7.3 Risk Assessment

Hazard analysis involves the identification and quantification of various hazards (unsafe conditions) that exist in the plant and mines. On the other hand, risk analysis deals with the identification and quantification of risks, the plant and mining equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant.

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

In the sections below, the identification of various hazards, probable risks in the plant, maximum credible accident analysis, and consequence analysis are addressed which gives a broad identification of risks involved in the proposed project. Based on the risk estimation disaster management plan has been also been presented.

7.3.1 Approach to the Study

Risk involves the occurrence or potential occurrence of some accidents consisting of an event or sequence of events. The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation point of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad DMP, On-site and Off-site Emergency Plan, which includes Occupational Health and Safety Plan.

7.3.2 Risk Assessment

Identification and quantification of hazards in the clinkering plant is of primary significance in the risk analysis. Hence, all the components of a system/plant/process have been thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident. The following two methods for hazard identification have been employed in the study:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (GOI Rules, 1989); as amended in 2000; and

- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

Hazardous substances may be classified into three main classes: Flammable substances, unstable substances and Toxic substances. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345-M. The storages of raw materials and product of clinker plant are given in **Table-7.2.**

Coal is the main fuel used in the proposed Kiln in clinkering plant and CPP. Furnace oil or HSD will be used for standby DG Sets (two numbers) and start-up of Kiln.

- ***Coal***

Coal is transported to the plant from the SECL by railway wagons. Coal requirement for the proposed clinker plant is estimated to be about 1560 tonnes/day. It is proposed to provide the pre blending stockpile of 2 x 20,000 tonnes.

Hazardous characteristics of the major flammable materials and chemicals that are employed in different processes and storages of the Clinkering plant are given in **Table-7.3.**

TABLE-7.2
CATEGORY WISE SCHEDULE OF STORAGE TANK

Sr. No	Product	No. of Tanks	Classification	Design Capacity (KL)
1	Furnace Oil	1	B	200

A: Dangerous Petroleum   B: Non- Dangerous Petroleum   C: Heavy Petroleum

TABLE-7.3
PROPERTIES OF FUELS/CHEMICALS USED AT THE CPP PLANT

Chemical	Codes/Label	TLV	FBP	MP	FP	UEL	LEL
			°C			%	
Furnace Oil	Flammable	5 mg/m^3	400	338	32-96	7.5	0.6

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

7.3.2.1 Identification of Major Hazard Installations Based on GOI Rules, 1989 (amended in 2000)

Following accidents in industries in India over a few decades, a specific legislation covering major hazard activities has been enforced by Govt. of India in 1989 in conjunction with Environment Protection Act, 1986. This is referred here as GOI Rules 1989 (amended in 2000). For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals. A systematic analysis of the fuels and their quantities of storage has been carried out, to determine threshold quantities as notified by GOI Rules and the applicable rules are identified. The results are summarized in **Table-7.4.**

TABLE-7.4
APPLICABILITY OF GOI RULES TO FUEL/CHEMICAL STORAGE

Sr. No.	Fuel	Listed in Schedule	Total Quantity [KL]	Threshold Quantity (T) for Application of Rules	
				5,7-9,13-15	10-12
1	Furnace Oil	3(1)	200	25 MT	200 MT

7.3.2.2 Hazard Assessment and Evaluation

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

Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally the vulnerable zones are plotted for which risk reducing measures are deduced and implemented. The potential risk areas in the plant are given in **Table-7.5.**

Fuel Storage

A HSD storage tanks is provided in the plant. In case of tank or fuel released in the dyke area catching fire, a steady state fire will ensue. Failures in pipeline may occur due to corrosion and mechanical defect. Failure of pipeline due to external interference is not considered as this area is licensed area and all the work within this area is closely supervised with trained personnel.

7.3.2.3 Coal Handling Plant and Coal Processing Plant - Dust Explosion

Coal dust when dispersed in air and ignited would explode. Coal crusher house and conveyor systems are most susceptible to this hazard. To be explosive, the dust mixture should have:

- Particles dispersed in the air with minimum size (typical figure is 400 microns);
- Dust concentrations must be reasonably uniform; and
- Minimum explosive concentration for coal dust (33% volatiles) is 50 grams/m^3.

Failure of dust extraction and suppression systems may lead to abnormal conditions and increasing the concentration of coal dust to the explosive limits. Sources of ignition present are incandescent bulbs with the glasses of bulk head fittings missing, electric equipment and cables, friction, spontaneous combustion in accumulated dust.

Dust explosions may occur without any warnings with maximum explosion pressure upto 6.4 bar and another dangerous characteristic of dust explosions is that it sets off secondary explosions after the occurrence of the initial dust explosion. Many a times, the secondary explosions are more damaging than primary ones.

The dust explosions are powerful enough to destroy structures, kill or injure people and set dangerous fires likely to damage a large portion of the coal handling plant including collapse of its steel structure, which may cripple the life line of the plant.

7.3.2.4 Generator Buildings in CPP

Turbo-Generator Buildings are exposed to risks due to similar hazards given below:

1. As per the summary of study of losses in United States for a period of 50 years, the probability of fire in Turbo-Generators is one in 185 unit years. Therefore there is a possibility of fire/explosion in turbo-generator set once in 50 years. The probable hazardous area is lubrication system in the turbo-generator.

2. Apart from the Turbo-Generator sets, other major hazardous areas in Turbo-Generator Buildings are :

   - Cable Galleries;
   - Control Rooms;
   - Switchgears;
   - Oil drums stored at Ground Floor level; and
   - Battery Rooms.

PVC cables can be involved in fire. Such fires are known to propagate at speeds upto 20 meter/min. Hence there is a possibility of starting fresh fires in all directions wherever cable runs cross each other or bifurcate. On combustion, every kilogram of PVC compound produces 1000 M^3 of highly dense smoke, which mainly contains hydrogen chloride fumes sufficient to produce 1 litter of Hydrochloric acid, which may condense on cooler metallic parts and instruments in presence of moisture damaging them severely. Since length of PVC cables is several kilometers in Turbo-Generator Buildings, the hazard is tremendous.

Apart from PVC cables, the oil installation is a large one for Turbo-Generator sets and can burn furiously spreading fires to Cable Galleries and other places.

The rapidity of spread of fire may create problems such as safe shutdown of units not involved initially in fire and safe evacuation of personnel, particularly operators and engineers in control rooms.

Turbo-Generator building is a steel structure with no insulation, and in case of a major fire, may collapse as the strength of steel would get reduced by half at temperature of 550^{O}C (yield point of steel) and above.

There will be also serious implications for supply in power grids including its total collapse following major fires.

TABLE-7.5
PRELIMINARY HAZARD ANALYSIS FOR PROCESS AND STORAGE AREAS

Sr. No.	Blocks/Areas	Hazards Identified
1	Kiln/Vertical Roller Mill	Fires in - a) Lube Oil systems b) Cable galleries c) Short circuits in i) Control Rooms ii) Switchgears
2	Boilers	Fire (mainly near oil burners), steam; Explosions, Fuel Explosions
3	Coal crusher/coal washery	Fire and/or Dust Explosions
4	Power Transformers	Explosion and fire.
5	Switch-yard Control Room	Fire in cable galleries and Switchgear/Control Room.

TABLE-7.6
PRELIMINARY HAZARD ANALYSIS FOR THE WHOLE PLANT IN GENERAL

PHA Category	Description of Plausible Hazard	Recommendation	Provision
Environ-mental factors	If there is any leakage and eventuality of source of ignition.	--	All electrical fittings and cables are provided as per the specified standards. All motor starters are flame proof.
	Highly inflammable nature of the chemicals may cause fire hazard in the storage facility.	A well-designed fire protection including protein foam, dry powder, CO_2 extinguisher shall be provided.	Fire extinguisher of small size and big size are provided at all potential fire hazard places. In addition to the above, fire hydrant network is also provided.

Fire Explosion and Toxicity Index (FE&TI) Approach

Fire, Explosion and Toxicity Indexing (FE & TI) is a rapid ranking method for identifying the degree of hazard. The application of FE&TI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information.

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

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

By comparing the indices F&EI and TI, the unit in question is classified into one of the following three categories established for the purpose are presented in **Table-7.7.**

TABLE-7.7
FIRE EXPLOSION AND TOXICITY INDEX

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

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 GOI Rules, the hazardous fuels used in the plant were identified. Fire and Explosion are the likely hazards, which may occur due to the fuel storages. Hence, Fire and Explosion index has been calculated for in plant storage. Detailed estimates of FE&TI are given in **Table-7.8.**

TABLE-7.8
FIRE EXPLOSION AND TOXICITY INDEX FOR STORAGE FACILITIES

Sr. No.	Chemical	Total Quantity	F&EI	Category	TI	Category
1	Furnace Oil	200 KL	10.1	Light	-	-

Furnace oil storage falls into light category of F&EI and nil toxicity index.

Maximum Credible Accident Analysis (MCAA)

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This section deals with the question of how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models. Major hazards posed by flammable storage can be identified taking recourse to MCA analysis. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapour cloud explosion, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed.

The reason and purpose of consequence analysis are many folds like:

- Part of Risk Assessment;
- Plant Layout/Code Requirements;
- Protection of other plants;
- Protection of the public;
- Emergency Planning; and
- Design Criteria (e.g. loading on Control Room)

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs in the plant and also to get information as how to deal with the possible catastrophic events. It also gives the workers in the plant and people living in the vicinity of the area, an understanding of their personal situation.

Damage Criteria

The fuel storage and the supply pipelines may lead to fire and explosion hazards. The damage criteria due to an accidental release of any hydrocarbon arise from fire and explosion. Contamination of soil or water is not expected as these fuels will vaporize slowly and would not leave any residue. The vapours of these fuels are not toxic and hence no effects of toxicity are expected.

- ***Fire Damage***

A flammable liquid in a pool will burn with a large turbulent diffusion flame. This releases heat based on the heat of combustion and the burning rate of the liquid. A part of the heat is radiated while the rest is convected away by rising hot air and combustion products. The radiations can heat the contents of a nearby storage or process unit to above its ignition temperature and thus result in a spread of fire. The radiations can also cause severe burns or fatalities of workers or fire fighters located within a certain distance. Hence, it will be important to know beforehand the damage potential of a flammable liquid pool likely to be created due to leakage or catastrophic failure of a storage or process vessel. This will help to decide the location of other storage/process vessels, decide the type of protective clothing the workers/fire fighters need, the duration of time for which they can be in the zone, the fire extinguishing measures needed and the protection methods needed for the nearby storage/process vessels. **Tables-7.9** and **Table-7.10** tabulate the damage effect on equipment and people due to thermal radiation intensity.

TABLE-7.9
DAMAGE DUE TO INCIDENT RADIATION INTENSITIES

Sr. No	Incident Radiation (kW/m^2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
1	37.5	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50% Lethality in 1 min. Significant injury in 10 sec.

Sr. No	Incident Radiation (kW/m^2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
3	19.0	Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment	--
4	12.5	Minimum energy to ignite with a flame; melts plastic tubing	1% lethality in 1 min.
5	4.5	--	Causes pain if duration is longer than 20 sec, however blistering is un-likely (First degree burns)
6	1.6	--	Causes no discomfort on long exposures

Source: Techniques for Assessing Industrial Hazards by World Bank.

TABLE-7.10
RADIATION EXPOSURE AND LETHALITY

Radiation Intensity (kW/m^2)	Exposure Time (seconds)	Lethality (%)	Degree of Burns
1.6	--	0	No Discomfort even after long exposure
4.5	20	0	1^{st}
4.5	50	0	1^{st}
8.0	20	0	1^{st}
8.0	50	<1	2^{nd}
8.0	60	<1	3^{rd}
12.0	20	<1	3^{rd}
12.0	50	8	3^{rd}
12.5	--	1	--
25.0	--	50	--
37.5	--	100	--

Fuel Storage

Only one storage tank is provided in the plant for Furnace Oil. The oil will be supplied by road tankers. In case of tank or fuel released in the dyke area catching fire, a steady state fire will ensue. Failures in pipeline may occur due to corrosion and mechanical defect. Failure of pipeline due to external interference is not considered as this area is licensed area and all the work within this area is closely supervised with trained personnel.
Modelling Scenarios

Based on the storage and consumption of Furnace Oil, the following failure scenarios for the plant have been identified for MCA analysis and the scenarios are discussed in **Tables-7.11.**

TABLE-7.11
SCENARIOS CONSIDERED FOR MCA ANALYSIS

Sr. No.	Fuel/Chemical	Total Storage Quantity (KL)	Scenario Considered
1	Failure of Furnace Oil Tank	200	Pool Fire

Details of Pool Fire Model

Heat Radiation program **RADN** has been used to estimate the steady state radiation effect from various storage of fuel and chemicals at different distances. The model has been developed by VIMTA based on the equations compiled from literatures by Prof.J.P.Gupta, Department of Chemical Engineering, IIT Kanpur. The equations used for computations are described below:

Properties of Fuels Considered for Modelling Scenarios (Pool fire)

The data for various fuels used for modelling is tabulated in **Table-7.12** and are compiled from various literature.

TABLE-7.12
PROPERTIES OF FUEL CONSIDERED FOR MODELLING

Sr. No.	Fuel	Molecular Weight	Boiling Point	Density
		kg/kg.mol	°C	kg/m³
1	Furnace Oil	114.24	400.0	920.0

Results and Discussion - Pool Fire

The results of MCA analysis are tabulated indicating the distances for various damages identified by the damage criteria. Calculations are done for radiation intensities levels of 37.5, 25, 19, 12.5, 4.5 and 1.6 kW/m^2, which are presented in **Table-7.13** for different scenarios. The distances computed for various scenarios are given in meters and are from the edge of the pool fire.

The radiation intensities are computed for the maximum and minimum diameter of the storage tanks. It is further assumed that all other tank diameters fall in between the maximum and minimum diameter, thereby the radiation intensities also falling in between the maximum and minimum radiation intensities.

TABLE-7.13
OCCURRENCE OF VARIOUS RADIATION INTENSITIES- POOL FIRE

Radiation	Quantity KL	Radiation Intensities (kW/m^2)/Distances (m)					
		37.5	25.0	19.0	12.5	4.5	1.6
Failure of Furnace Oil tank	200	20	25	30	38.5	69	124

A perusal of modelling results tabulated in Table-6.12 indicate that the radiation intensity of 37.5 kW/m^2 (100% lethality) and 25.0 kW/m^2 (50% lethality) are likely to occur within the radius of the pool, which is computed at 20.6 m and 26.0 m respectively.

Similarly the radiation intensity of 4.5 kW/m^2 is likely to occur within a distance of 69.0 m from the center of fuel storage tank. First-degree burns are likely to occur within this distance.
Effect of Thermal Radiation on Population

The radiation of 1.6 kW/m^2 represents the safe radiation intensity for human population even for long exposures.

In case of pool fire of tank the safe distance i.e. distance of occurrence of 1.6 kW/m^2 is observed to be 124 m and falls within the plant boundary.

7.4 Disaster Management Plan

7.4.1 Objectives of Disaster Management Plan

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the Disaster Management Plan, it should be widely circulated and personnel training through rehearsals/drills.

The objective of the Disaster Management Plan is to make use of the combined resources of the plant and mine and the outside services to achieve the following:

The objective of onsite disaster management plan for the plant is to be a state of perceptual readiness through training, development to immediately control and arrest any emergency situations, so as to avert a full-fledged disaster and the consequence of human and property damage. In the event of a disaster still occurring & to manage the same so that the risk of the damage to life and property is minimized.

ACC have a demented procedure for Emergency Preparedness & Responses. The emergency situations arising out of the situations as defined in the clause shall be addressed in the document.

The salient features are elaborated as below:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for the needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area; and
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the emergency.

In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.

- ***Emergency Organization***

It is recommended to setup an Emergency Organization. A senior executive (Manager) who has control over the affairs of the plant would be heading the Emergency Organization. He would be designated as Site Controller. As per the General Organization chart, in the plant and mines, the Manager would be designated as the Incident Controller. The Incident Controller would be reporting to the Site Controller.

Each Incident Controller, for himself, organizes a team responsible for controlling the incidence with the personnel under his control. Shift In-charge would be the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Co-ordinators would be appointed who would undertake the responsibilities like firefighting, rescue, rehabilitation, transport and provide essential and support services. For this purposes, Security In-charge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in-charge and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel.

Following officers will be responsible for co-ordination in case of emergency situated in any section of the mine. Emergency responses are given in **Table-7.14**.

TABLE-7.14
EMERGENCY RESPONSES

Person	Responsibility
Head of the department/ Mine Agent	Site Controller
Section In charge / Mine Manager	Accident Controller/ Communication officer
Employee who gives the first information about the incident/ accident	Primary Controller
P & A Deptt. (HOD)	Liaison officer

- ***Emergency Communication***

Whoever notices an emergency situation such as fire, growth of fire etc would inform his immediate superior and Emergency Control Center. The person on duty in the Emergency Control Center would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In-charge and takes a decision about an impending On Site Emergency. This would be communicated to all the Incident Controllers, Emergency Co-ordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

Key Personnel and their Responsibility

- ***Site Controller***

The head of the department/ Mine agent shall have an overall responsibility for controlling the incident/ accident and directing the personnel.

- To prepare a full proof plan for control of accident like, landslides, subsidence flood and other natural calamities;
- To inform statutory bodies of the State and Central Government;
- To inform communication officer about the emergency, control center and assembly point;
- To provide all assistance and call for Fire Squad, Security Officer and other services required for removing/ control of danger;
- To ensure that all necessary personnel assemble at assembly point; and
- To make arrangements for medical treatment to the personnel got injured seriously.

- ***Accident Controller/Mines Manager***

- Mock rehearsal of management plan prepared for accident;
- To withdraw men/ machines from the affected area with priority for safety of personnel, minimize damage to the machines, environment and loss of material;
- To act as an accident controller to all the later arrived;
- To make a report based on the facts and figure and submit to the Site Controller; and
- To communicate to the site in charge and make arrangement for transportation of the injured personnel.
- ***Primary Controller***

- To inform the Accident Controller/ Mine Manager from the nearest means of communication about the location and the nature of accident;
- To assist in clearing any obstruction in relief of accident;
- To carry out all instructions of accident controller; and
- To provide first aid treatment and communicate to the shift in charge.

7.4.2 Emergency Facilities

Emergency Control Center (ECC)

For the time being, Office Block is identified as Emergency Control Center. It would have external Telephone, Fax, Telex facility. All the Site Controller/ Incident Controller Officers, Senior Personnel would be located here. Also, it would be an elevated place.

The following information and equipment are to be provided at the Emergency Control Center (ECC):

- Intercom, telephone;
- P and T telephone;
- Safe contained breathing apparatus;

- Fire suit/gas tight goggles/gloves/helmets;
- Hand tools, wind direction/velocities indications;
- Public address megaphone, hand bell, telephone directories;
- Internal P and T, factory layout, site plan;
- Emergency lamp/torch light/batteries;
- Plan indicating locations of hazard inventories, sources of safety equipment, work road plan, assembly points, rescue location vulnerable zones, escape routes;
- Hazard chart;
- Emergency shut-down procedures;
- Nominal roll of employees;
- List of key personnel, list of essential employees, list of Emergency Co-ordinators;
- Duties of key personnel;
- Address with telephone numbers and key personnel, emergency coordinator, essential employees; and
- Important address and telephone numbers including Government agencies, neighboring industries and sources of help, outside experts, population details around the plant & Mine.

- ***Assembly Point***

Number of assembly depending upon the plant location would be identified wherein employees who are not directly connected with the disaster management would be assembled for safety and rescue. Emergency breathing apparatus, minimum facilities like water etc. would be organized.

In view of the size of plant, different locations should be ear marked as assembly points. Depending upon the location of hazard, the assembly points are to be used.

- ***Emergency Power Supply***

Power supply is drawn from the captive power plant of the cement plant. In the event of any supply failure, Diesel Generator will be provided, which is operated as soon as any power failure occurs. Thus mine lighting and emergency control center, administrative building and other auxiliary services are connected to emergency power supply.

- ***Fire Fighting Facilities***

First Aid Firefighting equipment suitable for emergency should be maintained in each operation areas as per statutory requirements.

- ***Location of Wind Sock***

On the top of the Administration block, windsocks would be installed to indicate direction of wind for emergency escape.

- ***Emergency Medical Facilities***

Stretchers, gas masks and general first aid materials for dealing with chemical burns, fire burns etc would be maintained in the medical center as well as in the emergency control room. Private medical practitioners help would be sought. Government hospital would be approached for emergency help.

First aid facilities would be augmented. Names of Medical Personnel, Medical facilities in the area would be prepared and updated. Necessary specific medicines for emergency treatment of Burns Patients and for those affected by toxicity would be maintained.

Breathing apparatus and other emergency medical equipment would be provided and maintained. The help of nearby industrial management's in this regard would be taken on mutual support basis.

- ***Ambulance***

An ambulance with driver availability in all the shifts, emergency shift vehicle would be ensured and maintained to transport injured or affected persons. Number of persons would be trained in first aid so that, in every shift first aid personnel would be available.

7.4.3 Emergency Actions

- ***Emergency Warning***

Communication of emergency would be made familiar to the personnel inside the plant and mine and people outside. An emergency warning system would be established.

- ***Evacuation of Personnel***

In the event of an emergency, unconnected personnel have to escape to assembly point. Operators have to take emergency shutdown procedure and escape. Time Office maintains a copy of deployment of employees in each shift. If necessary, persons can be evacuated by rescue teams.

- ***All Clear Signal***

Also, at the end of an emergency, after discussing with Incident Controllers and Emergency Co-ordinators, the Site Controller orders an all clear signal. When it becomes essential, the Site Controller communicates to the District Emergency Authority, Police and Fire Service personnel regarding help required or development of the situation into an Off-Site Emergency.

7.4.4 General

- ***Employee Information***

During an emergency, employees would be warned by raising siren in specific pattern. Employees would be provided with information related to fire hazards, antidotes and first aid measures. Those who would designate as key personnel and essential employees should be given training to emergency response.

- ***Co-ordination with Local Authorities***

Keeping in view of the nature of emergency, two levels of coordination are proposed. In the case of an On Site Emergency, resources within the organization would be mobilized and in the event of extreme emergency local authorities help should be sought.

In the event of an emergency developing into an off site emergency, local authority and District emergency Authority (normally the Collector) would be appraised and under his supervision, the Off Site Disaster Management Plan would be exercised. For this purpose, the facilities that are available locally, i.e. medical, transport, personnel, rescue accommodation, voluntary organizations etc. would be mustered. Necessary rehearsals and training in the form of mock drills should be organized.

- ***Mutual Aid***

Mutual aid in the form of technical personnel, runners, helpers, special protective equipment, transport vehicles, communication facility etc should be sought from the neighboring industrial management's.

- ***Mock Drills***

Emergency preparedness is an important aspect of planning in Industrial Disaster Management. Personnel would be trained suitably and prepared mentally and physically in emergency response through carefully planned, simulated procedures. Similarly, the key personnel and essential personnel should be trained in the operations.

- ***Important Information***

Important information such names and addresses of key personnel, essential employees, medical personnel, transporters address, address of those connected with Off Site Emergency such as Police, Local Authorities, Fire Services, District Emergency Authority should be prepared and maintained.

The on-site emergency organization chart for various emergencies is shown in **Figure-7.4.**

The task of preparing the Off-Site Emergency Plan lies with the district collector. However the off-site plan will be prepared with the help of the local district authorities. The proposed plan will be based on the following guidelines.

- ***Aspects Proposed to be considered in the Off-Site Emergency Plan***

The main aspects which should be included in the emergency plan are:

- **Organization**

Details of command structure, warning systems, implementation procedures, emergency control centers, names and appointments of incident controller, site main controller, their deputies and other key personnel

- **Communications**

Identification of personnel involved, communication center, call signs, network, lists of telephone numbers.

7.4.5 Off-Site Emergency Preparedness Plan

- **Specialized Knowledge**

Details of specialist bodies, firms and people upon whom it may be necessary to call e.g. those with specialized knowledge of fire control;

- **Voluntary Organizations**

  Details of organizers, telephone numbers, resources etc;

- **Chemical Information**

Details of the hazardous substances stored or procedure on each site and a summary of the risk associated with them;

- **Meteorological Information**

Arrangements for obtaining details of whether conditions prevailing at the time and whether forecasts;

- **Humanitarian Arrangements**

Transport, evacuation centers, emergency feeding treatment of injured, first aid, ambulances, and temporary mortuaries;

- **Public Information**

Arrangements for dealing with the media press office and informing relatives, etc;

- **Assessment**

Arrangements for:

(a) Collecting information on the causes of the emergency;
(b) Reviewing the efficiency and effectiveness of all aspects of the emergency plan.

- ***Role of the Emergency Coordinating Officer***

The various emergency services should be coordinated by an emergency coordinating officer (ECO), who will be designated by the district collector. The ECO should liaise closely with the site main controller. The ECO should inform the DGMS authorities in case of accidents as per the statutory requirement. Again depending on local arrangements, for very severe incidents/accidents with major or prolonged off-site consequences, the external control should be passed to a senior local authority administrator or even an administrator appointed by the central or state government.

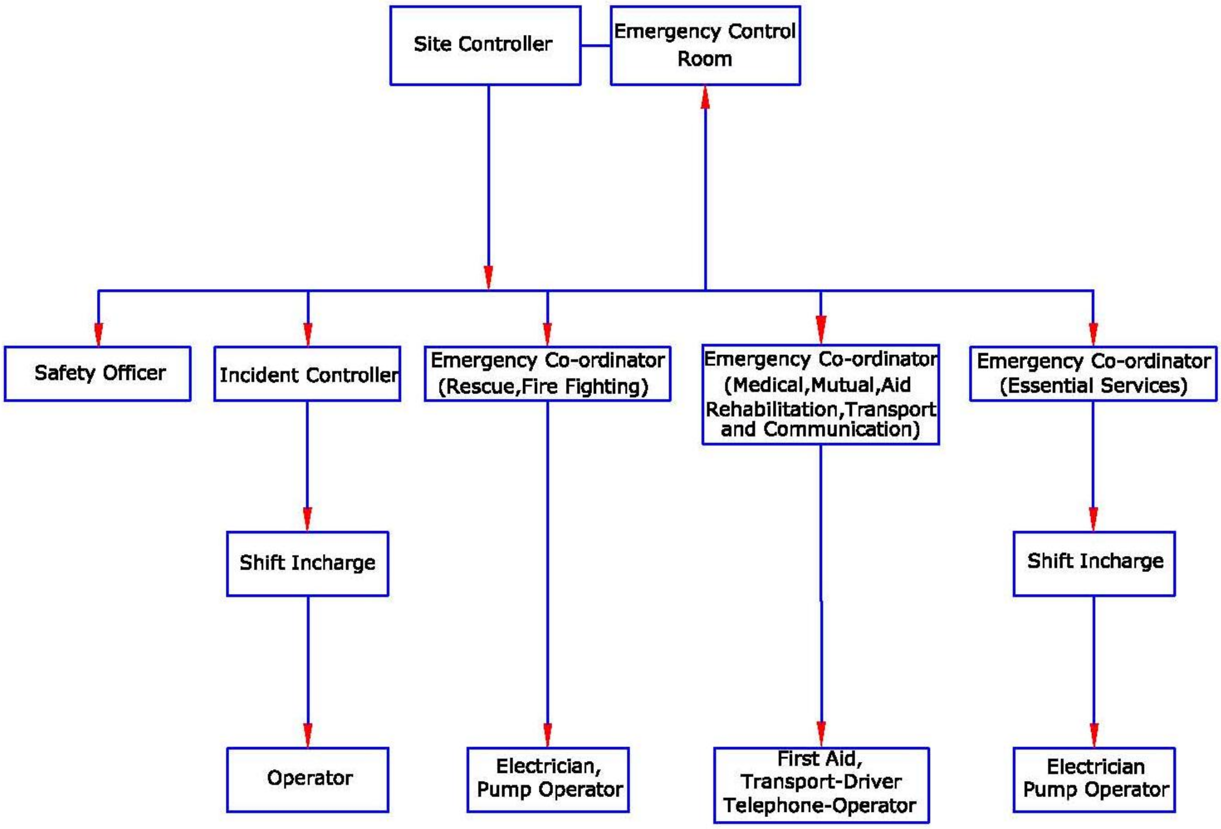

FIGURE-7.4
ON-SITE EMERGENCY PLAN

- ***Role of the Local Authority***

The duty to prepare the off-site plan lies with the local authorities. The emergency planning officer (EPO) appointed should carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO should liaise with the works, to obtain the information to provide the basis for the plan. This liaison should ensure that the plan is continually kept upto date.

It will be the responsibility of the EPO to ensure that all those organizations which will be involved off site in handling the emergency, know of their role and are able to accept it by having for example, sufficient staff and appropriate equipment to cover their particular responsibilities. Rehearsals for off-site plans should be organized by the EPO.

- ***Role of Police***

Formal duties of the police during an emergency include protecting life and property and controlling traffic movements. Their functions should include controlling bystanders evacuating the public, identifying the dead and dealing with casualties, and informing relatives of death or injury.

- ***Role of Fire Authorities***

The control of a fire should be 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 should also have a similar responsibility for other events, such as explosions. Fire authorities in the region should be apprised about the location of all stores of flammable materials, water supply points and fire-fighting equipment. They should be involved in on-site emergency rehearsals both as participants and, on occasion, as observers of exercises involving only site personnel.

- ***Role of Health Authorities***

Health authorities, including doctors, surgeons, hospitals, ambulances, and so on, should have a vital part to play following a major accident, and they should form an integral part of the emergency plan.

For major fires, injuries should be the result of the effects of thermal radiation to a varying degree, and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals.

Major off-site incidents are likely to require medical equipment and facilities additional to those available locally, and a medical "mutual aid "scheme should exist to enable the assistance of neighboring authorities to be obtained in the event of an emergency.

- ***Role of Government Safety Authority***

This will be the factory inspectorate available in the region. Inspectors are likely to want to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies. They may wish to see well documented procedures and evidence of exercise undertaken to test the plan.

In the event of an accident, local arrangements regarding the role of the factory inspector will apply. These may vary from keeping a watching brief to a close involvement in advising on operations in case involvement in advising on operations.

The off-site emergency organization chart for major disaster is shown in **Figure-7.5.**

Following facilities to be provided at ACC mine

- Public address system;
- Telephones/ Mobile handsets;
- Runners/messenger;
- Emergency alarm;
- Firefighting equipment & accessories with trained manpower;
- Full fledge hospital;
- Training centre;
- Fire tender;
- Ambulance van; and
- Jeep van.

Facilities available outside ACC site

- Primary health centres and hospitals at 3 km distance.
- As per Risk Assessment studies the possibility of "Offsite" emergency situation is ruled out as this proposed project is not likely to pose any off-site emergency hence does not call for any preparation of an off-site emergency plan.

7.4.6 Care and Maintenance during Temporary Discontinuance

In case of any temporary discontinuance due to court order or due to statutory requirement or any other unforeseen circumstance following measures for care and maintenance and monitoring of status shall be taken.

- Competent persons shall inspect the area regularly
- Air, water and other environmental monitoring shall be carried out
- Care and upkeep of plantation done shall be carried out on regular basis
- Status of the working and status monitoring for re-opening of the mines shall be discussed in weekly meeting on last working day of the week
- In case of discontinuance due to any natural calamities mining operation will be restarted as early as possible after completing rescue work restoring safety and security repairs of roads.

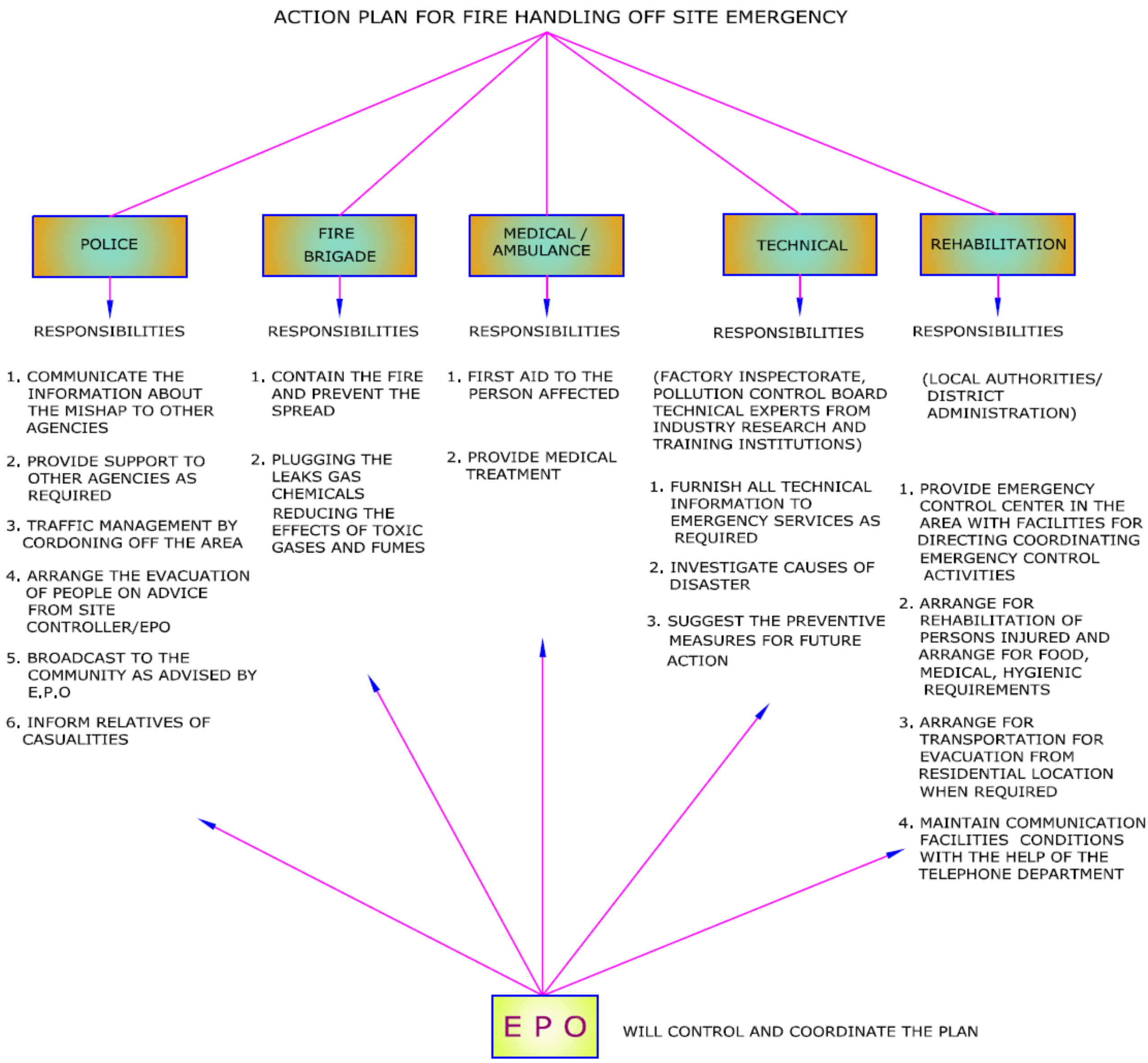

FIGURE-7.5
OFF-SITE EMERGENCY CHART

7.4.7 Fire Extinguishers at Different Locations

TABLE 7.15
NAME OF SITE AND TYPE OF FIRE EXTINGUISHERS

Name of Site	Type of Fire Extinguishers
Electrical equipment, power panels, control rooms and pump house	CO2 type, foam type, dry chemical powder type

Rescue and Repair Services

Effective working of rescue team is essential during a disaster. In order to make the services of rescue team effective following equipment/items shall be provided to the team:

- Gas mask respirators
- Fire proximity suits
- Petromax lamp/Torches
- Axes/hand saw
- Fire entry suits
- Fire blankets
- Ropes
- Ladders
- Rubber glove
- Blanket
- Rubber shoes or industrial shoes

7.4.8 Alarm System to be followed during Disaster

On receiving the message of 'Disaster, from site Main Controller, fire station control room attendant will sound SIREN I WAILING TYPE' FOR 5 MINUTES. Incident controller will arrange to broadcast disaster message through public address system. On receiving the 'message of "Emergency Over" from Incident Controller the fire station control room attendant will give "All Clear Signal,, by sounding alarm straight for two minutes. The features of alarm system will be explained to one and all to avoid panic or misunderstanding during disaster.

7.4.9 Actions to be taken on hearing the Warning Signal

On receiving the disaster message following actions will be taken:

- All the members of advisory committee, manager, security controller, etc. shall reach the SECR.
- All other persons in the plant/mine area will remain ready in their respective units for crash shutdown on the instruction from SECR.
- The persons from other sections will report to their respective officer.
- The concerned section will take immediate action to remove contractor's personnel outside the plant/mine gate.
- Alert signals will be given to the residents of surrounding villages.

7.4.10 Identification and Reporting System

When any near miss takes place same it should be brought to the notice of the supervisor and also to the concerned Departmental Head and the Safety Department. Then the respective department head report it to the ACC Near Miss Reporting Server (NMRS). Near Miss Reporting Box shall be kept at prominent places with Reporting Format so that no near miss incident can be missed. The Safety Department Head investigate the same incident along with the floor supervisor and corrective measures shall be taken as soon as possible. For near miss of critical nature Departmental Head along with Safety Head shall do the investigation and corrective action shall be taken. In the departmental safety meeting learning's from the previous near miss shall be discussed. To promote the Near Miss reporting system, Highest and Best near miss reporting person are awarded during the monthly safety gate meeting.

Cause analysis of the Near Miss Incident and SOT Format (to be filled by ACC, after operation)

Sr. No	Cause analysis of the near miss incident	Percent
1	Poor housekeeping/ disorderly housekeeping	
2	Operating equipment without authority	
3	Failure to adhere to warning signal/ alarm	
4	Failure of securing himself adequately	
5	Inadequate warning system	
6	Congestion	
7	Defective tools, equipment or material	
8	Failure to follow procedures	
9	Failure to use PPE	
10	Using equipment improperly	
11	Improper lifting	
12	Improper placement	
13	Inadequate guards or barriers	
14	Traffic congestion at workplace	
15	Operating at improper speed	

7.5 Utilisation of Hazardous Solid Waste

7.5.1 Hazardous Waste Generation

There are a large number of hazardous waste generating units located in India. About 11,138 units have been given authorization by State Pollution Control Boards under Hazardous Waste (Management & Handling) Rules, 2003 mostly for temporary storage of hazardous waste, within the plant premises. It is estimated that, about 4.43 Million Tonnes of hazardous waste is generated annually, out of which, only 71,833 tonnes of hazardous waste are incinerable.

7.5.2 Benefits of utilization of waste as fuel in Kiln

There is the need to promote utilization of hazardous combustible waste having higher calorific value in cement kiln as fuel. This will not only solve the disposal problem associated with hazardous waste but also conserve natural fuel resources.

The cement industry is known as high-energy consumption manufacturer since the final product, clinker is prepared by heating raw material over 1400°C. The industry has been striving to recycle by re-using combustible "wastes" as fuel for the cement kiln process. For these reasons, the cement industry utilizes a variety of wastes and by-products as substitutes for fuel.

As a policy measure, several procedures and guidelines for utilization of hazardous waste in cement kiln/clinker kiln as fuel has been suggested.

The benefits of using hazardous waste as a fuel in cement kiln/clinker kiln are as follows:

- High temperature and residence time of 4-5 seconds in an Oxygen rich environment, ensure the destruction of organic compounds found in the waste;
- Any acid gases (SO_2/HCl) formed during combustion are neutralized by the clinker and dust, being alkaline in nature and are incorporated into the cement clinker;
- Interaction of the flue gases and the raw material present in the kiln ensures that the non-combustible part of the residue is held back in the process and is incorporated into the clinker in a practically irreversible manner;
- No waste is generated that requires subsequent processing;
- Additional exhaust gas purification systems (scrubber etc.) are not required;
- Calorific value of the waste is fully utilized;
- Safer operation compared to incineration;
- Destruction of Poly Cyclic Biphenyl (PCBs) is almost complete to below detection limits;
- Wastes can be utilized in all types of cement plants (Wet /Semi wet / Dry); and
- Several investigations carried out suggest all kinds of solid, liquid and gaseous wastes can be gainfully utilized.

Types of Wastes

Utilization of following types of high calorific wastes in Kiln has been envisaged:

- Hazardous: waste oil, petroleum sludge, solvents, paints, thinners, printing ink etc. from petroleum refinery, pharmaceuticals, paint and other chemical industries; and
- Non-Hazardous: used tyres, paper and plastics.

7.5.3 Limitations of utilization of waste in Cement Plant Kiln

- There is a limit in terms of the amount of combustible solid wastes that can be fed directly into the kiln inlet for reutilization.
- There is possibility of emissions of toxic metals, volatile organic carbon compounds and other toxic gases, which needs to be controlled.
- Alternate fuels vary in their composition and the contaminants present in them. Depending on the composition of the chosen fuel there may be an increased input of Sulphur, chlorine, alkalies, phosphates, heavy metals. Therefore, the likely emissions need to be ascertained on case to case basis and care taken to contain them within prescribed limits.