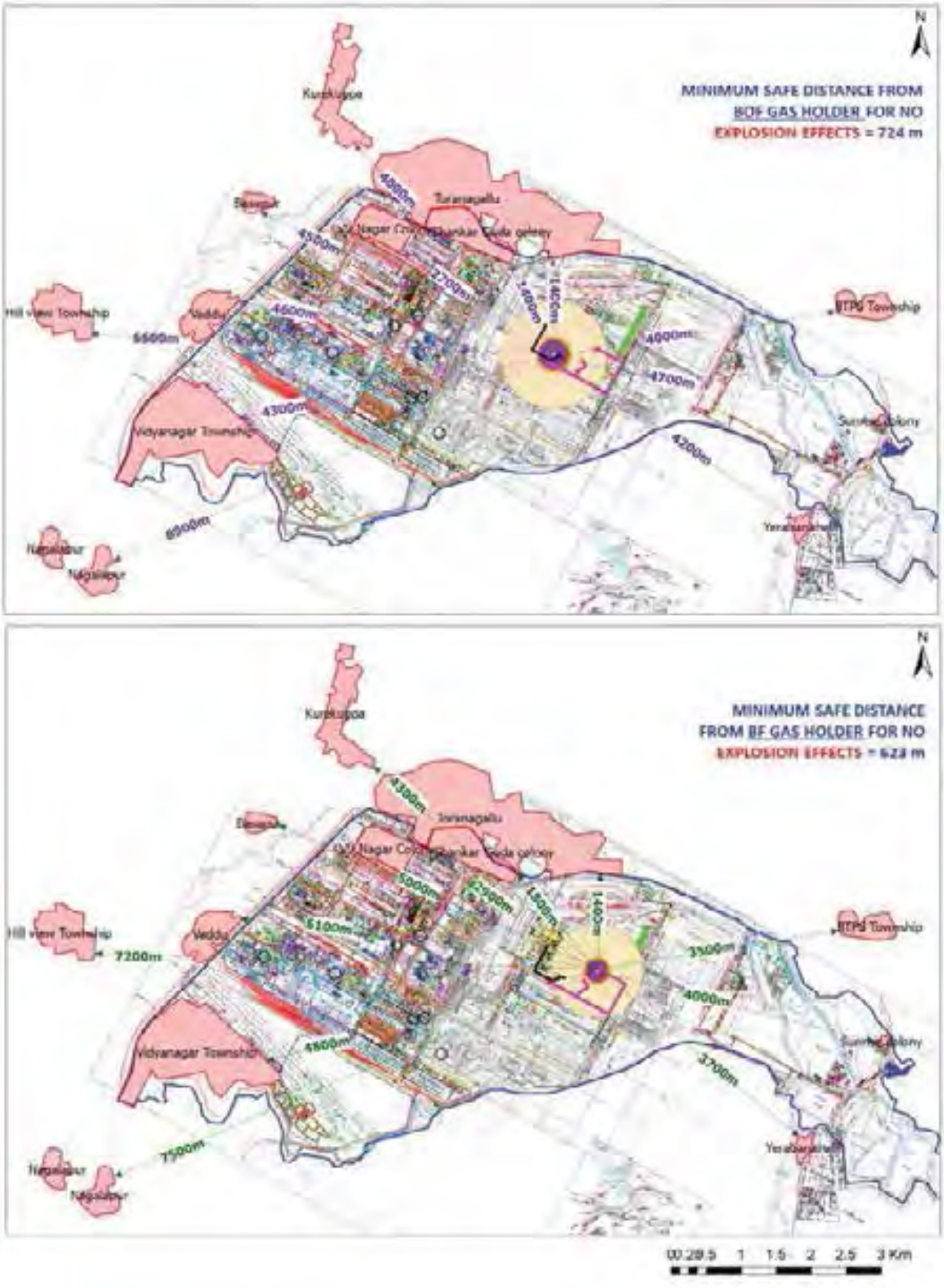
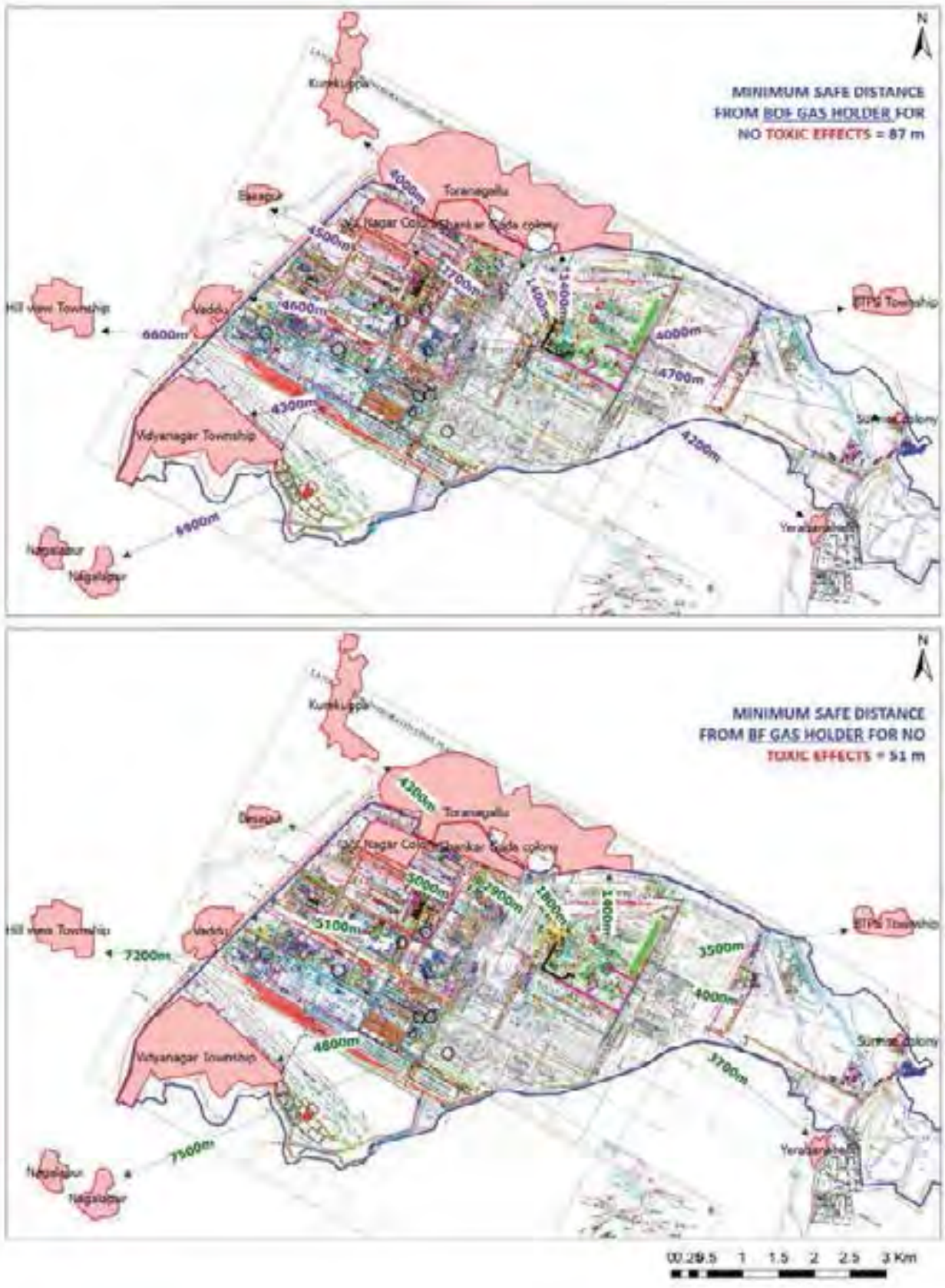


Fig.7.9.: Safe Distances from Hazardous Installations of JSWSL to Nearest Habitations (Toxic effects)



The proximity analysis of nearby habitations with the proposed gas storages, as illustrated in figures above indicates, that no habitations are falling within the effect radius of these storages and thus no offsite emergency is anticipated due to these storages.

7.1.9 Domino Effects

Domino effect is basically the propagation of an accident originated from a specific equipment or inventory to adjacent equipment or areas of an industrial site.

For the present risk assessment study, domino effect scenario has also been analyzed to assess the associated risk in the most dangerous condition where failure of one facility/unit may trigger a secondary hazardous event at a nearby hazardous unit/facility leading to multiple failures and accidents at JSWSL.

Normally the propagation of fires or explosions from one area to another is not very representative for the risk of external population, because as a secondary effect, it will be a highly localized event with high risk of damage to assets but low effect on people outside the limits of the installation.

Also, in considering a domino effect, the possibility of a new cloud dispersion from a flammable material undergoing delayed ignition from a secondary event release is not considered as the release due to domino effect will be immediately ignited from the energy of the first event.

Additionally, the secondary event occurrence takes into account that the majority of people located in adjacent areas of the initial event must have taken appropriate reaction to escape in safe conditions according to Emergency Response procedures, which leads to conclude that most of the time the exposed group are the Emergency Group inside the installation boundary, which reduce the number of fatalities related to secondary scenarios.

a) Identification of Domino Effects Scenarios

For each initial events selected for the domino effect risk analysis, the occurrence probability of domino effects on adjacent areas due to overpressure were identified. These probabilities, when cumulated with the frequency of release in the worst case scenario, gives the frequency of occurrence of an initiating event for all hazardous units in a facility/complex.

The proposed storages viz. new BF gas holder and new BOF gas holder have been considered together with the existing hazardous substance storages of BF gas, BOF gas and COREX gas at JSWSL for analyzing Domino effect.

Based on the consequence modelling carried out for the proposed storages and the estimated worst case hazard distances for overpressure effects that can pose a potential threat of causing a domino effect, the different units which could be affected and partake in causing a domino effect have been identified as below. The effect areas for existing units have been used from existing **Onsite Emergency Plan of JSWSL** for identifying the units that can be affected due to the secondary accident scenarios.

Table 7.14 - Units considered for Domino effect study along with effect radius

Units	Unit name	Effect radius for initiating a secondary event
PROPOSED UNITS		
N1	BF gas holder	178 m
N2	BOF Gas holder	121 m
EXISTING UNITS		
E1	SMS-1 Gas holder	56 m
E2	SMS-2 Gas holder	56 m
E3	BF1&2 Gas holder	56 m
E4	BF3&4 Gas holder	56 m
E5	COREX gas holder	56 m
E6	COB-3 Gas holder	56 m
E7	COB-4 Gas holder	56 m

Source:
- *Results of Consequence analysis for proposed projects*
- *Existing Onsite Emergency Plan of JSWSL*

Based on the distances of overpressure hazard and relative distances between each hazardous facility, the table below presents the origin and the affected units where secondary accident scenarios can occur.

Table 7.15 - Affected Units with Domino Effects Potential

Affected Units-Domino effect		Origin Units								
		N1	**N2**	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**
N1	BF gas holder		-	-	-	-	-	-	-	-
N2	BOF Gas holder	-		-	-	-	-	-	-	-
E1	SMS-1 Gas holder	-	-		-	-	-	-	-	-
E2	SMS-2 Gas holder	-	-	-		-	-	-	-	-
E3	BF1&2 Gas holder	-	-	-	-		-	-	-	-
E4	BF3&4 Gas holder	-	-	-	-	-		-	-	-
E5	COREX gas holder	-	-	-	-	-	-		-	-
E6	COB-3 Gas holder	-	-	-	-	-	-	-		-
E7	COB-4 Gas holder	-	-	-	-	-	-	-	-	
Domino effect observed (Y/N)		**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**

Index: ** – Affected unit - no effect*
Reference: *General Layout of JSWSL*

As can be seen from the table above, the siting of existing as well as proposed hazardous facilities has been done taking into consideration the respective effect distances. Thus, no facility is located within the effect distance of other hazardous facility. This indicates **no probability of a Domino effect** due to the proposed as well as existing hazardous facilities at JSWSL.

7.1.10 Failure frequency analysis

The hazardous facilities prone to failures and which may subsequently lead to an accident scenario for the proposed project are the BF & BOF gas holders as well as associated new pipelines.

The failure probabilities and frequencies for the different credible failure scenarios have been estimated based on published literature as well as failure history of storage

vessels and pipelines handling/storing similar hazardous gases in other similar process plants for an optimistic approach of failure frequency estimation.

The credible failure scenarios selected are as follows:

- **Failure of pipelines**: The possible route of hazardous material going out of containment in open atmosphere is the rupture of a pipeline. The probability of catastrophic rupture of a pipeline carrying BF gas or BOF gas is quite low. However, due to the high severity of the damage that can be caused due to such a failure, this low frequency failure event has been considered to be a "foreseeable" event.

- **Failure of pressurized storage vessel:** Instantaneous release of all of the hazardous gas inventory stored inside the storage vessel at pressurized conditions due to a complete failure of the storage vessel is considered as the worst possible scenario. It is to be noted that loss caused due to this event is very high but the probability is low; however, in case of neglect of maintenance or natural calamities such as earthquake the possibility of occurrence of this scenario exists. Such events are unlikely to happen and are not credible, however due to the severity of consequences, these events have also been considered for the risk analysis.

Estimates of failure frequencies has been made from data published by Health and Safety Executive (HSE), UK in its report titled "Failure Rate and Event Data for use within Risk Assessments", 2019. **Table 7.16** shows the failure frequencies of storage vessels as well as pipelines envisaged in the proposed project.

Table 7.16 - Failure frequencies for proposed hazardous facilities

Failure frequency (catastrophic failures)	
Pipelines (>1000 mm dia)	**Pressurised Storage vessel (large vessels >450 m^3 capacity)**
4 x 10^{-8} per m per year	5 x 10^{-6} per vessel per year
Source: *"Failure Rate and Event Data for use within Risk Assessments", 2019 by HSE*	

Event Tree Analysis (ETA)

Event Tree Analysis (ETA) is a graphical technique used to identify the different combination so events and circumstances in an accident sequence. Each branch of the Event tree represents a separate accident sequence, beginning with an initiating undesirable event and finally leading to a hazardous outcome. The method provides information on how a failure can occur and the probability of occurrence and assists in estimation of frequency of the incident.

Based on the above probabilities of immediate ignition and occurrence of different failure scenarios for pipelines as well as pressurized storage vessels, event tree analysis has been done and the consequent scenarios have been identified for the different LOCs. The Event Tree Diagram (ETD) for a pressurized storage vessel and above ground pipeline have been illustrated in **Figs. 7.10 & 7.11** respectively.

Fig.7.10.: ETD of a pressurized storage vessel

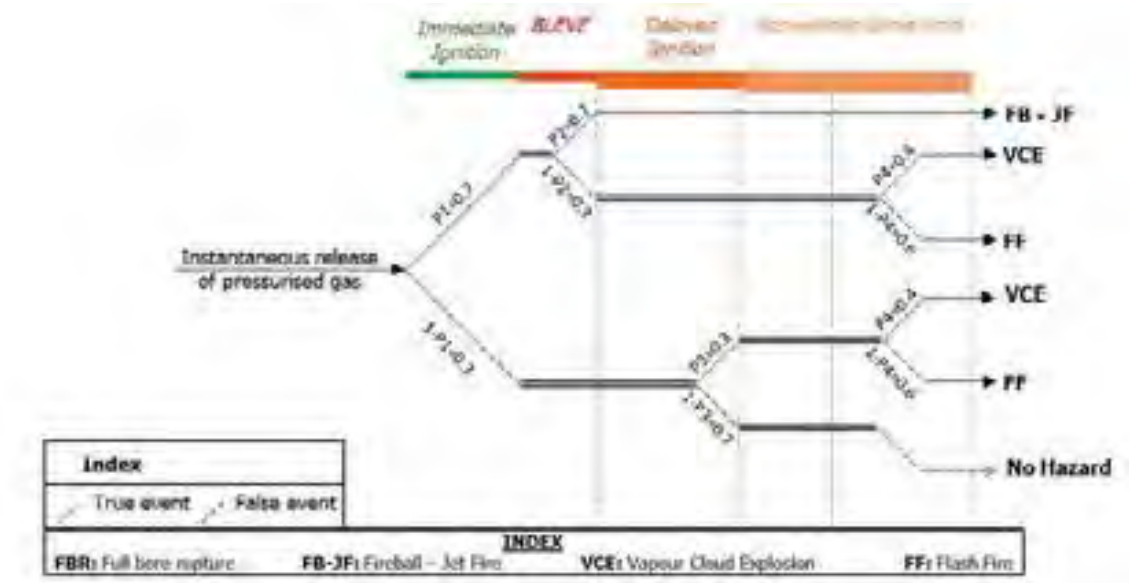
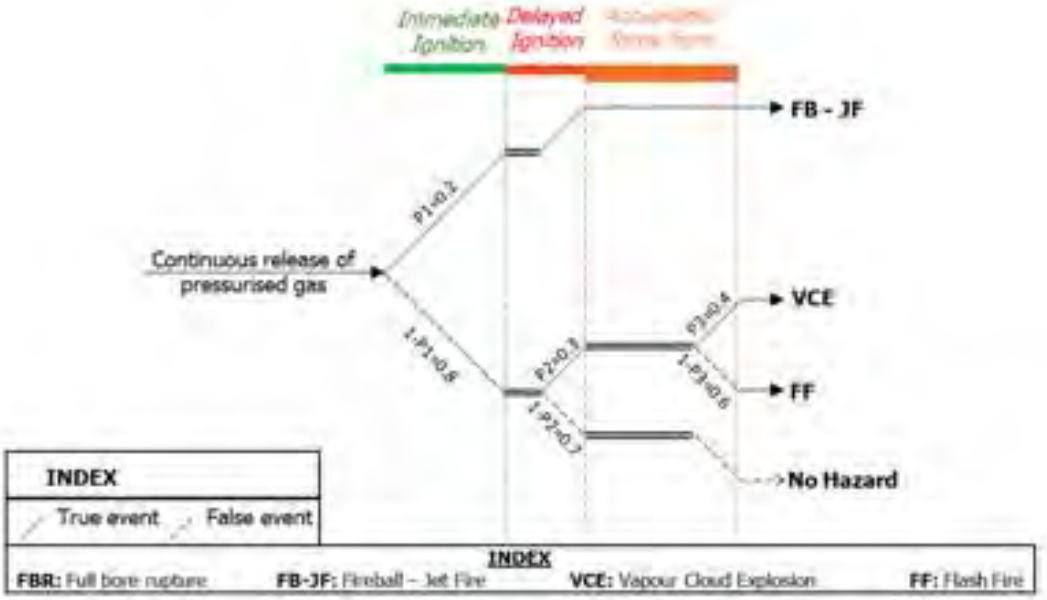


Fig.7.11.: ETD of aboveground pressurized pipelines



Based on the above Event trees and frequency of the failure events, the event frequencies of fire, explosion as well as toxic dispersion consequences have been calculated as shown in table below.

Table 7.17 - Estimation of event frequencies for proposed hazardous facilities

Failure scenario	Failure frequency, f	Consequence (event)	Probability of event, P (as per ETD)	Event frequency (f*P)
Catastrophic Rupture of BOF gas pipelines	3.9×10^{-5}	Fireball	0.2	7.7×10^{-6}
		Vapor Cloud Explosion	0.096	3.7×10^{-6}
		Flash fire	0.144	5.6×10^{-6}
		No hazard	0.56	2.2×10^{-5}

Failure scenario	Failure frequency, f	Consequence (event)	Probability of event, P (as per ETD)	Event frequency (f*P)
Catastrophic Rupture of BF gas pipelines	9.1×10^{-5}	Fireball	0.2	1.8×10^{-5}
		Vapor Cloud Explosion	0.096	8.7×10^{-6}
		Flash fire	0.144	1.3×10^{-5}
		No hazard	0.56	5.1×10^{-5}
Catastrophic Rupture of BOF gas Holder	5.0×10^{-6}	Fireball	0.49	2.5×10^{-6}
		Vapor Cloud Explosion	0.036	1.8×10^{-7}
		Flash fire	0.054	2.7×10^{-7}
		No hazard	0.21	1.1×10^{-6}
Catastrophic Rupture of BF gas Holder	5.0×10^{-6}	Fireball	0.49	2.5×10^{-6}
		Vapor Cloud Explosion	0.036	1.8×10^{-7}
		Flash fire	0.054	2.7×10^{-7}
		No hazard	0.21	1.1×10^{-6}

Reference:
- *"Failure Rate and Event Data for use within Risk Assessments", 2019 by HSE*
- *Event tree diagrams and consequence analysis carried out for proposed projects in this study*

7.1.11 Risk Estimation

Individual Risk

The Individual Risk (IR) level is more specifically defined as the Individual Risk Per Annum (IRPA), which is the calculated annual risk loading to a specific individual or group of individuals. This depends on the amount of time in a year that the individual spends in different risk areas. The individual risk calculation takes account of the fact that people move from one place to another. When calculating individual risk from major accident scenarios, it is normal to take account of protection by buildings.

The individual risks are calculated as below:

$$\text{Individual Risk (IR)} = \left(\frac{1}{\text{N}}\right) \sum I_i \times f_i$$

Where,
N = total number of persons at risk
i = Incident identification number
I = impact of i^{th} Incident (deaths for accident type i)
f = frequency of the i^{th} incident

It is estimated that a total of 2787 people working within the plant in close proximity to the proposed hazardous installations and will be at risk for a total exposure period of 8 hrs.

Based on the above, and taking into consideration the MCA analysis to identify worst case credible accident scenarios, the Individual risk is estimated to be **2.3×10^{-6} per year.**

Individual Risk Criteria and ALARP

A broadly acceptable level of individual risk as per the ALARP (As low as reasonably practicable) concept of HSE, UK is 10^{-6}/ year. However, Individual Risk of death to members of the public outside the plant boundaries which can be applied in the Indian

context, as per recommendation made in original article published in **Research Journal of Chemical and Environmental Sciences** titled *"Risk Criteria and its Acceptance in Indian Context"* dtd. Aug. 2015 are:

- Greater than 10^{-5} per year is intolerable risk
- Lower than 10^{-6} per year is negligible risk.

The IR calculated for the facility, when compared with the HSE IR criteria as well as the IR criteria recommended in Indian context, indicates that the IR due to the proposed facilities at JSWSL is **Tolerable and within ALARP**. Relevant good practices at the workplace as well as implementation of suitable risk reduction measures can reduce the actual risk to negligible level.

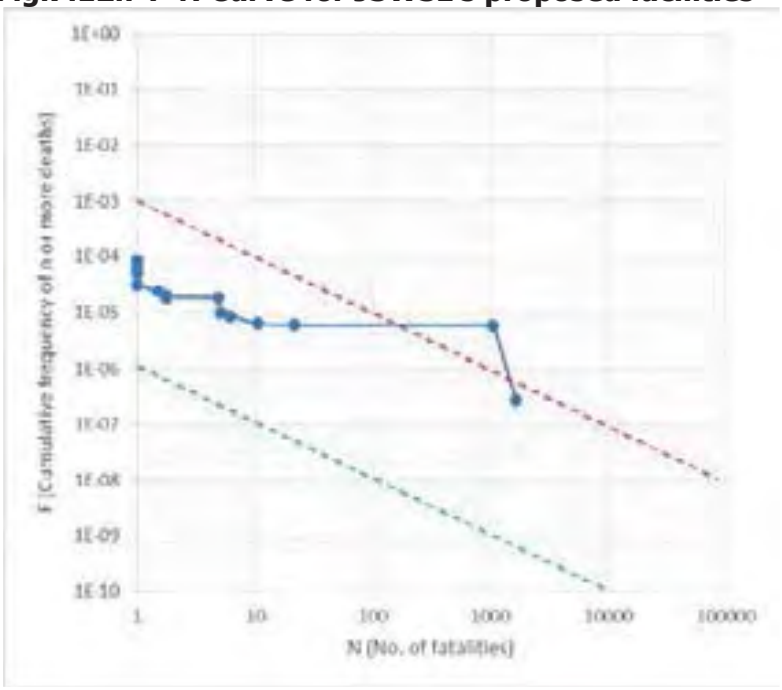
Societal Risk

Society usually judges accidents that result in multiple fatalities more harshly than multiple accidents that cause fewer fatalities per accident.

Societal risk is depicted on a cumulative graph called an F/N curve. The horizontal axis is the number of potential fatalities, N. The vertical axis is the frequency per year that N or more potential fatalities could occur, F. This risk indicator is used by authorities as a measure for the social disruption in case of large accidents.

The F-N Curve for JSWSL's proposed hazardous facilities is presented graphically utilizing modified Hong-Kong's Societal Risk Criteria and recommendation made in the article titled *"Risk Criteria and its Acceptance in Indian Context"* dtd. Aug. 2015 by Neeru Anand published in Research Journal of Chemical and Environmental Sciences in **Fig. 7.12.**

Fig.7.12.: F-N Curve for JSWSL's proposed facilities



The above figure indicates that the Societal Risk of the project falls mostly **within the zone of tolerable acceptability of the Societal Risk Acceptance Criteria**. However, an isolated accident scenario extends beyond the acceptable zone, which can be controlled by judicious implementation of risk reduction measures and providing PPEs to working personnel in close proximity to the facilities.

7.1.12 Hazardous events with greatest contribution to fatality risk

The hazardous event scenarios likely to make the significant contribution to the risk of potential fatalities are ranked in **Table-7.18**. The risks to people at plant site are categorized as "On-site" risks while the risks to communities outside the plant premises is categorized as "Off-site" risks.

Table 7.18 - Hazardous events contributing to risk and their risk ranking

			(A)	(B)	C = A*B
Sn.	**Hazardous event**	**Consequence of significant damage**	**Consequence severity*** *(1=least severe; 5=most severe)*	**Likelihood*** *(1=least likely; 5=most likely)*	**RISK RANK**
1.	Onsite vehicle impact on personnel	Potential for single fatalities, onsite impact only	3	3	9
2.	Entrapment/struck by Machinery	Potential for single fatalities, onsite impact only	3	2	6
3.	Fall from heights	Potential for single fatalities, onsite impact only	1	3	3
4.	Electrocution	Potential for single fatalities, onsite impact only	2	3	6
5.	New pipelines fire & explosion as well as toxic dispersion	Potential for multiple fatalities, onsite impact only	4	1	4
6.	BF & BOF gas holders failure and fire & explosion as well as toxic dispersion	Potential for multiple fatalities, onsite impact only	5	1	5

** based on Historical survey of similar facilities & risk assessment carried out in present study*

The above risk ranking indicates that although the most severe consequences will be due to rupture of Gas holders followed by the associated pipelines, their chances of occurrences are low due to implementation of better safety features in the installations and constant monitoring of vessel/pipework integrity for regular repair and maintenance, and hence these facilities have low levels of risk in the facility.

7.1.13 Summary & Conclusions of Risk Assessment

a) Consequence assessment

Gas holders (BFG & BOFG)

A maximum total of 1,00,000 m^3 each of BF gas and BOF gas is proposed to be stored in new BF gas and BOF gas holders at JSWSL's steel plant, wherein BF Gas and BOF gas will be tapped for existing as well as future producing units and will be mixed in suitable proportions to produce Mixed gas of desired calorific value for use at JSWSL. The results of MCA analysis indicates a maximum fire hazard distance for causing

significant damage (@37.5 Kw/m^2 thermal radiation) extending up to **95 m** in the case of complete failure of BOF gas holder and catastrophic release of BOF gas, subsequently being ignited resulting in a fireball. Explosion effects having significant potential for damage (@0.21 bar(g) overpressure) is observed to be upto a distance of **178 m** due to BOF gas holder failure. The toxic effect of BFG and BOFG (attributed to presence of Carbon Monoxide in the gases) will be limited to **87m** from the BOF gas holder, beyond which there will be no probability of fatality due to toxic effect in case of a release.

Gas Pipelines (BFG & BOFG)

The worst case hazard extent for fire effects from proposed additional pipelines is observed to be **22 m** (@37.5 kW/m^2) that could lead to 100% fatality. The explosion effects is estimated to extend to **85 m** (@0.21 bar) that could cause serious damage to human life as well as nearby property. The toxic effect of BFG and BOFG pipelines is predicted to extend to a maximum distance of **30 m**.

As observed from the overall analysis, *the hazard extents will be contained within the plant premises and will not extend beyond plant boundary into any nearby settlement in the area.*

b) Risk Analysis

The Individual risk (IR) and Social risk (SR) analysis and comparison with respective Individual risk and Societal risk acceptance criteria shows that the IR as well as SR for the proposed project of JSWSL are within the ALARP (As Low As Reasonably Practicable) for the criteria.

So, effective implementation of preventive and mitigative measures with vigilant, continuous watch for defects/failures of the gas holders as well as associated pipework is suggested for a minimizing the risks to negligible levels.

7.1.14 Recommended Risk Reduction & Mitigative Measures

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

- The zones identified from consequence modelling as affected areas due to thermal radiations greater than 12.5 kW/m^2 shall be marked as "Heat Zones" and provisions for fire fighting will be made available close to these zones.

- It is also recommended to provide portable gas detectors within the site in order to facilitate manual gas leak monitoring and regular leakage checks. Constant monitoring of gas leak shall be ensured for immediate identification of leaks and subsequent implementation of action plan to prevent development of any hazardous situation.

- Further, all major units / equipment shall be provided with the following safety facilities:
  - ► Smoke / fire detection and alarm system

- Water supply
- Fire hydrant and nozzle installation
- Foam system
- Water fog and sprinkler system
- Mobile fire-fighting equipment
- First-aid appliances

- Personal Protective Equipment (PPE) shall be provided for additional protection to workers exposed to workplace hazards in conjunction with other facility controls and safety systems.

- Restricted access to these areas to have minimum casualties in an event of exposure.

- The onsite Emergency Plan will be integrated with the Bellary district's Offsite Emergency Plan for comprehensive management of emergencies in minimum response time and maximum rescue results in an event of a disaster /emergency. Co-ordination with nearby industries will also be maintained for creating unified Disaster management resource pool to be utilised in case of any disaster occurrence.

- The plant structures shall be designed for seismic events to prevent structural collapse and integrity of weather (water) proofing for storage of dangerous goods.

- Isolate people from load carrying/mechanical handling systems, vehicle traffic and storage and stacking locations.

- 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 with site specific hazards and risks (fire, explosion, rescue and first aid).

- Regular safety audits shall be undertaken to ensure that hazards are clearly identified and risk-control measures are maintained within tolerable limits.

7.1.15 Offsite & Onsite Disaster Management & Emergency Plan[2]

In order to prevent occurrence of any disaster, the Disaster Management Plan (inclusive of the onsite emergency plan), DMP has been designed based on the range, scales and effects of "Major Generic Hazards" described in the Risk Assessment and prediction of their typical behavior. The DMP addresses the range of thermal and mechanical impacts of these major hazards so that potential harm to people onsite and off-site, plant and environment can be reduced to a practicable minimum. The scenarios of loss of containment are credible worst cases to which this DMP is linked. The project is in its formative stage and detail engineering is yet to be done, so the elements of the DMP are based on concepts.

7.1.16 Profile of JSWSL steel plant, Toranagallu

M/s Jindal South West (JSW) Steel Ltd., is a flag ship company of OP Jindal group of industries. This integrated steel plant at Toranagallu is the most modern, technologically efficient and eco-friendly integrated steel plant in India.

The steel plant site is located between latitude 15° 10′ - 15° 12′ N and longitude 76° 38′ - 76° 40′ E near Toranagallu Village of Bellary District in the State of Karnataka. The site is at distance of 30 Km from Bellary, 32 Km from Hospet and about 340 Km from Bangalore by road. Nearest Railway Station to the Steel Plant is Toranagallu.

Working pattern of employees

General shift – 9 am to 1pm working hours
1 pm to 2 pm lunch hours
2 pm to 6 pm working hours

A – Shift - 6 am to 2pm
B - Shift - 2 pm to 10 pm
C – Shift - 10 pm to 6 am

Population density around the plant

The population figures of surrounding villages in a radius of 10 Km from the plant were taken from the Directorate of census operation. The surrounding area will not be affected in case of gas leakage as carbon monoxide is lighter and get converts into carbon dioxide. A total of 19 villages/settlements were identified within 10 km of the plant, with a total population of 37,854.

7.1.17 Onsite Emergency Plan

The Onsite Emergency plan for existing JSWSL plant at Toranagallu covers all the units within the plant, including primarily the following:

- Pellet plant 1 &2
- Coke ovens 1,2,3 & 4
- COREX 1 & 2

2 *Standard TOR point 7(xiii)*

- Blast furnace 1, 2, 3 & 4
- Sinter Plant 1,2,3 & 4
- SMS-1,2 & 3
- HSM-1&2
- CRM 1 & 2 complexes
- Bar rod mills 1 &2
- Wire rod mill
- CPP 1 &2
- JSWSL's captive power plants III & IV
- CDQ

7.1.18 Identification Of Hazard

a) Hazardous materials handled

The hazardous materials handled at existing JSWSL plant are as follows:

COREX export gas:

The properties of COREX export gas and its composition is as follows:

Table 7.19 - COREX Gas composition and characteristics

Gas	Flammable limits	Auto Ignition Temp(Air)	Min. O_2 required for combustion
Hydrogen (H_2)	4 % to 74 %	570°C	5 %
Carbon Monoxide (CO)	13 % to 74 %	610° C	6 %
Methane (CH_4)	5.3 % to 14 %	630° C	12 %
LPG (Propane)	2.1 % to 10.1 %	450° C	Varies
COREX Gas	7.4 % to 69.98 %	Varies	Varies
Reference: *Onsite Emergency Plan of JSWSL*			

Hot metal and slag

Due to temperature up to 1500°C and liquid stage of these substances, each person assigned to work in the close vicinity of hot metal and / or slag must wear special heat protection clothing to avoid risk. Each person has been trained and advised to keep adequate safety distance to hot metal and slag especially troughs, ladles, ladle-carriers, slag pits, tap holes etc.

Coal dust, DRI dust, DRI fines

These substances show a tendency to self-ignition and/or explosion if treated improperly. Therefore handlings of these materials are taken at most care and being handled with all possible safety measures. The DRI is always kept in dry weather to avoid the self-ignition. Further, all kinds of dusts may be noxious for persons. Therefore, all persons working in areas are advised and ensured to wear dust masks.

Desulphurization compound:

The desulphurization compound (90 % Calcium carbide) is stored in SILO. It is being used for desulphurization of liquid hot metal. It is being received from the tankers and unloaded into the Silo with the help of Nitrogen pressure. The Desulphurization compound is added into the liquid hot metal through lancing pipe under Nitrogen pressure.

LPG Installation:

LPG used for the plant consists mainly 40 % propane and 60% butane. LPG forms an easily ignitable and explosive mixture with air. The main hazards associated with LPG is fire and explosion.

The LPG is stored (mounded storage) in six bullets of each capacity 25 Tonnes. LPG is being used as a fuel in the pilot burners of COREX gas Flare stack, Cast House to heat the runners. LPG is used at Flare stack of converter near ID Fan area of BOF and in TCM of CCP. It is also used at LCP, CDP, and LRS as fuel for pilot burners.

b) Identification Of Hazards (Dept. wise) with Precautionary Measures

The major hazards identified at JSWSL existing plant are as indicate din table below:

Table 7.20 - HIRA of existing facilities

Dept / Section	Hazards	Consequences	Precautionary measures
Material handling section	Pellets / DRI / Coal & coke transportation through Conveyor Belts	Fatal / Major Injuries Fire & Structural / Building Collapse	• Permit to work system is in place before carrying out any maintenance activity (HOT Jobs) • Inspection of structural / Building once in 5 years. • Monitoring of material temp before charging into Conveyor Belt • Maintaining good house keeping • Safety Operating & Maintenance Procedures in place • Fire Fighting System is in place for all the conveyors • Emergency quenching in place for all routes conveyors • Training of operators on Emergency preparedness
RMHS-Track hopper	Water entry into low lying areas	Water flooding Fatal/ Major Injury Property damage	• Flood Management Plan exist • Well maintained Drainage system • Availability of de-watering pumps both diesel and Electrical. • Availability of trained personnel for water rescue.
Pellet & Sinter Plants – Furnace	Mixed gas leakage in the expansion joints , Vents, furnace area	Fatal / Major injuries Fire & Explosion Property Damage	• Installation of fixed CO-Detectors • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month.

Dept / Section	Hazards	Consequences	Precautionary measures
			• Regular inspection of gas pipe lines, expansion joints & maintenance • Provision of Goggle valve & U-seals for isolation • SOPs developed for Gas lines operational controls and all personnel trained • Emergency Response Plan developed to tackle the situation & regular mock drills are being conducted to test the preparedness
Pellet Plant , Sinter Plant, OBP	Collapse of Building/ Structures / Silo/ Chimney. Dried Ore , Wet ore, Balling disc bins, Silo building, jig building, spillage chute, storage building may collapse	Fatal / Major Injuries Property Damage	• Inspection of structural / Building once in 5 years. • Maintaining good house keeping • Safe Operating & Maintenance Procedures in place • Training of operators on Emergency preparedness
Ore Beneficiation Plant	Fire	Fire / Major Injuries Property Damage	• Permit to work system is in place before carrying out any maintenance activity (HOT Jobs) • Maintaining good house keeping • Safety Operating & Maintenance Procedures in place • Fire Fighting System is in place for all areas • Training of operators on Emergency preparedness • Periodical Structural Inspection & taking remedial measures
Coke Oven Battery	Release of Carbon Monoxide, Fire / Explosion	Fatal / Major Injuries, Property Damage	• Installation of fixed CO-Detectors. • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month. • Fixed Fire detection & Fighting System. • Both the nitrogen & steam arrangements are provided in gas line in order to dilute the toxicity in case of emergency. • Provision of double disc gate valve & U Seals in case of emergency • Explosion proof /intrinsic safe instruments in hazardous area to avoid fire. • Safe Operating & Maintenance Procedures in place • Provision of Block & Bleed System to ensure complete isolation • Flare system for pressure safeguarding
Material handling section	Hot coal & coke transport through Conveyor Belt	Fatal / Major Injury Fire &	• Permit to work system is in place before carrying out any maintenance activity (HOT Jobs)

Dept / Section	Hazards	Consequences	Precautionary measures
		Structural / Building Collapse	• Inspection of structural / Building once in 5 years. • Monitoring of material temp before charging into Conveyor Belt • Maintaining good house keeping • Safety Operating & Maintenance Procedures in place • Fire Fighting System is in place for all the conveyors • Emergency quenching in place for all coke route conveyors • Training of operators on Emergency preparedness
Tuyere platform & all furnace floors	Spurting of Hot metal. Major Fire CO Gas leakage	Fatal / Major Injuries Property Damage Collapse of structures	• Installation of fixed CO-Detectors. • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month. • Risk Assessment of Blast furnace operation and ensuring all control measures implementation • Safe Operating Procedures are developed for all types of emergencies and mock drills are being conducted accordingly • Inspection of structural / Building once in 5 years. • Interlocks are provided for all control parameters of Blast furnace • Fire Hydrants installed • Ensuring no water accumulation around the blast furnace and surroundings • Availability of Breathing Apparatus sets, Oxypac and waterjel blankets
Pulverized Coal Injection	Coal blast	Fire & Explosion	• Nitrogen purging system is provided inside the bag filters and silos to cool the coal in case of Fire or rise in temperature. • Interlocks are provided for all control parameters of Coal injection system • Fire Hydrants are installed
Torpedo Puncture	Spurting of Hot metal	Spillage of hot metal on the road during transportation Hot Metal Explosion Derailment of loco	• Regular inspection Torpedo and ensuring its healthiness • Ensuring no water accumulation along the movement of torpedo
Tuyer platform & all furnace floors	Spurting of Hot metal Major Fire	Fatal / Major Injuries	• Installation of fixed CO-Detectors. • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months.

Dept / Section	Hazards	Consequences	Precautionary measures
	CO Gas leakage	Property Damage Collapse of structures	• Inspection of CO-Detectors once in a month. • Risk Assessment of Corex operation and ensuring all control measures implementation • Safe Operating Procedures are developed for all types of emergencies and mock drills are being conducted accordingly • Inspection of structural / Building once in 5 years. • Interlocks are provided for all control parameters of Corex • Fire Hydrants installed • Ensuring no water accumulation around the Corex and surroundings • Availability of Breathing Apparatus sets, Oxypac and waterjel blankets
Coal Drying plant	Coal blast	Fire & Explosion	• Nitrogen purging system is provided inside the bag filters and silos to cool the coal in case of Fire or rise in temperature. • Interlocks are provided for all control parameters • Fire Hydrants are installed
Torpedo / Ladle Puncture	Spurting of Hot metal	Spillage of hot metal on the road during transportation Hot Metal Explosion Derailment of loco	• Regular inspection Torpedo/Ladle and ensuring its healthiness • Ensuring no water accumulation along the movement of torpedo
Converters	Spurting of Hot metal Major Fire Converter puncture Failure of cranes while transporting hot metal from ladle to converter	Fatal / Major Injuries Property Damage Collapse of structures	• Risk Assessment system in place • Safe Operating Procedures are developed • Inspection of structural / Building once in 5 years. • Interlocks are provided for all control parameters of converters • Converter Refractory bricks are replaced as per the time schedule • Scanners are installed for inspection of refractory linings • Cranes are periodically inspected • Pits are made at zero meter of converter to collect any spilled hot metal • Stacks are kept in healthy condition in which there is no water leakage • Forced de-dusting system is provided • Aluminum suits are being used by the personnel working near to convertor.
Gas Pipe Lines & Gas Holder	Bursting of gas lines Fire & Explosion	Fatal / Major Injuries	• Risk Assessment of convertor operation and ensuring all control measures implementation • Safe Operating Procedures are developed for all types of emergencies.

Dept / Section	Hazards	Consequences	Precautionary measures
	CO Gas Release	Property Damage Flare Stack structure damage	• Interlocking arrangements are made for automatic shutdown the operations • Inspection of structural / Building once in 5 years. • Provision of Inert gas (Nitrogen) available along with gas lines • Provision of High-pressure alarm and bleeder system • Gas Holder Area is fenced to restrict un-authorized personnel • Flare gas System installed to burn the excess gas • Fixed Firefighting system installed around the gas holder • Explosion proof lighting systems are installed near Gas pipe lines. • Availability of Breathing Apparatus sets, Oxypac and portable gas monitors • Installation of fixed CO-Detectors. • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month.
HMPT (Hot Metal Pre-treatment)	Spurting of Hot metal Fire	Fatal / Major Injuries Property Damage	• Entire area is protected against water falling inside the ladle • Measures taken to avoid water getting stagnant in the area • HMPT operation is being monitored continuously • Risk Assessment of HMPT operation and ensuring all control measures implementation • Safe Operating Procedures are developed for all types of emergencies and being monitored accordingly
HMDS (Hot Metal De-sulphurisation)	Explosion Spurting of Hot metal Calcium carbide release to atmosphere	Fatal / Major Injuries Property Damage	• Calcium carbide is transferred in a closed pipe using inert gas Nitrogen as a media • Interlocks are provided on the system to check over pressurization • Area near ladle treatment is barricaded to restrict the personnel movement • Continuous monitoring of operations • Sand is stored at site to avoid spread of Calcium Carbide related fires • Fire Extinguishers are placed in area for suppressed of fire / spread of Calcium Carbide
Acid Regeneration Plant/ Continuous Annealing Line/ Continuous Galvanizing Line/ Batch	Carbon Monoxide Gas release	Fatal / Major Injuries Property Damage Fire/Explosion	• Installation of fixed CO-Detectors. • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month. • Fire Hydrant system installed • Isolation shut-off valves & U Seals installed in gas lines

Dept / Section	Hazards	Consequences	Precautionary measures
Annealing Furnace/ Annealing Coating Line			• Explosion proof light fitting installed • Safe Operating & Maintenance Procedures implemented • Safety Interlocks • Provision of Block & Bleed System to ensure isolation • Safety Valves & Flare system • Availability of Breathing Apparatus sets, Oxypac and portable gas monitors
Hydrogen Plant/ Continuous Annealing Line/ Continuous Galvanizing Line/ Batch Annealing Furnace/ Annealing Coating Line	Hydrogen gas leakage	Fire/Explosion by Hydrogen	• Provision of On line Gas Analyzers at identified areas • Installation of fixed Fire Fighting System at Hydrogen bullet area • Two Shut Off Valves in Sequence in critical areas ensure complete isolation. • SIL (Safety Integrity Level) Certified Shut Off Valves in emergency shutdown system to ensure the reliability • Explosion proof /intrinsic safe instruments in hazardous area to avoid fire. • Safety Operating & Maintenance Procedures • Safety Interlocks Provision of Block & Bleed System to ensure complete isolation • Safety Valves & Flare system for pressure safeguarding
Furnace Area	Corex Gas / Mixed gas leakage in the expansion joints , Vents, furnace area	Fatal / Major injuries Fire	• Regular inspection of gas pipe lines, expansion joints & maintenance • Provision of Goggle valve & U Seals for isolation • SOPs developed for Gas lines operational controls and all personnel trained • Emergency Response Plan developed to tackle the situation & regular mock drills are being conducted to test the preparedness • Installation of fixed CO-Detectors. • Use of personnel CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month.
Corex Gas Holder	Corbon monoxide gas (Toxic)	Intoxication by CO gas , fire and explosion	• Safe operating & Maintenance Procedures are in place • Eight nos. of volume relief safety valves are provided. These valves are provided on the top of the gas holder piston • The gasholder is provided with nitrogen purging system. A nitrogen ring is provided to inject purge nitrogen via condensate drain connection of the gasholder • Anti-vacuum protection • U-type water seals are provided on the inlet and outlet pipes of gasholder to ensure leak proof closure and isolation purpose.

Dept / Section	Hazards	Consequences	Precautionary measures
			• Four limit switches for "High –high level" , "High level", "Low-low level" and " Low level" are provided. • The gasholder is provided with an aviation obstruction light at the top • Lightning Arrestors are provided on the roof of gasholder. • Gas Holder Area is fenced to restrict un-authorized personnel • Installation of fixed CO-Detectors. • Use of personal CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month. • Safety Valves & Flare system for pressure safeguarding. • Bleed and block system is provided for emergency release and complete isolation • Spark proof hand tools provision while working on gas lines • Hose station with hoses placed in the premises for any emergency • Safety station in the area: Gas safety appliances like BA sets, BG-4, Oxy pac, ELBA & Air supplied blower face mask etc are always available in the premises. • Safe Operating Procedures are developed for all types of emergencies and mock drills are being conducted accordingly • The gas filling inside the gas holder is controlled through the control valve • Wind sock installed. • The gasholder provided with good earthing system. • Flare stock for releasing the excess gas and to burn the released gas
Blast Furnace Gas Holder	Carbon monoxide gas (Toxic)	Intoxication by CO gas , fire and explosion	• Safe operating & Maintenance Procedures are in place • Safety volume relief safety valves are provided. These valves are provided on the top of the gas holder piston • The gasholder is provided with nitrogen purging system. A nitrogen ring is provided to inject purge nitrogen via condensate drain connection of the gasholder • Anti-vacuum protection • U-seals are provided on the inlet and outlet of gasholder for isolation purpose. • Four limit switches for "High –high level", "High level", "Low-low level" and "Low level" are provided. • The gasholder is provided with an aviation obstruction light at the top

Dept / Section	Hazards	Consequences	Precautionary measures
			• Lightning Arrestors are provided on the roof of gasholder. • Gas Holder Area is fenced to restrict un-authorized personnel • Installation of fixed CO-Detectors. • Use of personnel CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month. • Safety Valves & Flare system for pressure safeguarding. • Bleed and block system is provided for emergency release and complete isolation • Spark proof hand tools provision while working on lines • Portable gas monitors are available with the people working in the area • Hose station with hoses placed in the premises for any emergency. • Safety station in the area: Gas safety appliances like BA sets, BG-4,Oxy pac, ELBA & Air supplied blower face mask etc. are always available in the premises. • Safe Operating Procedures are developed for all types of emergencies and mock drills are being conducted accordingly • The gas filling inside the gas holder is controlled through the control valve • Wind sock installed. • The gasholder provided with good earthing system. • Flare stock for releasing the excess gas and to burn the released gas
Coke Oven Gas Holder	Carbon monoxide gas (Toxic)	Fire & Explosion CO Gas Release	• Safe operating & Maintenance Procedures are in place • Safety volume relief safety valves are provided. These valves are provided on the top of the gas holder piston • The gasholder is provided with nitrogen purging system. A nitrogen ring is provided to inject purge nitrogen via condensate drain connection of the gasholder • Anti-vacuum protection • U-type water seals are provided on the inlet and outlet pipes of gasholder to ensure leak proof closure and isolation purpose. • Goggle valves are installed at both inlet and out of the gas holder for isolation purpose. • Four limit switches for "High –high level" , "High level", "Low-low level" and " Low level" are provided. • The gasholder is provided with an aviation obstruction light at the top

Dept / Section	Hazards	Consequences	Precautionary measures
			• Lightning Arrestors are provided on the roof of gasholder. • Gas Holder Area is fenced to restrict un-authorized personnel • Installation of fixed CO-Detectors. • Use of personnel CO-Detectors. • Calibration of CO-Detectors once in six months. • Inspection of CO-Detectors once in a month. • Safety Valves & Flare system for pressure safeguarding. • Bleed and block system is provided for emergency release and complete isolation • Use of Spark proof hand tools. • Hose station with hoses placed in the premises for any emergency • Safety station in the area: Gas safety appliances like BA sets, BG-4,Oxy pac, ELBA & Air supplied blower face mask etc. are always available in the premises. • Safe Operating Procedures are developed for all types of emergencies and mock drills are being conducted accordingly • The gas filling inside the gas holder is controlled through the control valve • Wind sock installed. • The gasholder provided with good earthing system. • Flare stock for releasing the excess gas and to burn the released gas
LPG installation	Liquefied Petroleum Gas, LPG	Olefin impurities may lend a narcotic effect. High concentration causes asphyxia, Fire and explosion	• Safe operating & Maintenance Procedures are in place • Mounded type storage • Water spray system at LPG Bullets exposed valves and unloading area. • Fire Hydrants and Water Spray Monitor are installed. • Sand Buckets and Portable Fire Extinguishers are installed • Tanks, Pipelines, Fittings and all valves are pressure tested as per statue • Good housekeeping is maintained. • Unloading operation is carried out as per the laid down procedures. • Only authorized Tankers and Drivers are allowed • Fencing around the LPG installation to prevent unauthorized entry in the installation area. • Wind sock installed. • Automatic Fire detection and High velocity Water sprinkler system is provided and also additional fire fighting pump house is attached with the Fire fighting system

Dept / Section	Hazards	Consequences	Precautionary measures
			• Electrical equipment, pipelines are earthed / bonded. • Material Safety Data Sheet displayed at the entrance. • Isolation Valves in Sequence in to ensure complete isolation, Provision of Auto shutoff valve along the line to isolate in case of LPG leakage • Hose station with hoses placed in the premises for any emergency • Safety station in the area: Gas safety appliances like BA sets, Oxy pac, ELBA etc are always available in the premises. • Sufficient number of Fire Safety sign boards is displayed. • Only trained employees are involving in the process. • LPG detectors are installed in the area.
Reference: *Onsite Emergency Plan of JSWSL*			

7.1.19 Mitigation Measures & resources for emergency management

a) Fire brigade

JSW Steel Ltd., has a full- fledged Fire Brigade consisting of following trained man power along with major firefighting appliances available with the Safety and Fire services Department. The personnel are being manned round the clock to meet any emergency inside the plant area as well as outside the plant as and when summoned by the local authorities.

Fire brigade consists of the following major firefighting appliances:

Table 7.21 - Existing fire brigade facilities at JSWSL

Sn.	Nomenclature	Pump	Water In Ltr.	Foam In Ltr.	DCP In Kg
01.	Water Tender (Tunga)	2250 LPM@7Kg/cm^2	4500	-	50
02.	Foam Tender (Bhadra)	2250 LPM @7Kg/cm^2	2750	500	100
03.	Foam Tender (Cauvery)	2250 LPM @7Kg/cm^2	5500	500	150
04.	Foam Tender (Ganga)	2250 LPM @7Kg/cm^2	5500	500	150
05.	Dry Chemical Powder Tender (Krishna)	2250 LPM @7Kg/cm^2	4000	`500	250
06.	Air Crash Fire Tender (Arjun)	4500LPM @8.5Kg/cm^2	7500	800	150
07.	Air Crash Fire Tender (Bheema)	4000LPM @8.5Kg/cm^2	8000	800	150
08.	Emergency Rescue Tender (Hanuman)	Containing different types of cutting and lifting tools, lighting unit, water rescue equipment and gas safety appliances.			
Reference: *Onsite Emergency Plan of JSWSL*					

Each tender is having sufficient firefighting and Rescue equipment available with it. In addition to the above, The following Vehicles are also available with this plant.

Table 7.22 - Existing transport support at JSWSL

Sl.No.	Nomenclature	Qty.
01.	Ambulance (Maruti van)	02 nos.
02.	Fire Jeep	01 no.
03.	Mobile Training Vehicle	01 no.
Reference: *Onsite Emergency Plan of JSWSL*		

b) Fire Water Network:

JSW SL is having dedicated Fire water line to cater only for fire hydrants and fixed firefighting system which are provided entire plant area. This plant is having more than 2000 nos. Internal and External fire hydrant line and also having following dedicated Firefighting pump houses located various area of the plant.

Table 7.23 - Dedicated Fire fighting pump houses located within the plant

PUMP HOUSE	HSM-1	BF-2	COREX	COKE 1&2	COKE 1&2 (Emergency PH)	COKE-3&4	SMS-2	LPG	AIRPORT	BF-3	BF-4	DRI	CRM-1	CRM-2	SMS3
DIESEL PUMPS	3	1	2	2	1	1	2	1	1	1	1	1	2	2	2
DISCHARGE (CU.M/HR)	171	223	171	171	171	273	273	171	171	273	273	410	273	273	171
ELECTRICAL PUMPS	1	2	2	1	2	2	3	1	1	2	2	1	1	2	4
DISCHARGE (CU.M/HR)	171	273	171	171	171	273	273	171	171	273	273	410	273	273	171
JOCKEY PUMPS	2	2	1	2	--	2	2	1	1	2	2	2	2	2	4
DISCHARGE (CU.M/HR)	10	10.8	30	17	--	10.8	10.8	17	17	10.8	10.8	20	10.8	20	10
BOOSTER PUMPS	--	--	1		--	--	1	--	--	--	--	3	--	--	--
HEAD (Mts)	88	88	88	88	88	88	88	88	88	88	110	88	88	88	140
Reference: *Onsite Emergency Plan of JSWSL*															

c) Fire Fighting Facilities :

JSW SL is having sufficient passive and active fire protection system available entire area of the plant. More than 8,000 nos. of Fire Extinguishers are being installed at the plant as well as township area to put out fire in the incipient stage and training also being imparted to the shop level employees regarding Suitability and Operation of Fire Extinguishers. Apart from this, fixed firefighting systems are also provided in the critical and vital area of the plant.

d) Mock Fire Drills:

Mock Fire Drills are being conducted twice in a month at the plant area covering all sections/facilities in rotation to inculcate the professional knowledge as well as to assess the operational preparedness, response time, team work, co-ordination, topographical knowledge, use and operation of proper equipment and appliances etc.

e) Search and Rescue Parties:

Some of employees are being identified and trained them to tackle the emergencies occur in their respective area till arrival of Safety and Fire services team and also they are being trained to assist emergency personnel during major incidents.

Assembly and Ambulance points have been identified in each and every departments and In-charge also nominated for the same.

7.1.20 Communication Facilities:

JSW Steel Ltd., is having a good communication network that consists of telephone system, wireless network, cell phones, to respond Fire Emergencies / Special Service calls in the plant. In addition to that, Manual Call Points (MCP) and Fire alarm systems are also installed in most of the plant area. In addition to the above, campaign dialling system for emergency voice broadcasting is also available with the safety control room for summoning off-duty personnel during emergency.

7.1.21 Emergency Shut Down Procedure

Stop of COREX Facilities

General: A planned stop of the plant from normal operation to idling condition should include few preparation measures to make next start easier and to achieve a normal production in shorter time period.

Pre-conditions: Oxygen supplier and gas receiver shall be informed.

A plant stop, which is planned, must coincide with a tap end of the last tapping.
Height of the fixed bed approx.80% of LRO1602 to have enough char for next start.
The overfilling of the Melter Gasifier should be avoided to prevent damages of the dust burners.

Stop Procedure: Do the following action as per the set procedure

- Make preparations for plant stop.
- Fill up the bed of the Melter Gasifier:
- Reduce addition of DRI to the Melter Gasifier
- Adjust dome temperature:
- Decrease bustle gas temperature (in case of longer shut downs)
- Adjust the adjustable top gas venturi scrubber
- Empty the dust recycling lines
- Start last tapping, bring down melting rate and process parameters:
- Reduce further melting rate and other process parameters:
- Prepare the plant for O2-stop.
- Devolatilize the coal.
- Reduce the plant pressure and the O2-flow.
- Stop Oxygen:
  - When the tap hole is closed
  - Select the group for star/stop of O_2/N_2 and press the stop button.
- Depressurizes the intermediate bins for coal and ore
- After finishing of closing sequence for respective material and sealing flap.
- Opens the depressurizing valves to depressurize the intermediate bin for coal, respectively for ore.
- These two valves should be closed by operator after depressurizing of the plant.
- Cool down the burden of the reduction shaft:
- Move the burden of the reduction shaft

- Maintain cooling gas compressor in operation

7.1.22 Identification of mutual aid partners :

We have mutual aid help with the following partners:

- JSW Energy Ltd, Toranagallu
- Jindal Praxair Oxygen Company Ltd, Toranagallu
- Bellary Oxygen Company, Torangallu
- Bellary Thermal Power Station, Kuditini
- JSW Cement Ltd
- JSW Severfield Limited.

7.1.23 Identification of resource suppliers (both Public & Private):

During an on-site emergency, the Incident controller would keep in touch with the Superintendent of Police, D.C, Bellary and brief them about the situation. The District Authority would handle the situation in case it becomes an off-site emergency.

In case of off-site emergency, the Declarer will inform SP., D.C, Inspector of Factories, KPCB and others. The DC will rush to the affected Site and take over the charge as Off-Site Emergency Controller and he will co-ordinate with the following Agencies.

Police:

i. To maintain the Law & Order at Site and nearby villages
ii. To inform the public about the nature of emergency thro' Loud Speaker
iii. To assist the Off-Site Emergency Controller in all respect.

Health Authorities:

Health authorities, including doctors, surgeon, hospital, ambulances have vital part to play and form an integral part of any emergency plan.

i. To provide immediate medical facilities to the injured persons
ii. To mobilize the affected person to the nearest Hospitals
iii. To mobilize the medicines and antidotes immediately

Fire Authorities:

The control of a fire is normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site. The senior fire brigade officer may also have a similar responsibility for other events such as an explosions and toxic releases.

Press:

To keep the Press informed about the nature of emergency, likely effects, number and condition of the affected persons and progress made on controlling the emergency.

District Administration:

To provide all available resources required to meet the emergency situation for safety of persons.

7.1.24 Emergency Transport Facility:

- Sufficient number of vehicles (buses) will be mobilized for transporting the victims by Company transport officer.
- Injured and affected persons are transported in ambulances to Occupational Health Centre and Jindal Sanjeevani Hospital.
- Doctors and nursing staff will be available with the ambulance.
- Additional requirements of vehicle will be mobilized by outsource agencies working with M/s JSW Steel ltd, and from the mutual partners if required.

7.1.25 Alert Action Plan During Working/Non- Working Hours

- Emergency coded Siren will be sounded for two minutes during any type of emergency.
- All plant personnel will rush to Assembly Point located outside the woks area and stand in orderly manner.
- HOD will brief the emergency situation. Concern HOD or nominated person by the HOD will act as Incident controller.
- Trained Search Team, Rescue Team, First Aiders and Fire Fighting Team will assemble and report to Incident Controller. All emergency teams will be put into operation.
- DPAO will take the personnel attendance and report to Incident controller.
- Safety & Fire Services, Security, OHC, Utility and Transport incharge along with the crew members will rush to the spot and keep in touch with the Incident Controller and Control Room.
- OHC incharge with Ambulance will rush to the spot
- Security incharge along with his Team will cardon off the area and assist the evacuation of Plant Personnel.
- The employees are educated to put wet handkerchief on their noses if they smell any gas or hearing siren from the gas monitor and run against wind direction at 90° (degree) so that the gas inhalation will be less

- HOD, Head of Safety & FS, Security and DPAO will discuss and take appropriate decisions in consultation with Incident Controller.

7.1.26 Emergency Planning

a) Establish line of control – Responsibility & Alternate line of control:

Training:

- All JSWSL & outsourcing employees are well trained with respect to on-site emergency plan and various hazards involved such as Carbon monoxide gas, liquid hot metal and shut down procedures.

- JSWSL has got full pledged Human Resource Department (HRD) Centre for conducting various training programs. Besides, Safety Department is also imparts training on different training modules i.e. permit system, work at height, confine space entry, Road safety , Fire Prevention and Protection etc.

- Training also provided in handling of Safety Appliances such as Blowers, Gas Masks, Resuscitator, CO Detectors and First Aid Treatment to Gas affected persons.

- The Contractor's drivers are trained in defensive driving training and issued the Safety Badges

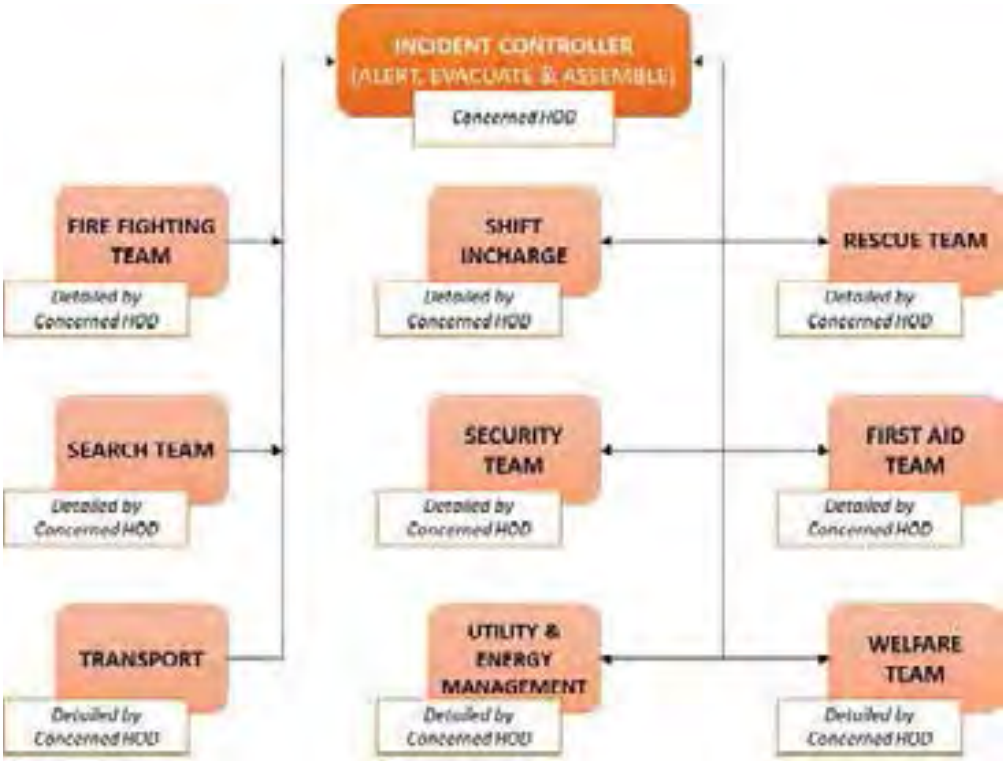
- Regular Education and Training to employees about Emergency Control Plan will be rendered through the following Avenues:
  - ► Shop floor talks by line Executives and Staff Executives
  - ► Safety Induction Training Programs
  - ► Job Safety Training Programs at Shop-floor levels
  - ► Monthly Training Programs on specialized subjects
  - ► Firefighting demonstrations
  - ► Toolbox Talks

- Regular rehearsal of On-Site Emergency Plan is being conducted involving all persons shown below in order to train them to combat emergency situation effectively by creating an artificial emergency scene in the required plants or areas.

Role & Responsibility

The emergency management team and their interdependent interactions are shown in figure below:

Fig.7.13.: Organization chart of Emergency Management team



The responsibilities/duties of the emergency management team is briefed in paragraphs below.

Duties of Incident Controller:

Head of Department (HOD) or his nominated officer will retain overall responsibility for the site and its personnel in case of emergency. Concerned HODs of the incident area will act as Incident Controller jointly, in case of an emergency encapsulating a large area with multiple departments. As soon as he is informed of the emergency, he shall proceed to the control room and meet the Administrative Officer.

His **duties on first notice of an emergency** shall be:

- Assess the magnitude of the situation and decide if employees need to be evacuated from their working points.
- Exercise direct operational control over the area other than that which is affected.
- Maintain a continuous review of possible development and assess in consultation with incident controller and other key personnel as to whether shutting down of the plant and evacuation of personnel is required.
- Give necessary instruction to Admn. Officer to co-ordinate with Sr. officials of Police, Fire Brigade, Medical and Factory Inspectorate. Provide advice on possible effects on area outside the factory premises.
- Control rehabilitation of affected area and persons on discontinuous of emergency.

- Issue authorized statement to news media and ensures that evidence is preserved for statutory inquiries to be conducted by authorities.

On hearing of emergency alarm the Incident Controller will rush to the scene of occurrence and take overall charges and report to site controller. He will assess scale of emergency and inform the communication officer accordingly.

His **duties at site during emergency** will be:

- Direct all operation within the affected area with the priorities for safety of personnel, minimize damage to the plant, property and environment.
- Pending arrival of site controller assume the duties of his post and in particular direct the shutting down and evacuation of plant and area likely to be adversely affected. Ensure that all-key personnel and outside help is called in.
- Provide advice and information to the Fire & Security Officer and the local fire service as and when required.
- Ensure that all non-essential workers / staff of the area affected are evacuated to the appropriate assembly point.
- In the event of failure of electric supply and nearby PAS and internal telephones, setup communication points and establish contact with emergency control centre.
- Report to communication officer on all significant developments.
- Have regard to need for preservation of evidence to facilitate any inquiry.

Duties of Emergency services:

The different services and their respective teams for controlling an emergency are:

- ► Fire Fighting Team
- ► Shift in-charge
- ► Rescue Team
- ► Search Team
- ► Security
- ► Ambulance
- ► Transport
- ► Utility & EM
- ► Welfare Team

Duties of Shift Incharge:

The Shift incharge of will immediately inform to his superiors and simultaneously pass on the message to the following department to take further actions immediately.

i. Safety & Fire Services Department.
ii. Occupational Health Centre
iii. Security Services
iv. Utility & Energy Management
v. Transport dept.
vi. If necessary other depts. – Logistics, RMHS, PP, COREX, BOF-CCP-LCP, HSM, CMD, Glasshouse, Stores, HR&FIN.
vii. HR & Admn. – Acts as Communication centre in case of serious incidents.

Duties of Rescue Team:

- Trained rescue team members internal and other depts. will rush to the affected area and rescue the victims.
- In case of gas leakage, suitable gas mask should use before entry into the affected area.
- Rescue team members also help the fire-fighting operations if necessary.

Duties of Search Team:

- Search team members internal and other depts. will rush to the affected area for searching the affected victims.
- In case of gas leakage, suitable gas mask should use before entry into the affected area.
- Search team members also help the fire fighting operations if necessary.

Duties of Security department:

- Cordon off the Area immediately.
- Control the Traffic and keep them away
- Keep the Road clear leading to OHC/Hospital to transport the injured persons.
- Co-ordinate with the Police & State Fire Brigade if necessary.
- Help in emergency operation if necessary.

Duties of Occupational Health Centre (Ambulance & First Aiders):

- Mobilize the Ambulance accompanied by Doctor to the site.
- Ensure that those requiring medical attention are separated.
- Provide First Aid to all injured persons in Occupational Health Centre.
- Transport the other injured / affected persons to local Hospitals
- Inform the local Hospitals about the cause of an Incident, required Antidotes and supply if necessary.
- Follow up the cases till normalizing the situations.
- Trained First Aiders also join and help in First Aid Treatment.

Duties of Transport Department:

- Sufficient number of vehicles will be mobilized for transporting the victims.
- Ensure the additional requirements of vehicles.

Duties of HR & Admn. Dept.

- As per the directives of the Declarer, Inspectorate of Factories, Pollution Control Board and District Govt. Authorities etc. will be intimated immediately.
- Head counting the employees including contractors / visitors and collect the details of the affected persons.
- To inform the relative of all the victims and extend all possible help to them.
- To mobilize sufficient number of vehicles to the affected site.
- To mobilize the trained First Aiders, Fire Fighters, Safety Stewards

- To alert the nearby villages if necessary.

In order to meet the emergency situations, the workers and all the members of all the teams are being trained and educated about various possibilities of dangerous occurrences and to act effectively in the emergency situation by conducting rehearsal programs.

Hands-on training through Mock Drills/Rehearsal programs:

Each member of the above teams/groups are being trained in the form of mock drills to face the actual situation in case of emergency in a systematic manner. The communications will be made in the following way. The mock drill procedure is as follows:

- The Shift-in charge will inform to Incident controller / declarer.
- The Incident Controller / declarer rush to the spot and take necessary action depending upon the situation for declaring the emergency.
- Arrangements are made to blow intermittent siren continuously.
- The search team will take suitable action to search the injured persons
- The rescue team will take effective actions to rescue the affected persons
- In case of gas hazards, the search & rescue team will start evacuating trapped persons to assembly area.
- Emergency Services agencies will be informed to rush to the spot to render the required services.
- Fire Brigade & First Aid Services will be put into service immediately.
- The Security Co-ordinator shall ensure the law and order.
- Welfare Co-ordinator maintains the morale of the workers.
- When the incident controllers feels that, the Emergency situation is no more prevailing, issues directives to blow siren continuously for 3 minutes

b) Actions in case of Emergency:

Fire incidents:

Sn.	Action to be taken	Action by
1	Alert the all personnel by Shouting "Fire, Fire" after noticed the fire or activate the fire alarm.	First who notice the fire
2	Inform Safety& Fire Services and JSH	Concern Control room I/C
3	Declaration of On-site emergency and act as per the responsibilities given in point no. 21(iii)	Incident Controller
4	Evacuate the personnel and asked them to assemble in Assembly point	Area Search and Rescue team
5	To cut-off Electrical supply if fire involve in the electrical equipment or central Air condition system is available in that area.	Line Manager
6	Indentify exact area of the fire and cordon-off it	Security personnel
7	Inform Concern personnel of the Department i.e. Utilities, EMD and Transport	Concern Control room I/C
8	Try to extinguish the fire with the help of available fire extinguishers and Fire hydrants.	Area Search and Rescue team, Safety & Fire services
9	Guide the fire fighting team to fire spot and assist them during fire fighting and rescue operation.	Area Search and Rescue team

Sn.	Action to be taken	Action by
10	Summon help from mutual Aid partners and inform local authorities if fire is major	Incident Controller
11	Declare ALL CLEAR signal	Incident Controller
12	Blow clear siren and ask all employees to resume their work	Respective shop /section I/C
Reference: *Onsite Emergency Plan of JSWSL*		

Gas Leakages:

Sn.	Action to be taken	Action by
1.	Alert the all personnel by activating alarm	Concern Control room I/C
2.	Inform Safety& Fire Services and JSH	Concern Control room I/C
3.	Declaration of On-site emergency and act as per the responsibilities given in point no. 21(iii)	Incident Controller
4.	Evacuate the personnel and asked them to assemble in Assembly point.	Area Search and Rescue team, Safety & Fire services Department.
5.	To cut-off Extractor or central Air condition system is available in that area.	Line Manager
6.	Identify exact area of the Leakages and cordon-off it	Shift Manager ,Security personnel
7.	Inform Concern personnel of the Department i.e. Utilities, EMD and Transport	Concern Control room I/C
8.	Try to arrest the leakage of the gas and Isolate the line and arrange for nitrogen purging	Concern department , EMD
9.	Availability of sufficient BA cylinder at the site.	Safety & Fire services
10.	Provide first aid and causalities shift to the JSH	Search and Rescue team, Safety &Fire services.
11.	Summon help from mutual Aid partners	Incident Controller
12.	Inform local authorities if leakages is major	Incident Controller
13.	Declare ALL CLEAR signal	Incident Controller
14.	Blow clear siren and ask all employees to resume their work	Respective shop /section I/C
Reference: *Onsite Emergency Plan of JSWSL*		

Building/Structural collapse:

Sn	Action To Be Taken	Action By
1.	Alert the all personnel by activate the alarm	Concern control room I/C
2.	Inform Safety& Fire Services and JSH	Concern Control room I/C
3.	Declaration of On-site emergency and act as per the responsibilities given in point no. 21(iii)	Incident Controller
4.	Evacuate nearby personnel and asked them to assemble in Assembly point	Area Search and Rescue team
5.	To cut-off Electrical supply and Utility services.	Line Manager
5.	Mobilise Crane, Bull dozer , Excavator etc	Line Manager , CMD
6.	Cordon-off the area and nearby building	Security personnel
7.	Inform Concern personnel of the Department i.e. Utilities, EMD and Transport	Concern Control room I/C

Sn	Action To Be Taken	Action By
8.	Start rescue operation and extricate the causalities	Area Search and Rescue team, Safety & Fire services.
9.	Provide First aid and if require shift causalities to JSH	Area Search and Rescue team, Safety & Fire services, First Aid Team.
10.	Summon help from Local authorities & mutual aid partners if requires	Incident Controller
11.	Declare ALL CLEAR signal	Incident Controller
12.	Blow clear siren and ask all employees to resume their work	Respective shop /section I/C
Reference: *Onsite Emergency Plan of JSWSL*		

Gas leakage and explosion in hot blast stoves

Sn	Action to be taken	Action by
1	Alert by blowing siren from the control room and inform it to all respective agencies and HOD	Control room operator, Field operator
2	Declaration of On-site emergency and act as per the responsibilities given in point no. 21(iii)	Incident Controller
3	To control over the situation considering the severity initially blast pressure reduced after informing Boiler and EMD	Control room operator
4	Evacuate the area.	Search & Rescue team
5	Immediately arrange for tapping both side	Cast house in charge
6	Open both the bleeders.	Control room operator.
7	Open snort valve fully.	Control room operator.
8	Inform Boiler/Blower operator to trip the blower if severity of leakage is not in control	Control room operator.
9	Close the cold blast mixer shutoff valve	Control room operator.
10	Isolate the stove from on-blast & depressurize	control room operator
11	Box-up all stoves from the Gas (if any) and depressurize all the stove after isolation	Control room operator.
12	Fill U-seals at GCP , Stove & Net work	GCP operator & EMD
13	Open N2 purging in Dust catcher and Network gas line as well as Stoves	GCP Operator
14	Arrange Fire-tender and put off fire with the help of fire and safety dept. personnel's from the safe distance	Safety & Fire Services
15	Cordoning the affected area	Security
16	Start rescue operation and extricate the causalities	Area Search and Rescue team, Safety & Fire services.
17	Provide First aid and if require shift causalities to JSH	Area Search and Rescue team, Safety & Fire services, First Aid Team.
18	Summon help from Local authorities if requires	Incident Controller
19	Declare ALL CLEAR signal	Incident Controller
20	Blow clear siren and ask all employees to resume their work	Respective shop /section I/C
Reference: *Onsite Emergency Plan of JSWSL*		

c) Emergency communication

Notification of Emergency:

In case of any emergency situation, concerned person will immediately inform to Shift incharge of respective units and simultaneously pass on the message to Safety & Fire Services Control Room. After assessment of magnitude of situation, the Site Controller will notify the Emergency and act as per the responsibilities mentioned above.

Declaration of Emergency:

- During emergency due to incidents -gas leakage / fire, any employee who notices the same will inform to Shift in charge. The shift incharge will communicate situation immediately to all employees through Telephone / walkie-talkies/local Siren. The shift incharge will also assess the emergency situation and take necessary steps.

- The shift incharge of the Plant will take necessary action to control the leakage / fire with the available resources. In case the emergency situation is of serious nature, the shift incharge will declare the emergency **himself**.

- The shift incharge will rush to the spot of leakage / fire with necessary Fire/Safety Appliances and assess the situation and take appropriate steps to control the same.

- Once he is convinced that it may lead to an on-site emergency, he will declare emergency after informing the Declarer / Incident Controller through Coded Siren. He will inform immediately to Control Room of S&FS to sound the main Siren to alert the whole plant.

- All plant personnel will rush to **Assembly Point** located outside the woks area and stand in orderly manner. HOD will brief the emergency situation.

- Trained Search Team, Rescue Team, First Aiders and Fire Fighting Team will assemble and report to Incident Controller. All emergency teams will be put into operations.

Emergency Siren - Style and duration:

- **First two minutes** : Sounding of Coded Siren i.e. low and high pitch

After controlling the emergency:

- **Last three minutes** : Continuous sounding the Siren

This is final scenario of the emergency and works activities will be restarted and functions as usually.

In the event of an Off-Site emergency, the Declarer will in touch with the District Authorities mainly District Magistrate, SP., Inspectorate of Factories, Pollution Control

Board. The Supdt. of Police will take over the charge and act as a Declarer and controlling the Off-Site situations.

d) Evacuation of Personnel:

- Emergency coded Siren will be sounded for two minutes during any type of emergency.
- All plant personnel will rush to Assembly Point located outside the woks area and stand in orderly manner.
- HOD will brief the emergency situation.
- Trained Search Team, Rescue Team, First Aiders and Fire Fighting Team will assemble and report to Incident Controller. All emergency teams will be put into operation.
- DPAO will take the personnel attendance and report to Incident controller.
- Safety & Fire Services, Security, OHC, Utility and Transport incharge along with the crew members will rush to the spot and keep in touch with the Incident Controller and Control Room.
- OHC incharge with Ambulance will rush to the spot
- Security incharge along with his Team will cardon off the area and assist the evacuation of Plant Personnel.
- The employees are educated to put wet hand kharchiff on their noses if they smell any gas and run against wind direction at 90• (degree) so that the gas inhalation will be less.
- HOD, Chief of Safety & FS, Security and DPAO will discuss and take appropriate decisions in consultation with Incident Controller.

e) Accounting of Personnel:

- The DPAO will cross check the Attendance of persons present on duty with the help of Search Team, Rescue Team and report to Incident Controller.
- Plant is to be shut down on emergency basis by the shift incharge depending upon the situation and type of emergency.
- In case of off-site emergency, the Police will take over the charge and maintain the Law and Order.
- Finally, after clearance from Incident Controller, the Emergency coded Siren will be sounded for three minutes to clear Emergency Evacuation and thereafter, Plant will be normalized.

f) Arrangements for Medical Treatment

- Mobilize the Ambulance accompanied by Doctor to the site.
- Ensure that those requiring medical attention are separated.
- Provide First Aid to all injured persons in Occupational Health Centre.
- Transport the other injured / affected persons to local Hospitals
- Inform the local Hospitals about the cause of an Incident, required Antidotes and supply if necessary.
- Follow up the cases till normalizing the situations.
- Trained First Aiders also join and help in First Aid Treatment.

g) Information to the Government Authorities

During an on-site emergency, the Incident controller would keep in touch with the Superintendent of Police, D.C, and Bellary and brief them about the situation. The District Authority would handle the situation in case it becomes an off-site emergency.

In case of off-site emergency, the Declarer will inform SP., D.C, Inspector of Factories, KPCB and others. The DC will rush to the affected Site and take over the charge as Off-Site Emergency Controller and he will co-ordinate with the following Agencies.

h) Law and Order :

Police:

- To maintain the Law & Order at Site and nearby villages
- To inform the public about the nature of emergency thro' Loud Speaker
- To assist the Off-Site Emergency Controller in all respect.

Health Authorities:

Health authorities, including doctors, surgeon, hospital, ambulances, and son, have vital part to play and form an integral part of any emergency plan.

- To provide immediate facilities to the injured persons
- To mobilize the affected person to the nearest Hospitals
- To mobilize the medicines and antidotes immediately

Fire Authorities:

The control of a fire is normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site. The senior fire brigade officer may also have a similar responsibility for other events such as explosions and toxic releases.

Press:

To keep the Press informed about the nature of emergency, likely effects, number and condition of the affected persons and progress made on controlling the emergency

District Administration:

To provide all available resources required to meet the emergency situation for safety of persons.

i) Declaration of End of emergency/All clear signal

- The Declarer will inform to everyone concerned through sounding the Siren "All Clear Signal" continuously for three minutes.
- Once the "All Clear Signal" is given, all the persons inside and outside the plant can perform their normal duties.

7.1.27 Offsite Emergency Plan

The offsite emergency plan of Bellary District has been comprehensively prepared by the District Crisis Group, Bellary district of Government of Karnataka. The plan identifies steps for emergency preparedness of emergency services from the district authorities such as police, fire, health, etc., for handling off-site emergency situations which have the potential to cause serious damage or loss of life beyond plant boundaries in a prompt and effective manner.

a) Objectives of Offsite Emergency Plan

The objectives, extent and scope of the plan are as follows:

- To provide resources and methods for effective control of emergencies arising out of the leakage ,explosion and fire due to hazardous materials
- To prevent emergency turning into disaster
- Synchronized action from all the coordinating agencies with least possible delay
- To minimize damage to the property ,people and the environment
- Effective rescue operation and treatment of the causalities
- To train the people and the concerned to act efficiently and with confidence in an emergency
- To bring back normal situation in the least possible time
- To provide authoritative information to the news media and government agencies
- No panic among the general public .No exploitation or exaggeration of the situation by any agency
- The Off Site Emergency Plan is applicable to the following industries of Bellary

The Scope of the plan is to mobilize all the resources through its Chief Disaster Controller (CDC) to oversee the effective implementation in achieving its objectives and extend assistance to the needy.

b) Major Accident Hazard (MAH) Industries

The MAH industries identified in Bellary district are:

- M/s. JSW Steel Limited, Toranagallu.
- M/s. JSW Praxair Oxygen Company Limited, Toranagallu.
- M/s. Bellary Oxygen Company ltd, Toranagallu.
- M/s. Linde India Limited, Toranagallu.
- M/s. Praxair India Private Limited, Toranagallu.
- M/s. BMM lspat Limited, Danapur. Hosapete Taluka.

These are shown in the map as presented in figure below:

Fig.7.14.: Location of Major Accident Hazardous (MAH) Industries in Bellary District

Other potentially hazardous industries identified in the district were

- M/s. United Spirits Limited, Hospet
- M/s. JAMIPOL, Toranagallu, Ballari
- M/s. Galaxy Chemicals, Mundargi Industrial Area, Ballari

c) Potential for Off Site emergencies

Off Site Emergencies Due to Accidents at MAH Industries

The Offsite emergency plan based on a study of chemicals stored, used, transported & manufactured in these MAH units reveals that the hazards associated with these industries are:

- Fire
- Explosion
- Asphyxiation
- Toxic release

Consequently the disasters would be

- Fire and Explosion
- Asphyxiation
- Toxic release

Chemical emergencies either arise from the industrial installations or from transportation of chemicals. Wherever it occurs, depending on the nature and quantity of hazardous chemical and the location of accident, it may have the potential of affecting the general population in the surrounding area.

Accidents during Transportation

Accidents involving the transport of chemicals from industries are rare. The industries are striving continually to prevent such accidents by:

- Careful selection, auditing and evaluation of transport contractors
- Training of drivers and attendants employed by transport contractor
- Careful selection and design of packaging materials
- Advising transporters on design and material of construction for road tankers avoiding the need to transport altogether whenever possible.

d) Hazard Identification For Natural & Other Man Made Disasters

Chemical disasters could also occur as an outfall of natural disasters such as earthquakes, floods and cloud bursts, cyclones, aircraft strike and sabotage/war. Floods and earthquakes could result in large-scale damage to life and property even without the exposure to chemicals. The presence of chemicals in the affected area could only complicate the emergency and would have to be dealt with special precautions. In order to make informed decisions, it is essential to understand the hazard potential due to such natural calamities also.

Floods & Heavy Rain

Tungabhadra River passes through the Bellary District and Tungabhadra dam built across at certain upstream locations, which during heavy rains breach could cause flooding in the District.

Earthquake

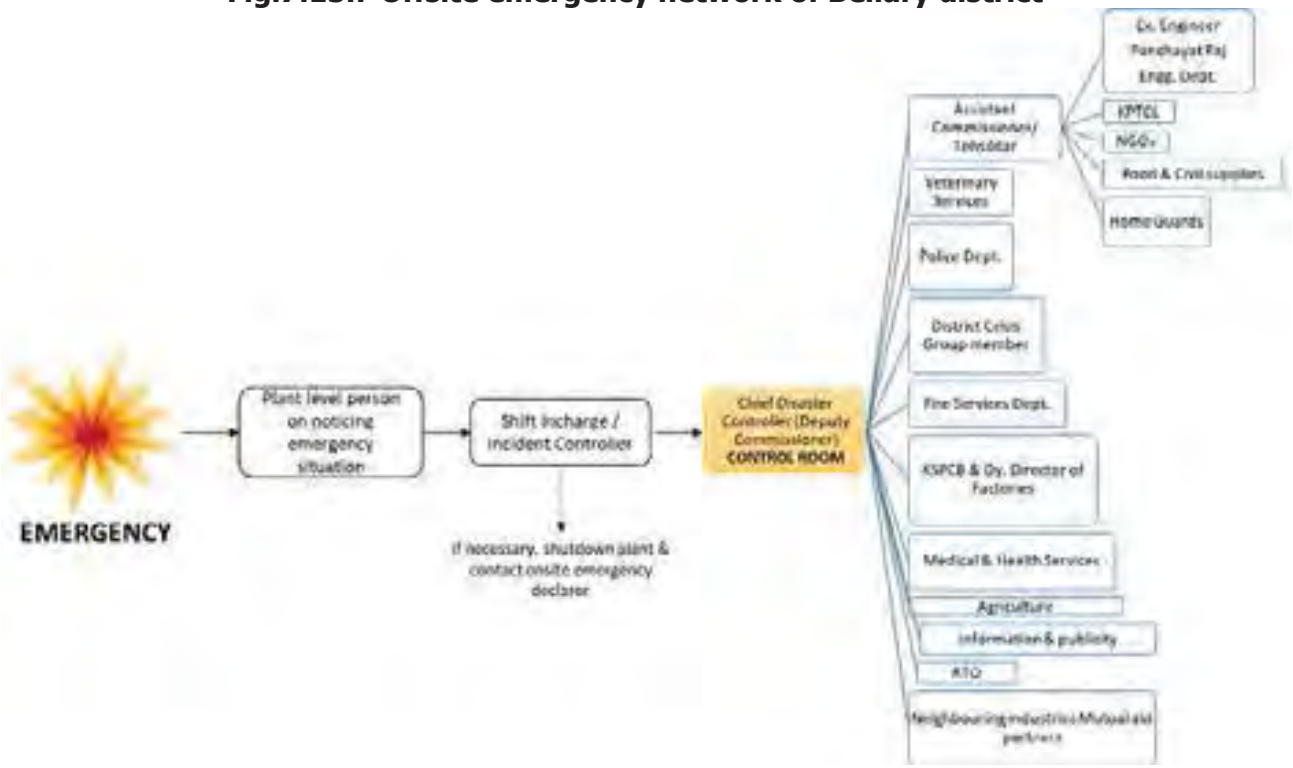
Based on the Seismic Zone Map of India, State of Karnataka lies in seismic zone II and III, which is a medium-risk zone and earthquakes of medium intensity, can occur in this region. This does not guarantee an earthquake free operation and therefore, it prudent to take appropriate measures during planning phase for earthquake safety.

e) Offsite Emergency Management at Bellary district

The Offsite Emergency Management at Bellary district involves multiple agencies including the concerned plant personnel as well as other services of the District administration.

The offsite emergency network of Bellary district is through the Chief Disaster Controller (CDC) and the same is shown in figure below.

Fig.7.15.: Offsite emergency network of Bellary district



The emergency management for an offsite emergency will be carried out via the CDC.

Functions of the Chief Disaster Controller (CDC):

The main functions of the Chief Disaster Controller (CDC) are

- Declaration of emergency;
- Taking control of situation to mitigate the emergency;
- Dissemination I Acceptance of information to I from various agencies like rescue, police ,fire, transportation, traffic control, medical aid, maintenance of rehabilitation centre , rallying posts, parking yards ,supply of food & water for affected people & the evacuees ,live stock
- Mobilization of all resources to mitigate the emergency;
- Establishing of safe rescue, evacuation of people, supplementing firefighting/
- rescue equipment at the site of emergency
- Activation of various NGO's I Voluntary organization for necessary materials;
- Establishments liaison with public, media, kith & kin of the affected persons
- Notifications of termination of emergency & declaration of all clear signal
- Assessment of damage to human life, livestock, property, environment & provide adequate relief for subsistence.

Emergency Control Room:

The Office of the Deputy Commissioner will be the control room. The control room will be equipped in line with the control room at site I installation to the extent of serving as information cum communication centre.

Taking into the consideration the maximum accident credible scenario, Safety & Fire Services Department at M/S JSW and M/S JSW E will be designated control rooms for operation in the event of any emergency. Either of the two will be used as per convenience. The control rooms are equipped with the following infrastructure facilities.

The incident controller of the factory will shoulder the responsibility of combating emergency till such period; the Chief Disaster Controller comes and assumes the task. The Various responders who are involved in the mitigation procedure will work under the advice of the Incident Controller.

Functions of Various Departments during an Offsite emergency:

Police Department:

- The main function of police authorities would be to maintain law order, regular patrolling of affected areas, establish rescue safe routes in advance for timely response, cordoning off the area, control of traffic, shifting of all vehicles to the parking yards
- To render assistance in controlling and fighting disasters, salvage operations rendering first aid and medical help ,shifting of the affected to rallying posts / rescue shelters, deploying adequate protection at the rescue shelter and at the place of incident.
- Another important function would be identification of the deceased, informing their relative, removal and disposal of dead bodies. Finally preparing of the list of missing persons and take steps to trace them.

Fire Services Department:

Station Fire Officer -

- On receipt of emergency call, the fire officer will rush to the site of incident with all crew members and equipment and start fighting the fire and control the gas leakage.
- Assist the police, home guards and other rescue, evacuation of persons, salvage operations etc.
- Continue to be in action till such time the District Fire Officer or his deputy arrives at the place of incident and takes charge. From there onwards, he will continue to assist the said officials.

District Fire Officers -

- The District Fire Officer is made responsible to fight and control the fire, leakage, spillage of cryogenic liquids as the case may be and deploy adequate number of men for control of fire, leakage, spillage etc with proper instructions and guidance.
- Rush to the site of emergency on receipt of information from the site controller or an emergency call or CDC
- Establish safe routes in advance from Bellary in association with police personnel for rushing to the site and to ensure best response time to minimize damage Work out advance plan for requirement of resources like fire tenders,

trained personnel, protective equipment and the ways to meet the extra requirement, if any.

- Assist the on Site Emergency personnel in fighting emergency, rescuing injured/ affected people trapped in dangerous zones & participate in salvage operation.
- Assistant medical I police personnel in imparting first aid.
- Ensure availability of adequate water supply.
- Maintain Constant contact and communicate the message to the CDC with regard to control measures undertaken, salvage operations, rescue methods etc. and any other information's required by the CDC on continuous basis.
- Take any other appropriate actions as deemed necessary and in concurrence with CDC in controlling the Emergency.

Revenue Department:

Asst. Commissioner Bellary -

- He will be the over all in charge of Rescue Shelter I rallying pot & parking yard.
- He will ensure adequate food and clothing in co-ordination with Dy. Director of Food and civil supplies
- Voluntary organizations will function under the guidance of Asst. Commissioner and seeking his opinion
- He will also ensure proper medical aid (first aid as well as shifting of affected persons in consultation with District Health Officer)
- He will ensure adequate security & safety in Co-ordination with S.P of Bellary at the site of emergency and at the rescue shelters.
- In addition to these specific responsibilities, the A.C will assist the CDC in all other matters as the case may be.

Tahsildar, Bellary -

- He will look after all the facilities required at rescue shelter I rallying past like food, clothing, medical aid, water, electricity, sanitation and other basic necessities in coordination with respective Government agencies as well as voluntary organization
- He will manage & arrange for any other requirements on need basis at that point of time in coordination with respective Government Authorities
- He will alert all his subordinates and utilize their services to manage the rescue shelters/rallying posts.
- His action will be in concurrence from A.C- Hospet/Bellary.

Health and Medical Services Department:

- District Health Officer (DHO) will be the overall in charge of health and medical services to be rendered at the site of emergency or at various rescue shelters, affected places, hospitals pathology laboratories etc.
- On receiving the information from CDC, he will contact all Hospital Superintendents, Drug Controller, and Blood Banks for mobilization of required Ambulance/Doctors/Nurses/Medicines I Life Saving drugs, Blood etc.,

- Rush to the site, assess the extent of Severity & establish adequate TMCs (Temporary Medical Centers).Ensure hygienic conditions at the rescue Shelter cum rallying Post , temporary , medical centers .Take appropriate action in shifting affected persons to hospitals either in Koppal or Hospet and ensure them appropriate treatment.
- Arrange for removal of dead bodies if any after post mortem and dispose the same in consultation with CDC & SP
- Render advises to CDC on precautionary measures to be taken by public at the affected site I villages, rescue shelter cum rallying posts to prevent the out breaks of epidemic diseases.

Karnataka State Pollution Control Board:

- On receiving the information from CDC, the Environment officer will mobilize the possible resource at his disposal and keep the laboratory functioning for analysis of pollutants, emissions etc.
- Rush to the site ,collect the sample, analyze the pollutants and the likely effect on human life I environment and inform the CDC about the same & the corrective actions to be taken to prevent for further damage
- Act as an expert and advice the CDC about the kind of message to be disseminated to the public and press etc. on pollution matters.

Mutual Aid- Neighbouring Industries:

- On receiving the information from CDC or Emergency alarm, the neighboring industries will alert their workmen;
- Mobilize the resources viz., doctor, ambulance van, trained personnel in the firefighting and first aid and rush to emergency area and report to the CDC.
- Will Mobilize firefighting equipment and other implements and gear required for combating emergency and supply to the emergency site against the request and instructions of the CDC;
- Will help the rescue activities with the trained personnel and work on the instructions of the CDC
- Provide any expertise and help if required by the CDC in emergency combating proceedings.

District Crisis Group:

- All the members of DCG will be communicated about the emergency
- On receipt of emergency communication they will immediately inform the Control room about the place of their availability and simultaneously report to the CDC.
- They will receive the necessary instructions from the CDC and act accordingly
- They will render adequate & timely technical guidance and assist CDC and other agencies involved in the mitigation of emergency
- They will also advise CDC on the message to be given to the public/ press on technical matters.