

## CHAPTER 7

### RISK ASSESSMENT AND ONSITE EMERGENCY PLAN

#### 7.1 Hazard Identification

Identification of causes and types of hazards is the primary task for planning for risk assessment. Hazard can happen because of the nature of chemicals handled and also the nature of process involved. So for risk analysis first step is to identify the hazardous chemicals which are to be studied for risk analysis.

Identification of **Hazardous Chemicals** is done in accordance with **The Manufacture, Storage and import of Hazardous Chemical Rules, 1989**.

Schedule 1, of the Rule provides a list of the Toxic and Hazardous chemicals and the flammable chemicals. It defines the flammable chemicals based on the flash point and boiling point.

"**Major accident hazards (MAH) installations**" is defined as the isolated storage and industrial activity at a site handling (including transport through carrier or pipeline) of hazardous chemicals equal to or, in excess of the threshold quantities specified in Column 3 of Schedule 2 and 3 respectively

Schedule 3 has classified hazardous substances in an operating plant into 5 groups and has provided the threshold quantities for application of above rules.

Group1 & 2 – Toxic substances

Group 3 – Highly reactive substances

Group 4 – Explosive substance

Group – 5 Flammable substances

The following **Table 7.1** shows the list of major chemicals which have been identified as hazardous chemicals in The Manufacture, Storage and import of Hazardous Chemical Rules, 1989 and which are to be considered as Major accident hazards (MAH) installations.

**Table 7.1  
Hazardous Chemicals in Plant**

<b>Sr No.</b>	<b>Chemical</b>	<b>Use</b>	<b>Nature of Chemical (Schedule 1 &amp; 3)</b>	<b>Storage Quantity</b>	<b>Threshold quantity for MAH</b>
1	Fuel Oil	Supporting Fuel	Highly Flammable	3750 KL*	2500 tonnes
2	Transformer Oil	Transformer	Highly Flammable	15 KL	2500 tonnes
3	Chlorine	Cooling Tower	Toxic – Group 2	25 tonnes*	10 tonnes
4	Sulfuric Acid	Water Treatment	Hazardous	24 tonnes	Not considered
5	Caustic soda	Water Treatment	Hazardous	24 tonnes	Not considered

\* To be considered as MAH

The chemicals which are stored more than the threshold quantities are to be considered for major accident hazard. Fuel oil (LDO/HFO), used as supportive fuel in the boiler, is classified as Highly Flammable liquid as its flash point remains within 30°C–90°C. Its threshold quantity is 2500 tonnes. Similarly for Chlorine is a toxic gas and its MAH quantity is 25 tonnes. So Fuel oil and Chlorine will be considered for further analysis for risk assessment

Quantity stored for transformer oil very low to be considered for the study. Sulphuric Acid and Caustic soda are hazardous chemicals but are not included in Schedule 3 for MAH.

.Material Safety Data Sheets (MSDS) for Fuel Oil and Chlorine are provided at the end of this chapter.

## **7.2 Storage conditions and Quantities**

### **a) Fuel Oil (LDO/HFO)**

LDO/HFO is flammable liquid. It is stored in a steel tank at ambient temperature and pressure. The tank is installed within a dyked area. The tank capacity is 3750 KL, having a diameter of 18 m.

b) Chlorine

The liquefied chlorine is stored in tonner cylinders in the chlorination rooms. Each cylinder contains about 930 kg of liquid chlorine stored under pressure at ambient temperature.

### 7.3 Hazards Scenarios

#### **Nature of Hazard from Oil Storage:**

Diesel is a petroleum product. It is a highly flammable liquid having flash point between 32 –96 °C. However its auto ignition temperature is 256 °C. Its boiling point ranges between 150-400 °C. Furnace Oil is of similar characteristics having flash point above 66 °C.

Major Hazards from oil storage can be fire. Maximum credible accidents from oil storage tank can be

- a) Tank Fire
- b) Pool / Dyke fire.

#### **Tank Fire:**

Oil is stored in floating roof tank. Leak in rim seal leading to accumulation of vapour is a source of fire. Lighting can be a source of ignition and can cause tank fire.

Overflow from tank leading to spillage may cause vapour cloud formation. This can catch fire and it can flash back to the tank to cause tank fire.

#### **Pool / Dyke Fire:**

If there is outflow from the tank due to any leakage from tank or any failure of connecting pipes or valves, oil will flow outside and form a pool. Where the tank is surrounded by a dyke, the pool of oil will be restricted within that dyke. After sometime, the vapour from the pool can catch fire and can cause pool or dyke fire.

**Heat Radiation and Thermal Damage Criteria:**

The level of damage caused by heat radiation due to fire is a function of duration of exposure as well as heat flux (i.e. radiation energy onto the object of concern). This is true both for the effect on building and plant equipment and for the effect on personnel. However the variation of likely exposures times is more marked with personnel, due to possibility of finding shelter coupled with protection of the skin tissue (clothed or naked body). Further, it is assumed that everyone inside the area by the pool fire will be burned to death (100% lethality) or will asphyxiate. Radiation at various heat flux levels which are critical in risk analysis, are given in the **Table 7.2**.

**Table 7.2  
Effect of Heat Radiation**

Heat Radiation	Effect
37.5 kw/m <sup>2</sup>	Damage to equipment
30.0 kw/m <sup>2</sup>	Limit for Class 1 building materials
12.5 kw/m <sup>2</sup>	Melting plastic
4.0 kw/m <sup>2</sup>	Blistering
1.6 kw/m <sup>2</sup>	Severe hot feeling

The damage and fatality (percentage of the exposed people to be killed) due to the exposure time is very important in determining the degree of fatality and corresponding effect distance. It is observed that the exposed persons normally find shelter or protection from the heat radiation (e.g. against a wall) within 10 seconds. However, exposure time of 30 seconds is normally assumed for pessimistic calculation which applies if people do not run away immediately or when no protection is available. The variation of the effects on humans due to heat flux and duration of exposure have been developed in the form of a Probit Equation which gives following values for human fatality levels in **Table 7.3**.

**Table 7.3  
Heat Radiation and Fatality**

<b>Radiation Level (kw/m<sup>2</sup>)</b>	<b>Exposure Time in seconds for % Fatality</b>		
	<b>1 %</b>	<b>50%</b>	<b>99%</b>
1.6	500	1300	3200
4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

**Nature of Hazard from Chlorine Storage**

Chlorine is a gas at ambient temperature and pressure. Its boiling point at 1 atmosphere pressure is -34.1oC. It is a greenish yellow gas with irritating pungent smell. It is heavier than air and its molecular weight is 70.9. Chlorine poses a major health hazard if human beings are exposed to higher concentration. Chlorine is non-combustible in air but most combustible materials will burn in chlorine as they do in oxygen. Flammable gases and vapours will form explosive mixtures with chlorine.

Hazards from chlorine come from loss of containment which may be leakages, pipe rupture or vessel rupture. As liquefied chlorine is released under pressure it forms a liquid pool and then evaporates. A substantial release will then form a vapour cloud. A considerable amount of mixing with air occurs during evaporation. As the cloud travels under the influence of wind, it disperses and its concentration becomes further diluted and at some distance concentration becomes non hazardous.

Four specific scenarios can be considered

- a) Failure of Liquid outlet valve
- b) Failure of Gas outlet valve
- c) Body leakage of a corroded cylinder
- d) Any leakage in the gas pipeline

These scenarios have been detailed later in Consequence analysis.

**Toxic Damage Criteria**

Chlorine poses a major health hazard if human beings are exposed to higher concentration. Its odour threshold value is about 1 ppm and lowest reported lethal concentration at 30 minutes is 60 ppm. Threshold limit value (TLV) for workplace (8 hours, 5 days in a week exposure) for chlorine is 0.5 ppm and Short term exposure limit (STEL- exposure up to 15 minutes) is 3 ppm. According to Factories (Amended) Act, 1987, for workplace Time weighted concentration for 8 hours is 0.5 ppm and Short term exposure limit (15 minutes) is 3 ppm. Impact of chlorine is dependent on concentration and time. 30 minutes exposure of about 250 ppm of chlorine may cause 50% fatality among healthy people. Immediate Danger to Life and Health (**IDLH**) for chlorine is 25 ppm.

The hazards from loss of containment of chlorine will cause different levels of damage. This is dependent on concentration of the gas at a particular location and duration of exposure of the victim. The harm is expressed as probability of fatal cases or injury. The following **Table 7.4** shows the fatality criteria for certain exposure to chlorine.

**Table 7.4**  
**Chlorine Mortality in 30 minutes (ppm)**

	10%	50%	90%
Healthy people outdoor			
Up and about	125	250	500
Vigorous Walking	62	125	250
Vulnerable people indoor			
Up and about	50	100	200
Vigorous Walking	25	50	100

In the present study IDLH value of 25 ppm is considered for consequence analysis. The people should be evacuated from the zone of impact within 7 minutes to avoid any injury.

## 7.4 Consequence Analysis

### Methodology

Consequence models estimate the potential hazards of the release of a chemical. It is done based on the release characteristics of the chemical concerned. A number of formulae and softwares are used for these purposes.

For the present study, for Pool fire and Tank fire, steady state burning is assumed. Also for large fire wind speed is considered insignificant. Heat radiations at different distances have been calculated based on equations of USEPA's CAMEO model.

Dispersion of chlorine has been calculated using software WHAZAN (World Bank Hazard Analysis) - II, version- 2.1. WHAZAN is a software package, which contains a set of hazard analysis models (called consequence models) together with a physical properties database of chemicals. The models estimate the effects of hazardous chemical releases.

### Failure Scenarios for LDO and Consequences

This study is intended to find about the worst-case scenarios, as that will cover the other scenarios. A number of scenarios have been considered and finally the following failure scenarios have been analyzed following the MCA approach which will cover all the worst scenarios in this installation. Following Table shows the heat radiation zones for different scenarios.

**Table 7.5  
Tank Fire Heat Radiation**

Consequence	Heat dose (KW/m <sup>2</sup> )	Tank Fire	Pool / Dyke Fire
		Distance from Centre, m	Distance from Centre, m
<b>Heavy Damage to Plant Equipment, 99% Fatality</b>	37.5	12.56	160.8
<b>Limit for Class 1 building materials</b>	30	14.06	179.9
<b>Melting Plastic, 1% Fatality</b>	12.5	21.79	278.9
<b>First degree burns in 20 seconds, non-fatal</b>	4.0	38.5	493

**Failure Scenarios for Chlorine and Consequences**

Liquid chlorine at ambient temperature and higher pressure (about 6.5 kg/cm<sup>2</sup>) is stored in tonner cylinders. Each cylinder contains 930 kg of chlorine in liquid form. Two major scenarios of Liquid chlorine discharge and gaseous chlorine discharge are considered. For worst meteorological case, low wind speed condition (1.5 m/sec) during daytime and night time and for winter and summer seasons have been considered. For winter day temperature of 25°C and night temperature of 12 °C has been considered. For summer day temperature of 35°C and night temperature of 25 °C has been considered.

**Table 7.6** shows the impact distances for chlorine discharge for different scenarios.

**Table 7.6**  
**Risk Distances for Chlorine Discharge**  
(Concentration of 25 ppm)

<b>Failure Type</b>	<b>Meteorological Condition</b>	<b>Risk Distance m</b>
Liquid Chlorine Discharge	Winter - Day	1580
	Winter - Night	1620
	Summer - Day	1990
	Summer - Night	1580
Gaseous Chlorine Discharge	Winter - Day	550
	Winter - Night	520
	Summer - Day	720
	Summer - Night	550

## 7.5 Risk Assessment

The risk assessment determines whether the risks are tolerable or if risk mitigation measures are required to reduce the risk to a level which can be considered to be as low as reasonably practicable (ALARP). UK standards are generally followed here. Risk assessment depends on failure frequency of the system and probability of ignition and explosion. These are assessed below.

### Failure frequency

The range of possible releases for a given component covers a wide spectrum from a pinhole leak upto a catastrophic rupture (of a vessel) or full bore rupture (of a pipe). It is both, time consuming and unnecessary to consider every part of the range; instead, representative failure cases are generated.

For various types of component and for each of the representative hole sizes, failure frequencies are summarized in below in **Table 7.7**.

Frequency of lightning striking an object is 1.0E-07.

**Table 7.7**  
**Failure Frequency**

Type	Failure Case	Failure per year
Pipe Damages		
	Leaks	1.7 E-04
	Holes	1.4 E-04
	Ruptures	4.2 E-05
Total		3.5 E-04
Liquid Storage Tank	Significant Leak	1.0 E-04
Pressurised Vessel		3.0E-06

### Ignition Probability

Ignition probability data is important in quantification of risks. Historical data on ignition of flammable releases are used as a basis for determining suitable ignition probabilities. As probability of ignition depends upon availability of source of ignition, it also depends on the maintenance of safety level. **Table 7.8** shows the ignition probability for flammable liquids.

**Table 7.8**

**Ignition Probability for Flammable Liquids**

Type of Ignition	Probability
Immediate	0.065
Delayed	0.065
No Ignition	0.87

**Estimated Risk level**

Tank fire will take place mostly due to occurrence of leak at rim and subsequent struck by lightning.

Tank fire and Dyke fire will take place due to full rupture of liquid outlet and then delayed ignition. As described before Risk level will be decided on two important parameters of failure frequency and ignition probability.

For Chlorine dispersion it will take place due to failure of pressurized vessel or some leak at the inlet outlet pipes.

It is assumed that there will be continuous presence of a person within the fatality zone.

Risk assessment level for each hazard scenario is calculated and given below;

**Table 7.9**

**Risk Level**

Scenario	Estimated Risk Level	Acceptability	Remarks
		<b>10<sup>-3</sup></b>	Max tolerable to Workers
<u>Tank fire / Dyke fire</u> Liquid Line rupture	2.73 x 10 <sup>-6</sup>	<b>10<sup>-4</sup> to 10<sup>-6</sup></b>	Max tolerable to Public  ALARP
Tank Failure	6.5 x 10 <sup>-6</sup>		
Chlorine Dispersion (Considering 25 cylinders)	7.5 x 10 <sup>-5</sup>		
Tank Fire by Lightning	6.5 x 10 <sup>-13</sup>	<b>Below 10<sup>-6</sup></b>	Negligible

**The results show that the risk from fire and chlorine dispersion remains within ALARP region. Tank fire by lightning is of negligible risk.**

**Limitation of the Risk Assessment Study**

Any mathematical expression of physical events has some limitations. The properties of chemicals, release conditions, meteorological data are all used as ideal data which can have variation in the actual condition. Therefore the consequences of hazardous incidents will have varying accuracy. Many types of hazardous incidents can only be assessed by making a variety of simplifying assumptions. Many times an ideal simple mode of failure could not be identified in real disaster event. A number of apparently independent events can occur at a time because of some simple events.

Failure rates are also statistical averages depending upon the reporting accuracy. Also all the failure rate data are generated in the western developed countries which may not be always same for here.

Thus Risk Assessment and consequence analysis have a lot of subjective input and should not be considered an end in itself. These results should be used in judicious manner utilizing practical knowledge and common wisdom.

**7.6 On Site Emergency Plan**

In recent years public awareness of hazards from industry have increased considerably. Local people and employees have now better legal safeguards against industrial disasters. The management today has more responsibilities in respect of any kind of disaster in its project. So specific management plan to encounter a disaster situation is of utmost importance. As disaster types, sources, effects are different, it needs multidisciplinary and multi-organizational approach to tackle such situation.

**Types of Disaster**

Disaster is an event which causes severe disruption to life of number of people or to the project activities resulting in suffering and loss of life and property.

Disasters can be

- I) Plant oriented- due to design errors, operational defects, chemical changes, failure of equipments human errors etc. (in the plant area).
- II) Natural- flood, cyclone, fire, earthquakes, biological disaster.
- III) Manmade- war, riot, sabotage.

### **Degrees of Disaster**

Disaster can be classified in 3 types depending on its effects.

1. LO - can cause injury, illness and equipments damage but not very serious and quickly manageable.
2. MID - Critical situation, can cause serious injuries to personnel, serious illness property and equipment damage.
3. HIGH - Catastrophic situation, major danger, can cause deaths, major widespread illness, injuries, loss of major property and equipments. Immediately uncontrollable.

The above contingencies will be declared by the chief coordinator. The following will be the mode of action during different degrees of disaster.

**HIGH DISASTER-** Catastrophic condition. All employees to be evacuated. Local administration to be properly informed and interacted.

**MID DISASTER-** All project activities to be stopped. All employees to be in safe place. To be ready for High disaster situation. Inform local administration.

**LO DISASTER-** Activities in the affected area stopped. To be ready for MID disaster condition.

### **Stages of Disaster**

The duration of disaster's effect can be divided into following stages:

- Warning
- Impact

- Rescue
- Relief
- Rehabilitation

1) Warning:

The natural calamities which may lead to disasters e.g. flood, cyclone can often be predicted. There are possibilities of disasters during local trouble, riot and war etc. also. All facilities to encounter the disaster should be kept ready and employees in full alert.

2) Impact:

This is the time when the disaster actually strikes and very little can be done to counter the situation. The impact period may be of few seconds (like explosion or earthquake) or for days (like flood, fire etc.).

3) Rescue:

This is the most important stage which starts before the predicted disaster of just after the impact. All available resources need to be immediately engaged in operation.

4) Relief:

This is a longer stage of work depending on the degree of disaster. Work during this stage will need external help for medical, food, clothing and shelter.

5) Rehabilitation:

This is an important stage in terms of future planning. It includes rebuilding of damaged properties, restart of project work, compensation etc.

### Emergency Plan

On site Emergency Plan is required to meet the emergency condition during disastrous event in the plant. Its objectives are to:

- Rescue and treat casualties
- Safeguard other people & Installations
- Minimize damage
- Control initially and restore ultimately to normal situation
- Arrange rehabilitation of the affective people

The obligation of an occupier of hazardous chemicals to prepare an on - site emergency plan is stipulated in Rule 13 of the Manufacture, Storage and Impact of Hazardous Chemicals Rules, 1989. Section 41B (4) of the Factories Act, 1948 (as amended) also states that every occupier is to draw up an on site emergency plan with detailed disaster control measures.

It is there fore necessary to develop an on site disaster management plan through a systematic study of the hazard possibilities.

A summary of the plan is given below. The plan will be revised and detailed after the commissioning of the plant, as then all the units will be in final shape. The exact name and designations of all personnel will be then provided in the plan.

### **7.7 Key Persons and their role**

**Site Controller** is the person who assumes absolute control of the Factory and determines the action necessary to control the Emergency. He/She will wear a Red & White Helmet to confirm his identity. The General Manager will be the site controller.

Site controller will ensure that all members of his/her team have been informed to collect at Emergency Control centre. He/She will then proceed to Emergency Control Centre to take charge.

After firsthand assessment of situation he/she will give necessary instructions to Emergency Control Team. He/She will maintain a Log book of all the activities.

He/she will keep in touch with the external communication Team.

He/she will ensure that information is sent to outside emergency services (Police and Fire Brigade).

He/she will depute people to,

- Attend to telephone
- Keep in touch with incident controller
- Communicate with Assembly Points
- Meet outside emergency services
- Ensure proper flow of traffic and security
- Meet media/ other people coming at site from outside.
- Arrange for Medical Aid

**Incident Controller** is the person who goes to the scene of emergency and supervises the actions taken at the incident to overcome the Emergency. Shift Manager will act as Incident Controller. His responsibilities will be

- Direct all efforts to contain and control the incident.
- Keep non-essential persons away from the site.
- Guide outside emergency services at the site.
- Arrange to remove any casualties at the site.
- Keep in touch with Emergency Controller.

**Security In-Charge will**

- a) Actuate the Emergency Siren, if not done already.
- b) Send one guard to start the fire pump.
- c) Attend to incoming telephone.
- d) Await instructions from the Emergency Controller

**Communication Officer**

Public Relations Officer will act as Communication Officer.

On hearing alarm He will proceed to Emergency Control Centre.

- Maintains communication with Incident Controller and Deputy Incident Controller
- Recruits suitable staff to act as messengers if telephone and other communications fail

- Organizes all requirement of Emergency Control Centre
- Arranges Food, Transport, Nursing Home etc

#### **Personnel Manager**

- He/she will work as Liaison officer. He should be positioned in the office near gate.
- Will deal with police, media and outside enquiries in consultation with Site Controller.
- Will keep in touch with Union
- Will arrange for refreshments if required
- Will control traffic movement traffic movement inside the factory and arrange for alternative transport if required
- Will keep a record of attendance of workers, staff, contractor's personnel, and visitors at the Gate which will act as Assembly Point.

#### **Safety Officer**

- Will assist the Incident Controller with his special knowledge on the safety aspects in the factory. He will help to identify the hazardous chemicals, hazard zones and zone of probable impact in different accident scenarios
- Will select people with special training in safety matters to assist in the control activities

#### **Fire & Security Officer**

- His/her main task is fire fighting and control
- Announce through PAS about the incident zone and any other immediate information needed for the people nearby
- Maintains liaison with the Fire Brigade team from outside

#### **Medical Officer**

- Will immediately open a First Aid Centre at Control Centre or at Assembly Point

- Will take up the full responsibility of providing medical assistance during emergency
- Will arrange for outside medical help if required.

#### **Telephone Operator**

- On hearing the emergency alarm, he/she will immediately contact Site Controller
- On the advice of Site controller/Incident Controller/Security Officer will ring Fire brigade, Police etc
- Keep telephone board free for urgent communications.

**General employees** who have not been specified a duty in case of emergency should proceed to/contact the Emergency Assembly Point in their area. Designated persons will carry out the actions detailed in the Individual Plant Emergency Procedure. The Roll Call leader will hold a Roll call. Personnel not at their normal work place must go to the emergency assembly point. Personnel will remain at these points and await instructions from the Site Controller.

#### **Contractor's Employees**

Contractor's employees will be instructed in the Emergency Procedures before commencing work on this site. They will report to the emergency assembly point on this site. Personnel Manager will guide them in case a major decision like evacuation from the factory is taken.

#### **Visitors**

Infrequent visitors are registered on each visit. They will be given a Visitors pass which includes an emergency action statement. The responsibility for visitors in emergency situation rests with the person being visited.

**Responsibilities outside general shift hours**

**Shift Supervisor**

He/she will act as Site controller for the time being. As soon as becomes aware of the emergency and its location, he will proceed to the scene. He will assess the scale of the incident and direct operations within the affected areas.

He/she will contact and inform the Site Controller and Incident Controller immediately. Till their arrival he will continue to perform their duties.

He/she will contact the departmental head to act as incident controller and guide Safety Officer and Security Officers for containing the damage.

He/she will call the Medical Officer to the plant if necessary.

Other staff with designated responsibilities will act as instructed.

**7.8 Infrastructure**

Fire Fighting Facilities: The plant will have adequate fire fighting aids including fire hydrants close to the required locations. There will be Portable Fire Extinguishers of different types and sizes are installed in specific places.

The factory siren will be used for raising the alarm and also for ALL CLEAR signal

First Aid boxes are provided in specific locations including at the Assembly point for administering preliminary treatment. A number of employees are trained for first aid use.

Emergency Control Centre is the point from which the Site Controller directs the movements of Personnel and Equipment during an Emergency.

Contents of Emergency Control Centre:

- a) External telephone line and a list of relevant telephone numbers. **Table 7.10** provides a list of relevant telephone numbers
- b) Internal telephone and telephone list of Emergency Assembly Points.

- c) List of Emergency Control Team, who must be called showing addresses and telephone numbers.
- d) Emergency Controller's Red & White Helmet.
- e) A list of all persons (by title) responsible for groups of employees.
- f) Logs and Emergency Controller's checklist.
- g) Emergency lighting.
- h) Copy of the emergency plan.
- i) List of persons trained in First Aid & Fire Fighting.
- j) List of safety cabinets and their contents & locations.
- k) Battery operated torches.
- l) Detailed site plan.
- n) First aid equipment including stretchers (in surgery).

Assembly Point is a place containing an internal telephone and paging system, where people can wait in a group during emergency to receive instructions from the Emergency Controller.

External Communication will be done by Site Controller. The following persons and offices may be given updated information as necessary and ask for necessary help.

- ✓ SDO
- ✓ Police
- ✓ Fire Brigade
- ✓ District Hospital
- ✓ OPCB
- ✓ Factory Inspector
- ✓ Local Media
- ✓ District Magistrate

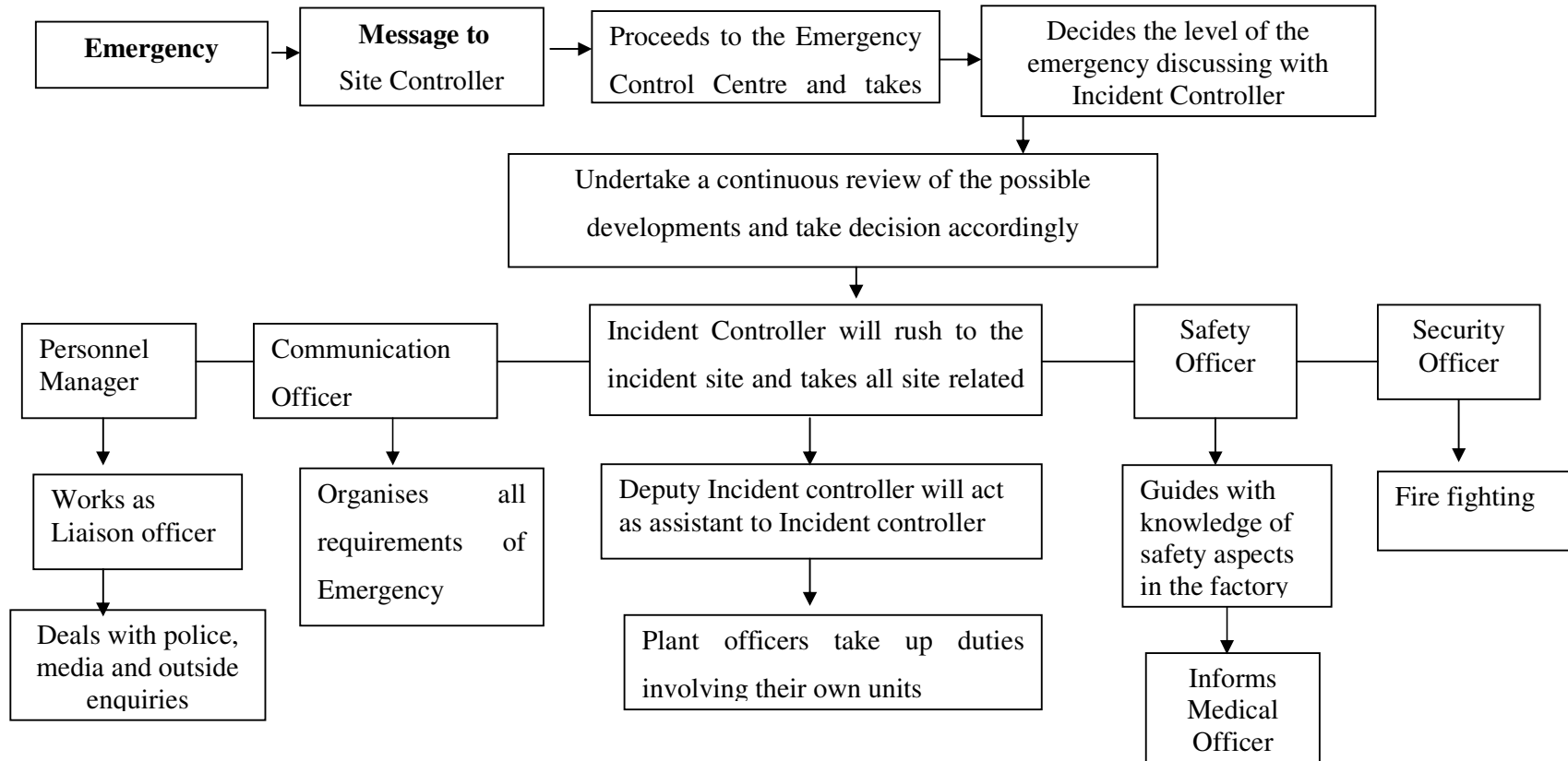
Some important information for Emergency Response and Common Terms in use are given Annexure.

**Table 7.10  
Important Telephone Numbers**

<b>S. No</b>	<b>Name</b>	<b>Tel. Numbers</b>
1	Inspector of Factories	
2	District Magistrate	
3	Fire Station	
4	Superintendent of Police	
5	The Chief Inspector of Factories Govt. of Orissa (Directorate of Factories)	
6	Director Orissal Fire Service	
7	Environmental Engineer, Orissa Pollution Control Board –Bhubaneswar	
9	Member Secretary, Orissa Pollution Control Board, Kolkata	
10	Police Station - Naraj	



### Emergency Response Diagram



**Material Safety Data Sheets (MSDS) for Fuel Oil and Chlorine**

<b>IDENTITY OF MATERIAL: DIESEL</b>	
<i>Product name</i>	↑ Diesel Oil, Gas Oil
<i>Trade name</i>	HSD
<i>Formula</i>	Complex mixture of Hydrocarbons
<i>Label / Class</i>	Red - FLAMMABLE LIQUID
<i>UN NO.</i>	1202
<i>CAS NO.</i>	
<i>HAZECHM code</i>	↓ 3Y*
<b>PHYSICAL AND CHEMICAL PROPERTIES</b>	
<i>Physical state</i>	↑ Liquid
<i>Boiling point/ Range C</i>	150 -400
<i>Melting/ Freezing pt. C</i>	18 to -46
<i>Vapour pressure</i>	<1S
<b>FIRE AND EXPLOSIVE HAZARDS DATA</b>	
<i>Explosivity</i>	↑ Moderate
<i>Auto Ignition Temp. C</i>	256.6
<i>Explosive Limits %</i>	0.7-5
<i>Flash Point, C, CC/ OC</i>	↓ 32 to 96
<b>HAZARDS SPECIFICATION</b>	
<i>NFPA RATING</i>	
<i>Health</i>	0
<i>Stability</i>	0
<i>Flammability</i>	2
<i>Material Factor</i>	10

## CHLORINE

### General

Synonyms: bertholite, molecular chlorine

Molecular formula: Cl<sub>2</sub>

CAS No: 7782-50-5

EC No: 231-959-5

### Physical data

Appearance: light greenish-yellow gas with an irritating odour

Melting point: -101 C

Boiling point: -34 C

Vapour density: 2.98 g/l

Vapour pressure: 5.8 bar at 20 C

Specific gravity: 1.47 g/ml at 0C

Flash point:

Explosion limits:

Autoignition temperature: n/a

### Stability

Stable. Incompatible with reducing agents, alcohols.

### Toxicology

Toxic by inhalation, ingestion and through skin contact. Inhalation can cause serious lung damage and may be fatal. 1000ppm (0.1%) is likely to be fatal after a few deep breaths, and half that concentration fatal after a few minutes. May irritate or burn skin. OEL (8hr TWA) 1 ppm.

### Toxicity data

IHL-HMN LCLO 2530 mg/m<sup>3</sup>/30m

IHL-HMN LCLO 500 ppm/5m

IHL-RAT LC50 293 ppm/1h

IHL-MUS LC50 137 ppm/1h

**Transport information**

Un No 1017. Major hazard class 8.0. Transport category 1.

**Environmental information**

Very toxic to aquatic organisms.

**Personal protection**

Safety glasses, gloves and good ventilation.

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