7.2 Risk Assessment

Hazard analysis involves the identification and quantification of various hazards (unsafe conditions) that exist in the plant. On the other hand, risk analysis deals with the identification and quantification of risks, the plant 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 coal washery plant. Based on the risk estimation, disaster management plan has also been prepared.

7.2.1 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 Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational Health and Safety plan.

7.2.2 Hazard Identification

Identification and quantification of hazards in 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 coal is to be beneficiated in washery. Raw coal, clean coal, middling & rejects storage needs about 5.17 acres area for its storage.

7.2.3 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, operations, facilities and safeguards.

7.2.4 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 after implementation of the proposed project for coal washery plant are given in **Table-7.4.** The preliminary hazard analysis for the whole coal washery plant is given in **Table-7.5**.

TABLE-7.4
PRELIMINARY HAZARD ANALYSIS FOR PROCESS AND STORAGE AREAS

Sr. No.	Blocks/Areas	Hazards Identified
1	Coal Handling Plant	Fire and/or Dust Explosions
2	Power Transformers	Explosion and fire
3	Switch-yard Control Room	Fire in cable galleries and Switchgear/Control Room

TABLE-7.5
PRELIMINARY HAZARD ANALYSIS FOR THE WHOLE PLANT IN GENERAL

PHA Category	Description of Plausible Hazard	Recommendation	Provision
Environmental factors	If there is any leakage and eventuality of source of ignition.	--	All electrical fittings and cables are provided as per the specified standards. All motor starters are flame proof.
Environmental factors	Highly inflammable nature of the chemicals may cause fire hazard in the storage facility.	A well-designed fire protection including protein foam, dry powder and 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.

7.2.5 Maximum Credible Accident (MCA) Analysis

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.

7.2.5.1 Damage Criteria

The coal storage 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 this mineral will vapourize slowly and would not leave any residue. The vapours of this mineral are not toxic and hence no effects of toxicity are expected.

7.2.5.2 Fuel Storage

No fuel storage tank is envisaged for the proposed coal washery plant. Coal storage area will be only closely supervised with trained personnel.

7.2.5.3 Risk Associated with Coal Handling Plant-Dust Explosion

Coal dust when dispersed in air and ignited will 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); and

- Dust concentrations must be reasonably uniform.

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 bars. 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 lifeline of the plant.

7.3 Disaster Management Plan

7.3.1 Introduction

Disaster Management Plan for an industrial unit is necessarily a combination of various actions, which are to be taken in a very short time but in a pre-set sequence to deal effectively and efficiently with any disaster, emergency or major accident with an aim to keep the loss of men, material, plant/machinery etc., to the minimum.

Creation and establishment of a cell within the industrial unit is a pre-requisite for an effective implementation of any disaster management plan. The main functions of the Disaster Management Cell are to prepare a detailed disaster management plan, which includes:

- Identification of various types of expected disasters depending upon the type of the industrial unit;
- Identification of various groups, agencies, departments etc. necessary for dealing with a specific disaster effectively;
- Preparation-by intensive training-of relevant teams/groups within the organization to deal with a specific disaster and keep them in readiness;
- Establishment of an early detection system for the disasters;
- Development of a reliable instant information/communication system; and
- Organization and mobilization of all the concerned departments/ organizations/groups and agencies instantly when needed.

Major disaster that can occur in this coal washery plant may be due to fire.

7.3.2 Emergency Planning for Disaster due to Fire

Coal storage, cable rooms, transformer unit, auxiliary transformers, coal bunkers including all conveyor lines etc., within the plant are the likely areas for which plan is outlined to deal with any eventuality of fire. Stores, workshop, canteen and administration building have also been included.

7.3.2.1 Classification of Fires

The various classes of fire, explanation of the classes of fire and method of fighting the different classes of fire are given in **Table-7.6**.

TABLE-7.6
CLASSES OF FIRE

Class	Explanation	Method of Fire	Fire Fighting
A	Solid–Carbonaceous inflammable material	Fire involving wood, paper, coal, cloth and other material	Water
B	Special	Electrical fire	Dry Chemical Powder or CO_2 extinguisher

7.3.2.2 Equipment System Dealing with Coal Handling and beneficiation Operation

The whole system dealing with coal handling can be summarized as follows:
Pre Treatment Section

Raw coal from ground hoppers will be subjected to two stage close circuit crushing and screening to obtain (-) 50 mm.

Washing

- (-) 50 mm through covered belt conveyors will be fed into coal wetting launder;
- Coal water slurry through the launder will flow to a set of Desliming Sieve Bend and Screen to remove (-) 1 mm coal fines;
- Deslimed coal [(+) 1 mm coarser fraction] from screen discharge chute will go to the launder. Magnetite media of required specific gravity will be added in the launder. The mixture from centre column will be pumped to Primary Heavy Media Cyclones;
- Clean coal & magnetite media received as over flow from the cyclone will be fed to a set of Clean Coal Sieve Bend and Clean Coal Draining & Rinsing Screen;
- Magnetite media will be re-circulated into the primary washing system;
- Magnetite carried away with coal particles will be removed by water spraying in the discharge part of the screen;
- Underflow of primary cyclone treated as primary discard will be fed to a set of double sieve bend. Magnetite media drained through sieve bend will be recirculated into the primary system;

- Primary discard from discharge end of double sieve bend will be fed to the central column of secondary heavy media tank along with magnetite media of required specific gravity;
- Coal and magnetite mixture from the secondary heavy media tank will be feed to secondary heavy media cyclones;
- Middling along with magnetite media will be received as overflow and will be fed to a set of sieve bend, draining & rinsing screen;
- Underflows of cyclone along with magnetite are also fed to a sieve bend & screen. Magnetite media drained through sieve bend will be re-circulated back to the secondary system;
- Clean coal collected from discharge end of clean coal screen will be dried in centrifuge and transported through belt conveyor to clean coal storage bunker;
- Reject collected will be transported to a reject bunker and from there to reject disposal area;
- Fine coal slurry collected in the fine coal tank will be pumped into a set of classifying cyclone;
- The underflow of classifying cyclone will be dewatered in Hi Frequency screen while the overflow from cyclone will be fed to a Hi-rate Thickener;
- Flocculants will be added to facilitate settling and dewatering process;
- Thickened slurry will be dewatered in a Multi Roll Belt Press filter;
- Flocculants will be added to facilitate settling and dewatering process; and
- Output from Hi Frequency screen and belt press will be mixed with middling for dispatch to the end users.

7.3.2.3 Need for a Fire Fighting Group

A small fire may result into loss of machines and conveyors and the damage by fire may be of the order of few crores of rupees. This type of losses can be avoided by preventing and controlling the fire instantly for which fire-fighting group shall be established.

7.3.2.4 Fire Fighting with Water

Adequate and reliable arrangement is required for fighting the fire with water such as:

- Identification of source of water and equipping with pumps;
- Arrangement of pipe lines along and around all vulnerable areas;
- Alternative water supply arrangements to divert the water from one set of pipe lines (connected to another source) or to connect to other source;
- Provisions of valves at appropriate points to enable supply of water at the required place/area or divert the same to another direction/pipe line; and
- Each source of water shall be equipped with one standby diesel driven pump to serve in case of power failure.

- ***Water Line Arrangement***

Water lines shall be provided at coal handling area along the conveyors and around the stockyards, transformers, coal crusher etc. Water lines shall also be provided around other infrastructures in the plant like administration building, canteen, stores and other plant equipment. Rain guns will be provided around coal stockyard areas. The system shall be designed in conformity with the recommendations of the NFPA of Insurance Association of India. A reserve water level shall be maintained in the sump as per NFPA requirements.

Hydrant system feed pressurized water to hydrant valves shall be located throughout the plant and also at strategic locations. The water pressure shall be maintained at 6 to 8 kg/cm^2 in these lines. By operating a few of the valves water pressure can be increased at one particular place. There are two types of valves. Non-return valves shall be provided to allow only unidirectional flow of water. Gate valves shall be provided for closing or opening the water supply. An adequate number of gate valves shall be provided at appropriate points to tap water to deal with fire if it breaks out at any point of the plant.

7.3.2.5 Fire Fighting with Fire Extinguishers

To deal with fires-other than carbonaceous fires, which can be dealt with by water-suitable fire extinguishers are required to do the job effectively. Adequate number of "Fire stations' are to be established with the following types of equipment and arrangements:

- Soda Acid Fire Extinguishers;
- CO_2 Extinguishers;
- Dry Powder Chemical Extinguishers;
- Foam Extinguishers;
- Fire buckets; and
- 50 mm spray hoses up to 150 m length.

Appropriate types of fire extinguishers shall also be provided at conveyor drive heads, crusher house, control rooms, in machines like stacker and reclaimer, electrical yard, sub-station and other infrastructure facilities within the premises.

In the transformer yard, automatic fire detecting and quenching system shall be provided for each transformer. This system comes into operation whenever the temperature of surrounding air exceeds 80°C and sprays water over the transformer to prevent spreading of fire and quenches the same. In order to avoid fire in cable galleries, all the power and control cables of FRLS type (Fire Resistant Low Smoke) shall be used. In addition, fire detecting and Fire Alarm Systems shall be installed in the cable galleries.

7.3.2.6 Inspection

- Fire alarm panel (electrical) shall cover the entire plant. Fire Extinguishers in Fire Stations and machines and other places shall be periodically inspected by the inspection group;

- The temperature of the coal stack shall be regularly measured and recorded. If the temperature exceeds 80°C, water quenching shall be carried out;
- Emergency telephone numbers shall be displayed at vital points by the groups; and
- General inspection for fire shall be regularly carried out by the group.

7.3.2.7 Procedure for Extinguishing Fire

The following steps shall be taken during a Fire Accident in the system:

- As soon as the message is received about fire, one of the spray groups in the system shall be diverted to the place of the fire accident along with a staff member;
- Simultaneously plant Fire Station shall be informed by phone, walkie-talkie for fire brigades;
- Fire stations nearby also be informed by phone to be in readiness;
- In the meanwhile, the pipe system shall be operated to obtain maximum pressure and output;
- In case cables are within the reach of fire, power supply shall be tripped and the cables shifted;
- Further, other spray groups from the system shall be diverted to the spot;
- In case of fire in the belt, belt shall be cut near the burning portion, to save the remaining parts; and
- After extinguishing the fire, the area shall be well prepared for re-use.

7.3.3 Emergency Action Plan

The emergency action plan consists of:

- First information;
- Responsibilities of Work Incident Controller;
- Responsibilities of Chief Incident Controller;
- Responsibilities for Declaration of Emergency;
- Responsibilities for Emergency Communication Officer;
- Responsibilities of key personnel;
- Responsibilities and action to be taken by essential staff and various teams during emergency; and
- Responsibilities for All Clear Signal.

7.3.3.1 First Information

The first person who observes/identities the emergencies shall inform by shouting and by telephone to the Shift Engineer and Fire Station about the hazard. The Shift Engineer will inform to Works Incident Controller, Chief Incident Controller and also telephone operator, who shall communicate it to all key personnel.

7.3.3.2 Responsibilities of Work Incident Controller (WIC)

The Work Incident Controller on knowing about an emergency immediately will rush to the incident site and take overall charge and inform the same to Chief Incident Controller (CIC). On arrival, he will assess the extent of emergency and decide if major emergency exists and inform the communication officer accordingly.

7.3.3.3 Responsibilities of Chief Incident Controller (CIC)

The Manager, who is also the Chief Incident Controller, will assume overall responsibilities for the factory/storage site and its personnel in case of any emergency. His responsibilities are to:

1. Assess the magnitude of the situation and decide if staff needs to be evacuated from their assembly point to identified safer places. Declare onsite/offsite emergency;

2. Exercise direct operational control over areas other than those affected;
3. Undertake a continuous review of possible developments and assess in consultation with key personnel as to whether shutting down of the plant or any section of the plant and evacuation of personnel are required;

4. Liaison with senior officials of Police, Fire Brigade, Medical and Factories Inspectorate and provide advice on possible effects on areas outside the factory premises;
5. Look after rehabilitation of affected persons on discontinuation of emergency; and

6. Issue authorized statements to news media, and ensures that evidence is preserved for enquiries to be conducted by the statutory authorities.

7.3.3.4 Responsibilities for Declaration of Major Emergency

It is important to make the emergencies known to everyone in the plant. The major emergency will be made known to everyone inside the plant by sounding the alarm. Separate alarms to warn different types of major emergencies such as fire and explosion or toxic gas escape are provided. Public address system is also available throughout the plant.

Announcement will be made by the concerned official/interpreter in local language. Similarly, announcement for termination of the emergency will also be announced.

7.3.3.5 Responsibilities of Emergency Communication Officer (ECO)

On hearing the emergency alarm, he will proceed to Emergency Control Center. He will

- Report to Chief Incident Controller and Work Incident Controller and maintain contact with them;
- On information received from the WIC of the situation, recommending if necessary, evacuate the staff from the assembly points;
- Identify suitable staff to act as runners or messengers who are listed in the Essential staff, between him and the Works Incident Controller if the telephone and other system of communication fail due to any reason;
- Maintain inventory of items in the emergency control center;
- Maintain a log of incidents;
- Keep in constant touch with happenings at the emergency site and with WIC;
- Liaise with neighbour fire brigade, hospital, civil and police authorities on advice from CIC.

7.3.3.6 Key Personnel

Apart from Works Incident Controller and Chief Incident Controller, other works personnel will have key role to play in providing advice and in implementing the decisions made by the Chief Incident Controller. The key personnel include:

A. Sr. Superintendents/Engineer - Incharge responsible for:
   - Operation;
   - Electrical maintenance;
   - Mechanical maintenance;
   - C & I; and
   - Chemical.

B. Head of Personnel and Officers connected with IR and Labour Welfare

C. Head (Technical Service)

7.3.3.7 Responsibilities of Key Personnel

- ***Department Heads***

The Departmental heads will provide assistance as required by the WIC. They will decide which members of their departments are required at the incident site.

- ***Chief Personnel Manager***

He will have following responsibilities:

a) Report to Work Incident Controller;
b) Ensure that all non-essential workers in the affected areas are evacuated to assembly points in consultation with the Chief Incident Controller;
c) Receive reports from nominated persons from assembly points, and pass on the absence information services;
d) Keep liaison with other coordinators to meet the requirements of services such as materials, security management, transportation, medical, canteen facilities etc. as required during emergency;
e) Be in constant touch with the Chief Incident Controller and feed him correct information of the situation;
f) Give information to press, public and authorities concerned on instructions from the CIC/WIC;
g) Ensure that casualties receive adequate attention at medical center and arrange required additional help and inform relatives of the injured;
h) Arrange to inform public on Radio and TV about evacuation etc.; and
i) Arrange TV coverage on handling emergency.

- ***In-Charge***

On knowing about an emergency, he will report to Chief Incident Controller (CIC) and assist him in all activities. He will also liaison with all teams.

- ***Medical Officer***

Medical Officer will render medical treatment to the injured and if necessary will shift the injured to nearby Hospitals. He will mobilize extra medical help from outside, if necessary.

- ***Head of Safety***

On hearing the emergency alarm, he will proceed to the site. He will:

a. Make sure that all safety equipment are made available to the emergency teams;
b. Participate in rescue operations;
c. Co-ordinate to transfer the injured persons to medical center and arrange for first aid; and
d. Keep in contact with ECO and the WIC and advice them on the condition of injured persons.

- ***Security Officer***

On hearing the Emergency alarm, he will proceed to main entrance/main gate. He will

a. Arrange to control the traffic at the gate and the incident area;

b. Direct the security staff to the incident site to take part in emergency operations under his guidance and supervision;
c. Evacuate the persons in the plant or in the nearby areas as advised by WIC after arranging the transport through the Transport incharge;
d. Allow only those people who are associated with handling emergency;
e. Maintain law and order in the area, if necessary seek the help of police; and
f. Maintain communication with CIC/WIC and ECO.

- ***Fire Officer***

On hearing the emergency, he will reach the fire station and arrange to sound the alarm as per the type of emergency in consultation with WIC, He will:

a. Guide the fire fighting crew i.e. firemen and trained plant personnel and shift the firefighting facilities to the emergency site. Adequate facilities will be made available;
b. Take guidance of the WIC for firefighting as well as assessing the requirement of outside help; and
c. Maintain communication with WIC, CIC and ECO.

- ***Transport Engineer-in-Charge***

On hearing the emergency alarm, he will immediately report to Work Incident Controller. He will:

a. Ensure availability of auto base vehicles for evacuation or other duties, when asked for; and
b. Make all arrangements regarding transportation.

7.3.4 General Responsibilities of Employees during an Emergency

During an emergency, it becomes more enhanced and pronounced when an emergency warning is raised, the workers if they are incharge of process equipment shall adopt safe and emergency shut down and attend any prescribed duty as essential employee. If no such responsibility is assigned, he shall adopt a safe course to assembly point and await instructions. He shall not resort to spread panic. On the other hand, he must assist emergency personnel towards objectives of DMP.

7.3.5 Emergency Facilities

7.3.5.1 Emergency Control Center (ECC)

For the time being Office Block is identified as Emergency Control Center. It would have external Telephone, Fax and Telex facility. All the Site Controller/Incident Controller Officers, Senior Personnel would be located here. In addition, 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, plant control room, 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 Coordinators;
- Duties of key personnel;
- Address with telephone numbers and key personnel, emergency coordinator, essential employees; and
- Important address and telephone numbers including Government agencies, neighbouring industries and sources of help, outside experts, chemical fact sheets population details around the factory.

7.3.5.2 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 are ear marked as assembly points. Depending upon the location of hazard, the assembly points are to be used.

7.3.5.3 Emergency Power Supply

Plant facilities would be connected to Emergency Power supply units and would be placed in auto mode. Thus water pumps, plants lighting and emergency control center. Administrative building and other auxiliary services are connected to emergency power supply. In all the blocks, flameproof type emergency lamps would be provided.

7.3.5.4 Fire Fighting Facilities

First Aid firefighting equipment suitable for emergency shall be maintained in each section in the plant. This would be as per statutory requirements as well as per NFPA Regulations. However, fire hydrant line covering major areas would be laid. It would be maintained as 6 kg/sq.cm pressure. Fire alarms would be located in the bulk storage areas. On the top of the Administration block, top of each production blocks, windsocks would be installed to indicate direction of wind for emergency escape.

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

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.

7.3.6 Emergency Actions

7.3.6.1 Emergency Warning

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

7.3.6.2 Emergency Shutdown

There are number of facilities which can be provided to help deal with hazardous conditions, fire breaks out. Under this situation the supply of the fuel has to be disconnected immediately. Whether a given method is appropriate depends on the particular case. Cessation of agitation may be the best action in some instances but not in others. Stopping of the feed may require the provision of bypass arrangements.

Methods of removing additional heat include removal through the normal cooling arrangements or use of an emergency cooling system. Cooling facilities, which use vapouring liquid, may be particularly effective, since a large increase in vapourization can be obtained by dropping pressure.

7.3.6.3 Evacuation of Personnel

There could be more number of persons in the storage area and other areas in the vicinity. The area would have adequate number of exits, stair cases. 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, at ECC. If necessary, persons can be evacuated by rescue teams.

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, Fire Service personnel regarding help required or development of the situation into an Off-Site Emergency.

7.3.7 General

7.3.7.1Employee Information

During an emergency, employees would be warned by raising siren in specific pattern. Employees would be given training of escape routes, taking shelter, protecting from toxic effects. Employees would be provided with information related to fire hazards, antidotes and first aid measures. Those who would be designated as key personnel and essential employees shall be given training to emergency response.

7.3.7.2 Public Information and Warning

The industrial disaster effects related to this plant may mostly be confined to the plant area. The detailed risk analysis has indicated that the effects would not be felt outside. However, as an abundant precaution, the information related to chemicals in use would be furnished to District Emergency Authority for necessary dissemination to general public and for any use during an offsite emergency.

7.3.7.3 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 shall 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 shall be organized.

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

7.3.7.4 Mock Drills

Emergency preparedness is an important aspect in the planning of 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 shall be trained in the operations.

7.3.7.5 Important Information

Once the plant goes into stream, important information such names and addresses of key personnel, essential employees, medical personnel, outside the plant, transporters address, address of those connected with Off Site Emergency such as

Police, Local Authorities, Fire Services, District Emergency Authority shall be prepared and maintained.

7.4 Off-Site Emergency Preparedness Plan

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.

7.4.1 Introduction

Off-site emergency plan follows the on-site emergency plan. When the consequences of an emergency situation go beyond the plant boundaries, it becomes an off-site emergency. Off-site emergency is essentially the responsibility of the public administration. However, the factory management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighbouring population.

The off-site plan in detail will be based on those events, which are most likely to occur, but other less likely events, which have severe consequence, will also be considered. Incidents, which have very severe consequences yet have a small probability of occurrence, shall also be considered during the preparation of the plan. However, the key feature of a good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.

The roles of the various parties who will be involved in the implementation of an off-site plan are described below. Depending on local arrangements, the responsibility for the off-site plan shall be either rest with the works management or, with the local authority. Either way, the plan shall identify an emergency coordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center shall be setup within which the emergency coordinating officer can operate.

An early decision will be required in many cases on the advice to be given to people living "within range" of the accident - in particular whether they shall be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following:

In the case of major fire but without explosion risk(e.g oil storage tank), only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically.

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

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

- **Organization**

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.

- **Specialized knowledge**

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

- **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 the weather conditions prevailing at the time and weather forecasts.

- **Humanitarian arrangements**

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

- **Public information**

Arrangements for:

(a) Dealing with the media press office; and
(b) Informing relatives, etc.

- **Assessment of emergency plan**

Arrangements for:

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

7.4.3 Role of the Emergency Coordinating Officer

The various emergency services shall be co-ordinated by an emergency coordinating officer (ECO), who will be designated by the district collector. The ECO shall liaise closely with the site main controller. Again depending on local arrangements, for very severe incidents with major or prolonged off-site consequences, the external control shall be passed to a senior local authority administrator or even an administrator appointed by the central or state government.

7.4.4 Role of the Local Authority

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

7.4.5 Role of Police

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

7.4.6 Role of Fire Authorities

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

7.4.7 Role of Health Authorities

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

For major fires, injuries shall 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 shall exist to enable the assistance of neighbouring authorities to be obtained in the event of an emergency.

7.4.8 Role of Government Safety Authority

There 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.

7.5 Occupational Health and Safety

Existing large industries, in general where multifarious activities are involved during construction, erection, testing, commissioning, operation and maintenance, the men, materials and machines are the basic inputs. Along with the boons, the industrialization generally brings several problems like occupational health and safety.

The industrial planner, therefore, has to properly plan and take the steps to minimize the impacts of industrialization and to ensure appropriate occupational health, safety including fire plans. All these activities again may be classified under construction and erection, and operation and maintenance. The proposed safety plan is given below:

7.5.1 Occupational Health

Occupational health needs attention during operation and maintenance of the plant. However, the problem varies both in magnitude and variety in the above phases.

The hazardous area of work place in the coal washery plant, the projected numbers of employees to be employed in the hazardous activities and the safety measures to be adopted in the proposed coal washery plant are given in **Table-7.7.**

TABLE-7.7
HAZARDOUS ACTIVITIES AND SAFETY MEASURES TO BE ADOPTED

Sr. No.	Hazardous Activities	Safety Measures
1	Working in confined spaces	Work permits system to be followed strictly
2	Working at height	Work permits system to be followed strictly
3	Excavations/Trenching/Penetration/Digging	Work permits system to be followed strictly
4	Hot work	Work permits system to be followed strictly
5	Lockout/tag out	Work permits system to be followed strictly
6	Scaffolding	Training, checklist and continuous monitoring by safety patrollers

Sr. No.	Hazardous Activities	Safety Measures
7	Demolition works	Safe work procedures and under supervision and SOPs
8	Reinforcement bending & laying	Training and use of PPEs
9	Concrete formwork	Use of PPEs
10	Concreting	Use of PPEs
11	Structural works	Use of PPEs
12	Lifting with Cranes	Proper training to personnel and lifting area barricading
13	Lifting tools and tackles operation	Testing of all lifting tools and tackles with competent and training to operators
14	High pressure testing, cleaning and painting	Proper training , use of PPEs and work procedures for high pressure vessels
15	Overhead works	Use of PPEs and
16	Working in dust and noise	Use of PPEs display of sign boards
17	Storing, Transportation & handling of Materials	Proper work instructions
18	Machining operations (drilling, shaping, turning, sawing, grinding etc.)	Use of PPEs and Awareness training
19	Bending & rolling	Use PPEs
20	Hand tools operation	Use of PPEs and WI
21	Pneumatic tools operation	Use of PPEs and Proper WI
22	Electrical tool operation	Use of PPEs SOPs
23	Commissioning	Use of PPEs SOPs
24	Working in electrical load centers EHT/HT/LT	Use of PPEs SOPs

The personnel protective equipment will be given to employees based on the work area.

- Industrial Safety Helmet;
- Crash Helmets;
- Face shield with replacement acrylic vision;
- Zero power plain goggles with cut type filters on both ends;
- Zero power goggles with cut type filters on both sides and blue color glasses;
- Welders equipment for eye and face protection;
- Cylindrical type earplug;
- Ear muffs;
- Leather hand gloves;
- Acid/Alkali proof rubberized hand gloves;
- Canvas cum leather hand gloves with leather palm;
- Electrically tested electrical resistance hand gloves;
- Industrial safety shoes with steel toe; and
- Electrical safety shoes without steel toe and gum boots.

Hospital facilities will be made available round the clock for attending any emergency, if any. All working personnel shall be medically examined at least once in every year and at the end of his term of employment.

The problem of occupational health, in the operation and maintenance phase is due to noise and dust, which may lead to ailments related to lung and hearing losses. Paras Power Coal & Beneficiation Limited (PPCBL) will establish hospital facility, or will tie-up with available hospital facility in the nearby region, where the Occupational Health Survey of the employees is carried out regularly. During occupational health survey, following tests are conducted:

Lung Function Test; and

1. Hearing Loss (audiometer).

7.5.2 Safety Plan

Safety of both men and materials during construction and operation phases is of concern. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster in proposed plant is possible due to leakage of fuels, collapse of structures and fire/explosion etc.

Keeping in view the safety requirement during construction, operation and maintenance phases, the plant shall formulate safety policy with the following regulations:

- To allocate sufficient resources to maintain safe and healthy conditions of working environment;
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment;
- To ensure that adequate safety instructions are given to all employees;
- To provide wherever necessary protective equipment, safety appliances and clothing and to ensure their proper use;
- To inform employees about materials, equipment or processes used in their work, which are known to be potentially hazardous to health or safety;
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge;
- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work;
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters;
- To ensure proper implementation of fire prevention methods and an appropriate firefighting service together with training facilities for personnel involved in this service;
- To organize collection, analysis and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action;
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees;
- To publish/notify regulations, instructions and notices in the common language of employees;
- To prepare separate safety rules for each types of occupation/processes involved in a project; and
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipment, work places and operations.

7.5.3 Safety Organization

- **Construction and Erection Phase**

A qualified and experienced safety officer shall be appointed. The responsibilities of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/Statutory Provisions.

- **Operation and Maintenance Phase**

When the construction is completed the posting of safety officers shall be in accordance with the requirement of the Factories Act and their duties and responsibilities shall be as defined thereof.

7.5.4 Safety Circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles would be constituted in each area of work. The circle would consist of 5-6 employees from that area. The circle normally shall meet for about an hour every week.

7.5.5 Safety Training

Safety training shall be provided by the Safety Officers with the assistance of faculty members called from Corporate Center, Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labours shall also be provided safety training. To create safety awareness safety films shall be shown to workers and leaflets etc. Some precautions and remedial measures proposed to be adopted to prevent fires are:

- Compartmentalization of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual firefighting operations;
- Spread of fire in horizontal direction would be checked by providing fire stops for cable shafts;
- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries;
- Housekeeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and firefighting; and
- Proper fire watching by all concerned would be ensured.

7.5.6 Health and Safety Monitoring Plan

All the hazardous work places such as fuel storage area, coal-handling area shall be monitored regularly. The health of employees working in these areas shall be monitored once in 5 year for early detection of any ailment.

Though effective measures are taken to combat pollution in ambient conditions, occupational health hazards are not overlooked. Project will provide well organized occupational health services to all its employees by taking responsibility for establishment and maintenance of safe and healthy working environment and assessment of the physical and mental capabilities to turn out specific workloads.

Paras Power & Coal Beneficiation Limited (PPCBL) will take-up monitoring activities periodically to assess hazards due to dusts, vibrations etc.

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