Risk Assessment

&

Disaster Management Plan

RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

1.1 RISK ASSESSMENT

1.1.1 Introduction

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

It involves the identification and assessment of risks at the project site and in the neighboring population who could get exposed to, as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc.

In the sections below, the identification of various hazards, probable risks in the proposed power plant, maximum credible accident analysis, consequence analysis are addressed which gives a broad identification of risks involved in the plant. The Disaster Management Plan (DMP) has been presented based on the risk estimation for fuel storage only since there is no hazardous chemical storage in the power plant.

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 and Health Safety Plan.

1.1.2 Hazard Assessment & Evaluation

Methodology

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

Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally, the vulnerable zones are plotted for which risk reducing measures are deduced and implemented. Preliminary hazard analysis for the whole plant is given in **Table-79**.

Table- 1: 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 liquid fuels may cause fire hazard in the storage facility.	A well designed fire protection including foam, dry powder, and CO_2 extinguisher should be provided.	Fire extinguisher of small size and big size are provided at all potential fire hazard places. In addition to the above, fire hydrant network is also provided.

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.

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 unloading at the storage facility may lead to fire and explosion hazards. The damage criteria due to an accidental release of any hydrocarbon arise from fire and explosion. The vapors of these fuels are not toxic and hence no effects of toxicity are expected.

1.1.3 Construction Hazards

Conventional Construction Hazards are given as follows:

- Falls: either people falling or things falling on people
- Electrical contact – see proximity requirements to work around overhead power lines
- Working on or near live equipment – workers who are asked to work on or near energized equipment (regardless of the energy source) must comply with plant requirements to be applied in all work situations where systems are to be de-energized and locked out by devices such as switches or valves rigging and hoisting hazards
- Site-specific hazards — to be identified by the plant representative.

1.1.4 Chemical Hazards

Identification of Hazardous Chemicals is done in accordance with The Manufacture, Storage and import of Hazardous Chemical Rules, 1989. Schedule-1, of the Rule provides a list of the Toxic and Hazardous chemicals and the flammable chemicals. It defines the flammable chemicals based on the flashpoint and boiling point.

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

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

Group1 & 2 – Toxic substances
Group 3 – Highly reactive substances
Group 4 – Explosive substance
Group 5 – Flammable substances

The following **Table-80** shows the list of major chemicals which have been identified as hazardous chemicals in The Manufacture, Storage and import of Hazardous Chemical Rules, 1989 and which are to be considered as Major accident hazards (MAH) installations.

Table- 2: Hazardous Chemicals in Thermal Power Plant

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

* To be considered as MAH

The chemicals which are stored more than the threshold quantities are to be considered for major accident hazard. Fuel oil (LDO/HFO), used as supportive fuel in the boiler, is classified as Highly Flammable liquid as its flash point remains within 30°C–90°C. Its threshold quantity is 2500 tonnes. Similarly for Chlorine is a toxic gas and its MAH quantity is 25 tonnes. Quantity stored for transformer oil very low to be considered for the study. Sulphuric Acid and Caustic soda are hazardous chemicals but are not included in Schedule-3 for MAH.

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

- Failure of Liquid outlet valve

- Failure of Gas outlet valve
- Body leakage of a corroded cylinder
- Any leakage in the gas pipeline

1.1.5 Fire Hazards

Diesel is a petroleum product. It is a highly flammable liquid having flash point between 32 –96°C. However its auto ignition temperature is 256°C. Its boiling point ranges between 150-400°C. Furnace Oil is of similar characteristics having flash point above 66°C. Major Hazards from oil storage can be fire. Maximum credible accidents from oil storage tank can be

- Tank Fire: Oil is stored in floating roof tank. Leak in rim seal leading to accumulation of vapour is a source of fire. Lighting can be a source of ignition and can cause tank fire. Overflow from tank leading to spillage may cause vapour cloud formation. This can catch fire and it can flash back to the tank to cause tank fire.
- Pool / Dyke fire: If there is outflow from the tank due to any leakage from tank or any failure of connecting pipes or valves, oil will flow outside and form a pool. Where the tank is surrounded by a dyke, the pool of oil will be restricted within that dyke. After sometime, the vapour from the pool can catch fire and can cause pool or dyke fire.

1.1.6 Explosion Hazards

Explosion hazards can take place due to the following machineries:

- Hydrogen plant
- Turbo generators where hydrogen is used for cooling of TG
- Transformer (oil cooled)
- Boiler (Coal/Oil fired)
- Coal dust in Mills and Boilers

Explosion hazards can take place due to the following reasons also:

Bursting of Pipe Lines, Vessels

- Water / Steam pipes due to high pressure/ temperature
- H_2 Gas lines and Acid lines.
- Acid/Alkali tanks
- H_2 Gas Cylinders
- Compressed air header
- Compressed air receivers
- H_2 Gas Holder
- Electrical Hazards
- Fire Hazards

Release of Gases / Dust

- Chlorine in water treatment plant
- Hydrogen in turbo generator area of main plant
- Pulverized coal dust from mills and associated piping
- Fly ash from chimneys and ash ponds, ESP hoppers and bottom ash system
- Coal dust in transfer points, CHP, Crusher & mill area.
- Flue gas from the ducts

Release of Liquid

- Acid and alkali tanks in water treatment plants
- Chlorine toners in WTPs
- Fuel oil tanks in fuel oil handling section
- Ash dyke
- Turbine oil and seal oil leakage

Coal Handling Plant - Dust Explosion

Coal dust when dispersed in air and ignited would explode. 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 gm/m^3.

Failure of dust extraction and suppression systems may lead to abnormal conditions and may increase the concentration of coal dust to the explosive limits. Sources of ignition present are incandescent bulbs with the glasses of bulkhead fittings missing, electric equipment and cables, friction, spontaneous combustion in accumulated dust. Dust explosions may occur without any warnings with Maximum Explosion Pressure up to 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 life line of the power plant.

Stockpile areas shall be provided with automatic garden type sprinklers for dust suppression as well as to reduce spontaneous ignition of the coal stockpiles. Necessary water distribution network for drinking and service water with pumps, piping, tanks, valves etc will be provided for distributing water at all transfer points, crusher house, control rooms etc. A centralized control room with microprocessor based control system (PLC) has been envisaged for operation of the coal handling plant. Except for locally controlled equipment like traveling tripper, dust extraction/ dust suppression / ventilation equipment, sump pumps, water distribution system etc., all other in-line equipment will be controlled from the central control room but will have provision for local control as well. All necessary interlocks, control panels, MCC's, mimic diagrams etc. will be provided for safe and reliable operation of the coal handling plant.

1.1.7 Health Hazards

- Some workers in boiler rooms may suffer from diseases of the upper respiratory tract such as bronchitis, and from conjunctivitis caused by vanadium compounds (dust given off by oil combustion) and SO_2.
- Flue cleaners and cinder removers may, after some years, suffer from chronic bronchitis and rhino-pharyngitis as well as pneumo-sclerosis caused by cinder dust and sulphur dioxide and trioxide.
- The residues of oil combustion are more harmful than the dust given off after the combustion of other fuels.
- Dermatitis can develop from ashes contacting damp skin.
- Eczema may result from the combined action of compounds of nickel, vanadium, and sulphuric acid present in the residues.
- One potential health hazard of being in the vicinity of high electromagnetic fields in thermal generating plants. This concern should be monitored for future information.

1.1.8 Conclusion

The preliminary risk assessment has been completed for the proposed power plant and associated facilities and the broad conclusions are as follows:

- There will be no significant community impacts or environmental damage consequences; and
- The hazardous event scenarios and risks in general at this facility can be adequately managed to acceptable levels by performing the recommended safety studies as part of detailed design, applying recommended control strategies and implementing a Safety Management System.

1.2 DISASTER MANAGEMENT PLAN (DMP)

1.2.1 Introduction

Disaster management has assumed significant role due to modern complex nature of power plants, chemical and petrochemical operations. Disasters are major accidents, which cause wide spread disruption of human and commercial activities. Disaster can be defined as a sudden occurrence of such magnitude as to affect normal pattern of life in the plant and/or vicinity causing extensive damage to life and property. Normally, common accidents are absorbed by the community, but disasters are major accidents and community cannot absorb within its own resources. Most of the disasters, natural or technological (man-made) have sudden onset and give very short notice or no time to prevent the occurrence.

Disaster is a major emergency in plants, which has the potential to cause serious injury or loss of life, both inside and outside the works. It would normally require the assistance of outside emergency services to handle it effectively. Although the emergency may be caused by a number of

different factors, e.g. plant failure, human error, earthquake, vehicle crash or sabotage, it will normally manifest itself in three basic forms:

A disaster occurring in the plant may affect/cause

- several sections within it
- serious injuries / loss of lives,
- Extensive damage to property
- Serious disruption outside the works area

It requires the best use of internal resources as well as outside resources to handle it effectively. It is therefore, necessary to ensure safety and reliability of any power station, through a systematic study based on mathematical modeling to identify possible failures and prevent their occurrence before the disaster.

1.2.2 Disaster Control Philosophy

The principal strategy of Disaster Management Plan of power plant is prevention of the identified major hazards. Since these hazards can occur only in the event of loss of the chemicals from its containment, one of the key objectives of technology selection, project engineering, construction, commissioning and operation is "Total and Consistent Quality Assurance". The project authority is committed to this philosophy right from the conceptual stage of the plan so that the objective of prevention can have ample opportunities to mature and be realized in practice.

The second control strategy adopted for reducing potential emergencies is "Minimization of Operation Inventories of Hazardous Substances" both in process plants as well as in storage within limits of viability of continuous operation.

Another control measure that will be adopted is "Early Detection of any accidental leak and activation of well structured, resourced and rehearsed On-Site Emergency Plan" to intercept the incident with speed and ensure safety of employees, operating plants, public and environment as a matter of priority.

For Control of Disaster, Thermal Power Plant should obey the following rules:

- **Factories Act Requirement**

In accordance with the provision of Section-2(cb), read with The Factories Act-1948, **"power generating industry" is classified as hazardous process** under item 5 thereof.

According to Section 41-b, para–4, of Factories Act-1948, all factories engaged in hazardous processes must have Disaster Management Plan.

- **Section 41-b, Para -4 of Factories Act-1948**

Every occupier shall, with the approval of the Chief Inspector, draw up an on-site emergency plan and detailed disaster control measures for his factory and make known to the workers employed

there in and to the general public living in the vicinity of factory, the safety measures required to be taken in the event of an accident taking place.

The plan is developed to make best possible use of resources at its command and/or outside agencies for the following purposes.

- Prevention, Mitigation & Preparedness (Pre phase)
- Response, Rehabilitation & Recovery (Post phase)
- Safe guard others by evacuating them to safer places;
- Rescue of victims and treating them suitably to effect speedy recovery at hospital;
- Identify the personnel affected / dead;
- Inform relatives of those deceased / affected;
- Providing relevant records / data needed as evidence for subsequent enquiry;
- Rehabilitation of the affected persons;

1.2.3 Vulnerable Units

The maximum credible accident and consequence analysis carried out during Industrial hazards. Vulnerable units needing consideration in Disaster Management Plan (DMP) are coal, chlorine, high-speed diesel and heavy fuel oil/LSHS.

Analysis of Vulnerable Zones

From the analysis of the vulnerable zones the action suggested are discussed below:

- All the storage vessels containing hazardous chemicals like HSD, LSHS & HFO at the tank farm will be dyked. The dyke volume will not be less than 1.1 times the volume of the storage vessel.
- All the storage vessels will be placed in the storage area in such a manner so as to conform to the requirements of Chief Controller of Explosives.
- Presence of human beings in the hazardous storage areas will be controlled and no unauthorized person will be allowed in these areas.
- Weeds, long grass, deciduous shrubs and trees and any combustible material will be removed from hazardous storage areas from time to time.
- Windsocks will be provided at oil storage yard and chlorine storage area.
- Tank farm would be provided with PCC at ground.

1.2.4 Emergency Plan

Objectives

The On-site and Off-site emergency plans will be covered personnel of proposed project. The Emergency Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operation in this same order of priorities. The

objective of the emergency plan is to make use of the combined resources of the plant and the outside services to achieve the following:

- Affect 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 the affected
- Provide for the needs of relatives
- Provide authoritative information to the news media
- Secure the safe rehabilitation of affected area
- Preserve relevant records and equipments for the subsequent enquiry into the cause and circumstances of emergency

On-site Emergency Planning

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

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

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

Control Requirement of an On-site Emergency Plan

The Disaster Management Plan will set out the way in which designated people at the site of the incident can initiate supplementary action both inside and outside the works at an appropriate time. An essential element of the plan will be to make safe the affected unit, for example by shutting down. The plan will contain the full sequence of key personnel to be called in from other sections or form off-site.

Management will ascertain that sufficient resources exist at their works to carry out the plan for various assessed incidents in conjunction with preliminary services, for example, sufficient water for cooling and fire fighting.

- ✓ *Alarm and Communication Mechanism*

Communication is crucial factor in handling an emergency. As a general practice, all employees will be able to raise an emergency alarm so that the earliest possible action can be taken to control the situation. There will be an adequate number of points from where the alarm can be raised either directly by activating an audible warning or indirectly, viz. a signal or message to the permanently manned location.

- ✓ *Control Center*

The Emergency Control Center is the place from where the operations to handle the emergency are coordinated. An Emergency Control Center (ECC) will be established and equipped with relevant data and equipment to assist the control center personnel in disaster management. The Emergency Control Center will be manned by Deputy General Manager / Senior General Manager in charge of Operation and Maintenance of plant, Safety Officer and the senior officers of the other services. Other personnel will not have access to the control center. Emergency Control Center will be sited in an area of minimum risk and preferably close to a main road to allow for easy access to a radio-equipped vehicle for use if other systems fail or extra communication facilities are needed. An alternate center, similarly equipped, will also be available at a different location. Emergency Control Center will contain.

- An adequate number of external and internal telephones / mobile phones
- Public address system
- A few copies of the on-site emergency plan
- Note pads, pens and pencils to record messages received and any instructions for delivery by runners
- Rolls of employees
- Addresses of the employees
- List of key personnel, their addresses and telephone numbers.
- A tape recorder with battery and cassettes on which the incident occurred, actions being taken and progress can be recorded
- Torches, explosimeters, personnel protective equipment, artificial respirators, gas masks, emergency lights etc.

Two suitable emergency control center sites within power station complex will be:

- At security gate-Emergency Control Center No. 1
- At utility office-Emergency Control Center No. 2

- ✓ *Roles and Responsibilities (Proposed)*

Shift manager will take overall control of the works during emergency as CIC /WIC and will operate from Emergency Control Center (ECC). A multi-channel communication network will connect ECC with all the plant control rooms and also with local police control room, area fire station, area hospital and district authorities through hot lines.

Respective Unit Heads will immediately assume specific roles and emergency management responsibilities. The Roles and Responsibilities of power station personnel can be defined only after the commissioning of the plant.

- ✓ *Emergency Response Facilities (Proposed)*

Preliminary facilities envisaged are-

- Emergency shutdown procedure
- A dedicated and pressurized fire fighting ring-main with adequate number of fire hydrants, fixed position monitors, water curtains, fog nozzles located strategically throughout the site
- A number of fire fighting pumps with both electric and diesel prime movers backed by adequate supply of raw water
- Dedicated fire alarm networks with adequate number of fire alarm call points and emergency telephone handsets throughout the site
- A two-way Public Address (PA) system installed independently in all production units and also in important service areas
- Adequate supply of protective clothing & breathing apparatus will be made available to all personnel of emergency team
- On-site first aid and treatment center with round the clock medical attendance

- ✓ *Outline of Key emergency Actions*

The on-site emergency will in all probability commence with a major spill of hazardous chemical like HSD, HFO, Chlorine etc. or its uncontrolled release into the plant atmosphere.

In accordance with the detail on-site emergency plan, the following key personnel will immediately take control of the emergency.

- On-site fire crew led by a fire marshal will arrive at the scene of incident with firefighting equipment as necessary.
- Emergency Security Controller will commence his role from the main gate office.
- Incident Controller will rush to the scene of emergency.
- Works Main Controller will arrive at the ECC with members of Emergency Control team and will assume absolute control of the site. He will receive information continuously from Incident Controller & Emergency Security Controller and give directions to:
    - Incident Controller
    - All plant control rooms
    - Emergency Security Controller
    - Site or Shift Medical Officer
    - Personnel Manager

As soon as key emergency personnel will take up positions in their respective locations, the management of the incident will commence with the site main controller performing the lead functions.

At the site of incident, the incident controller will directly handle the emergency with the help of specific support groups.

At the security gate office the emergency security controller and personnel manager will be in contact with various external agencies as per requirements.

At the site medical center the shift/site medical officer will take control of medical support services.

Works main controller, will be directing and deciding a wide range of issues. In particular, WMC will decide and direct:

- Whether the incident controller requires reinforcement both in terms of manpower and other resources.
- Whether staffs in different locations are to be remaining indoors or are to be evacuated and assembled at the designated collection centers.
- Whether and when district emergency services are to be called to supplement the resources of plant's emergency crew, intimation to district authority should be given.
- How to deal with fatalities reported either by incident controller or by shift medical officer.

These are some of the key emergency decisions and actions, the Works Main Controller will have to take. When the incident has eventually been brought under control as declared by the incident controller, WMC will send two of his assisting managers for inspection of:

- Site of the incident for an assessment of total damage and prevailing conditions, with particular attention to possibility of re escalation of the emergency now under control
- Other parts of the site which might have been affected by impacts of the incident
- Personnel collection and roll call centers to check if all persons on duty have been accounted for
- All plant control rooms to assess and record the status of respective plants and any residual actions deemed necessary
- Site's first aid and medical center to inspect any casualty (ies), their state of treatment and also to get a report on off-site hospitalization, for subsequent follow-up

The post-emergency inspectors will return to ECC with their observations and report their findings to WMC

Based on these reports WMC will communicate further directive to all sub-centers of emergency management and will finally declare and communicate termination of emergency and authorize step by step restoration of normal operation of the site. The sirens will be sounded giving all clear signal.

- ✓ *Conducting Evacuation*

Once WMC will decide that an area is to be evacuated, the evacuation will be conducted in a well-coordinated and safe manner. Evacuation involves a number of steps, which include assigning tasks

to evacuation assistance personnel, informing potential evacuees, providing transportation, emergency medical care and security for evacuated areas and sheltering evacuees as necessary.

- ✓ *Evacuation Tasks*

The first step is to assign tasks to evacuation assistance personnel. These tasks include information concerning:

- The specific area to evacuate
- Route of evacuation
- Protective gear to be worn
- Instructions to be given to evacuees
- Transportation of evacuees who are without private transportation
- Assistance to specific population
- Shelter locations
- Traffic and pedestrian control
- Communication procedures

The progress of the evacuation efforts will be monitored by WMC who will also provide continuous direction to evacuation assistance personnel.

- ✓ *Security in Evacuated Areas*

Once an area is evacuated, law enforcement personnel will guard the area to prevent looting and other unauthorized sections. Security forces operating in or around an evacuated area will be dressed in appropriate protective gear.

- ✓ *Re-entry into Evacuated Areas*

Before making the decision to authorize re-entry, data collected by the monitoring crews will be verified and the advice of health officials to be considered.

- ✓ *Updating of On-site Plan*

On-site plan will be updated based on modifications in the factory or at-least once a year on specific authorization of Works Manager. Safety Officer will maintain a record to this effect.

- ✓ *Mock Drill for Rehearsing On-site Plan*

A mock drill to rehearse on-site plan with a view to train and make the personnel aware of the procedure in case of emergency will be carried out by works Manager. The drill will be conducted seriously and lessons learnt will be analyzed and corrective actions will be taken. The record of rehearsal will be maintained.

- ✓ Transport

Vehicles, ambulances and cars available with power plant, will immediately be made available for disaster management. Additional transport based on requirement will be requisitioned.

Off-site Emergency Planning

The off-site emergency plan is an integral part of a hazard control system. It will be based on the identified accident scenario, which could affect people and environment outside the works. Thus, the off-site plan follows logically from the analysis to provide the basis for the on-site plan and the two plans will therefore complement each other. During preparation of off-site emergency plan, the district authorities and other organization in the vicinity and pollution control board would be consulted. The key feature of a good off-site emergency plan is the flexibility in it's an application to emergencies.

- Educating the people around
- Mock drills
- Communication
- Transport
- Medical facilities
- Coordination
- Evacuation
- Mutual aid scheme

Post Emergency Relief To The Victims

The Public Liability Insurance Act, 1991 provides for the owner who has control over handling hazardous substances to pay specified amount of money to the victims as interim relief by taking insurance policy for this purpose. The District Collector has definite role in implementation of this act. After proper assessment of the incident, he shall invite applications for relief, conduct an enquiry into the claims and arrange payment of the relief amount to the victims.

1.2.5 Control Measures for Coal Yards

The total quantity of coal will be stored in separate stock piles, with proper drains around to collect washouts during monsoon season.

Water sprinkling system will be installed on stocks of coal in required scales to prevent spontaneous combustion and consequent fire hazards. The stock geometry will be adopted to maintain minimum exposure of stock pile areas towards predominant wind direction.

1.2.6 Preventive Measures for Loading/Unloading of Chemicals

Based on the preliminary identification, the major hazardous installation at power plant are storage of hydrogen, HFO, HSD and chlorine. Heavy Fuel Oil and HSD are the secondary fuel for combustion support at low load and for startup. Following are the important considerations for loading/unloading of hazardous chemicals.

- Written instructions will be given which clearly define responsibilities for all personnel involved in loading/unloading operations.

- A responsible person normally a section supervisor on site will check that the quantity and type of fuel oil being transferred is suitable for the receiving tanks. Tanks will be checked to see how full they are before filling, and also during filling using the contents gauge. The maximum level device will be used to ensure overfilling does not occur.
- The point of transfer, where connections and disconnection are made will be sited in a well-ventilated position.
- Flexible hoses used for conveying fuel oil to and from truck into fixed vessels will:
    - Have a means of identification.
    - Be examined for kinks and wear on every occasion prior to use. Hose fittings will be similarly examined,
    - Periodically checked for electrical continuity and written records of the tests should be maintained.
    - Properly used so that the hose will not be physically damaged or Adversely affected by the weather when not in use or when being conveyed.
    - Have means for protecting and fittings against damage or ingress of foreign material.
    - Loading hoses should be earth and should also be bonded with the wagon.
    - Replaced or repaired when damaged or worn-out.
    - Properly used so that the hose will not be physically damaged or adversely affected by the weather when not in use or when being conveyed.
    - Have means for protecting and fittings against damage or ingress of foreign material.
    - Loading hoses should be earth and should also be bonded with the wagon.
    - Be replaced or repaired when damaged or worn-out.
- In order to minimize the risk of accidental movement, the tanker will stand on a level site during loading or unloading. Checks will be placed against the vehicles wheels or other means provided to prevent vehicle movement prior to loading/unloading. These will only be removed when transfer is complete. The ground beneath the tanker will have a shallow gradient to a safe place to prevent any spillage from remaining under the vehicle.
- The loading/unloading operation will only be carried out when it is safe to do so and where practical be separated from other traffic movement. Where vehicles or pedestrian are likely to pass by, physical barrier will be provided to deter them approaching the transfer operation.
- Consideration will be given to the provision of a driveway protection device such as self-sealing, breakaway, coupling connected to the flexible hose, means to shut emergency isolation valves on the fixed plant, etc.

1.2.7 Fire Detection & Protection System

A comprehensive fire detection and protection system is envisaged for the complete power station. This system shall generally be as per the recommendations of TAC (INDIA)/ IS:3034& NFPA-850. The following protection systems are envisaged:

- Hydrant system for complete power plant covering main plant building, boiler area, turbine and its auxiliaries, coal handling plant, all pump houses and miscellaneous buildings of the plant. The system shall be complete with piping, valves, instrumentation, hoses, nozzles, hose boxes/stations etc.
- Automatic high velocity water spray system for all transformers located in transformer yard and transformers having rating 7.5 MVA and above located within the boundary limits of plant, Main and unit turbine oil tanks and purifier, Oil canal, generator seal oil system, lube oil system for turbine driven boiler feed pumps, boiler burner fronts, fuel oil station in boiler, etc. This system shall consist of QB detectors, deluge valves, projectors, valves, piping & instrumentation.
- Automatic medium velocity water spray system for cable vaults and cable galleries of main plant, switchyard control room and ESP control room consisting of smoke detectors, linear heat sensing cable detectors, deluge valves, isolation valves, piping, instrumentation, etc.
- Automatic medium velocity water spray system for coal conveyors, transfer points, Stacker reclaimer, consisting of QB detectors, linear heat sensing cables, deluge valves, nozzles, piping, instrumentation, etc.
- Automatic medium velocity water spray system for LDO tanks consisting of QB detectors, deluge valves, nozzles, piping, instrumentation, etc.
- Automatic fire detection cum sprinkler system for crusher house along with alarm valves, sprinkler nozzles, piping, instrumentations etc.
- Automatic Foam injection system for fuel oil / storage tanks consisting of foam concentrate tanks, foam pumps, in-line inductors, valves, piping & instrumentation etc.
- For protection of Central control room, Control equipment room, Programmer room, UPS room, etc. Inert Gas extinguishing system as per NFPA-2001 would be opted.
- Fire detection and alarm system - A computerized analogue, addressable type Fire detection and Alarm system shall be provided to cover the complete power plant. Following types of fire detection shall be employed.
    - Multisensor type smoke detection system
    - Photo electric type smoke detection system.
    - Combination of both multisensor type and photo electric type smoke detection systems.
    - Linear heat sensing cable detector.
    - Quartzoid bulb heat detection system.
    - Infra red type heat detectors (for selected coal conveyors)
- Portable and mobile extinguishers, such as pressurized water type, carbon-dioxide type, foam type, dry chemical powder type, will be located at strategic locations throughout the plant.
- CW blow down shall be used for supply of fire water. An alternate connection from raw water line shall also be provided as a back-up source for fire water. It is proposed to provide two numbers of Steel tanks for storage of fire water system. Fire water pumps shall be located in the fire water pump house and horizontal centrifugal pumps shall be installed in the pump house for hydrant and spray system and the same shall be driven by electric

motor and diesel engines as per the regulations of TAC. The water for foam system shall be tapped off from the hydrant system network.

- For the above fire water pumping station, automatic pressurization system consisting of jockey pumps shall be provided.
- Complete Instrumentation and Control System for the entire fire detection and protection system shall be provided for safe operation of the complete system.

1.2.8 Electrical Protection System

Emergency Power Supply System

For the safe shutdown of the plant under emergency condition and in case of total power failure, diesel generating sets shall be installed for feeding certain essential applications like battery chargers, emergency lighting, essential air conditioning/ventilation and all auxiliaries necessary for barring operation of main and BFP turbines etc. The unit emergency switchgear section shall be fed by one diesel generator of adequate capacity. One Diesel Generator (DG) set per unit along with one standby DG set common for two units shall be provided as indicated in the single line diagram.

Protective Relaying

The necessary protective relaying system according to established norms shall be provided for EHV switchyards, over head lines, generators, transformers, motors, auxiliary system etc., to minimize damage to equipment in case of fault and abnormal conditions.
The generator would have winding temperature recorders and instruments for measuring coolant temperature, flow, pressure, conductivity and purity, with alarm and trip contacts as necessary. The protection against stator overheating would be provided by the generator temperature monitoring system. Limiters for stator current, V/f, Rotor current and under excitation would be included in Automatic Voltage Regulator. One Disturbance/fault recorder (DFR) – microprocessor based shall be provided for each generator. It shall have the facility of fast scan as well as slow scan to record transient as well as dynamic performance of the system.

Protection of Switchyard Equipment & Outgoing Lines

- **Busbar Protection:** Each busbar will have a separate three phase differential protection along with area zone bus wire supervision and hand reset relays.
- **Breaker Failure Protection:** All circuit breakers shall be provided with breaker failure protection to take care of stuck breaker condition. If in the event of fault, a breaker fails to trip on receipt of a trip command, the breaker failure protection shall de-energize that particular bus to which the faulty breaker is connected and also send trip impulse to the remote end breaker to isolate the fault.
- **Line Protection:** Each EHV line shall be provided with duplicated Numerical Distance Protections (Main I and II) based on different hardware platforms. These shall be of three zone carrier aided distance protection operating on permissive under-reach principle. Each line shall also be provided with a two stage over voltage protection

- **Power Line Carrier Communication:** Power line carrier communication equipment complete for speech transmission line protection and data channels shall be provided for the transmission line at both end of the line. For the purpose of matching of frequency of transmission and receivers at the two ends of the line, the equipment at both ends of the line shall be arranged by appropriate transmission agency. Only wave trap and PLCC battery feeders have been considered for cost purposes.
- **Metering System:** 0.2 accuracy class Availability based Tariff (ABT) energy meters along with metering Master Station and software, for export & import of active and export and import of reactive energy meters shall be provided for each outgoing lines, generator /Station transformer feeders. Static meters of 0.2 Accuracy class have been considered for active energy measurement at other locations for energy accounting/trend analysis. ABT based tariff meters shall be provided at all outgoing line feeders and EHV side transformers by PGCIL(CTU) as per relevant process of metering regulations.

Control Philosophy for Switchyard

The control, protection and data acquisition including SOE data for 400 kV switchyard bays shall be accomplished by Substation Automation System with Distributed Architecture comprising of Bay Control Units, Bay protection Units, Operators Workstation, engineering Workstation, Large Video Screen (LVS) etc. The Bay Control Units and Bay Protection Units shall be located suitably in bay kiosks. The adoption of Distributed Architecture shall help in reducing the cost by reduction of cables, cabling and related civil works and shall also provide better tariff accuracy. The SA system will be based on standard communication protocol IEC 61850. The Substation Automation System shall facilitate following functionality:

- Dynamic display of switchyard mimic, real time measurement values, etc.
- Monitoring ON/OFF status and remote closing/ synchronizing of circuit breakers, isolators and earth switches
- Display of Switchyard alarms, events and trends
- Interlocking functions
- Sequential Event Recording
- Communicating with protection relay IEDs for settings and Disturbance Recording functions
- System self supervision
- Hard copy printing and other network functions

As already described in control philosophy for CCR, it is also proposed to provide two numbers of OPC compliant gateways in the station level network such that desired interface with main plant DCS can be achieved. Two more redundant gateways along with associated RTU and modems shall be provided in the station level network for sharing information with RLDCs through PLCC link. These two would communicate through IEC:60870:5:101 standard protocols. Two more gateways shall be configured for suitable OPC link to Central OS control room.

1.2.9 Preventive Measures for Men & Material

For the safety of man and material, various preventive measures will be taken. These are:

- Periodical checking of electrical wiring, fittings, and equipment.
- Immediate removal of all combustible and flammable material from the vicinity of sources of ignition.
- All welding/cutting operations will be carried out taking suitable precautions under permit procedure in consultation with the office-in-charge of the plant and the Fire and Safety division.
- All the pipelines and vessels will be clearly marked for its content and quantity and will also be colour coded for easy identification.
- All plant equipment, lines, vessels and storages will be inspected in all shifts for leakage and release of inflammable liquids. Any such leakage, if found will be stopped and attended to at once.
- All the hazardous areas will be marked with prominent display symbols.
- Areas where spontaneous combustion is possible due to storage of material or in scrap yard will be inspected regularly for immediate control of fire on its outbreak.
- Stacked material, which can generate heat or can spontaneously ignite, will be inspected regularly to detect any fire. Material will be stacked with sufficient space in between the rows to permit free circulation of air and remove any heat if generated.
- Plant and machinery will be operated under close supervision. Any malfunction will be attended to at once before it can lead to breakdown, fire or any such dangerous occurrence.
- Air-conditioning equipment will be inspected regularly and defects are to be attended at once.
- Dry grass and vegetation will be cut as and when required.
- Smoking will be prohibited in the plant premises. It may be allowed in the safe locations outside the plant area. All persons will be checked at plant gate for matches, lighters, beedi, cigarettes and other smoking materials.
- Safety display boards should be provided wherever hazardous chemicals are stored.

1.2.10 Responsibilities

THDC INDIA LTD. recognizes, and accepts its responsibility for establishing and maintaining a safe working environment for all its employees. This responsibility arises from:

- Company's moral responsibility to its employees, to provide the best practicable conditions of work from the point of view of health and safety.
- The obligation to consult with its staff and their representative to implement policies and procedures developed as a result of discussions.
- Statutory responsibility in respect of health, safety and welfare of employees emanating from relevant legislations such as the Factories Act. The Indian Electricity Act. The Explosive Act, the Boiler Act etc.

Responsibilities of THDC INDIA LTD

The Company shall take all such steps which are reasonably practicable to ensure best possible conditions of work, and with this end in view the company shall do the following:

- To allocate sufficient resources to provide and maintain safe and healthy conditions of work
- 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 and 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, prompt treatment of injuries and illness at work
- To provide appropriate instruction, training, retraining and supervision in health and safety and first aid and ensure that adequate publicity is given to these matters
- To ensure proper implementation of fire prevention and an appropriate fire fighting service, together with training facilities for personnel involved in this service
- To ensure that professional advice is made available wherever potentially hazardous situations exist or might arise
- 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 type of occupation/process involved in a project
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations
- To co-ordinate the activities of the company and of its contractors working on the Company's premises for the implementation and maintenance of safe systems of work, to comply with their legal obligations with regard to the health, safety and welfare of their employees.

Responsibilities of the Employees

The establishment and maintenance of best possible conditions of work is, no doubt, the responsibility of management. However, it is also necessary that each employee follows prescribed safe methods of work. He should take reasonable care for the health and safety of himself and his fellow employees and of other persons who may be affected by his action at work. With this in mind, employees should be health and safety conscious and:-

- **Report:** Potential hazards
- **Observe:** Safety rules, procedures and codes of practice.
- **Use:** With all reasonable care the tools, equipment, safety equipment and protective clothing provided by the Company; these items should be kept in good condition.
- **Participate:** In safety training courses when called upon to do so.
- **Make Use:** Of safety suggestions schemes.
- **Take:** An active and personal interest in promoting health and safety at work.

Responsibility for Implementation

- The ultimate responsibility for ensuring the implementation of the policy on health and safety at work rests on the THDC INDIA LTD. Management - Corporate Human Resources Division at the corporate level and the concerned General Managers at the Project/Station level. The Officers in charge of Safety will be functionally responsible to the Corporate Center for ensuring that the policy is promulgated, interpreted and carried out in the manner expected.
- Immediate responsibility for safety at work is that of the Manager/ Executives of each department/section who are primarily responsible to prevent accidents involving members of their staff and other persons. It is their responsibility to issue clear and explicit working instructions, compliance with which will ensure safe working and to require the effective use of approved equipment.
- Accepted rules, procedures and codes of practice which are formulated with proper regard to health and safety consideration must be strictly observed by all concerned. Contracting Agencies executing works should be made responsible, through various measures including appropriate provisions in the contract, for discharging their safety obligations.
- In designated areas of particular hazard the concerned executives are required to authorize, in writing, the commencement of any work and, before doing so, personally satisfy themselves that all necessary safety precautions have been carried out. Such executives must themselves be authorized, in writing as competent to perform these duties.
- Safety Officers are appointed to advise management on questions of safety at work including advice on the application in particular local situations of the system of work, implementation of Company's Rules and Relevant Codes of Practices in consultation with Area Engineer. They will be consulted in the interpretation of rules and codes being formulated by the corporate management and shall advise management in the investigation and analysis of accidents and circulation of appropriate statistics.

1.2.11 Reporting of Incidents

Major Site Incidents

The General Manager at each Project/Station is required to ensure that plans are devised for action in the event of fire, major site incident or necessity for evacuation procedure. These plans must be communicated to all staff and rehearsed from time to time.

- Fire fighting training and the formation of fire-fighting team on a voluntary basis will be encouraged by the Project/Station Management.
- All accidents and dangerous occurrences will be reported immediately to the General Manager who will implement an established procedure to ensure that an investigation takes places and recommendations are made to prevent recurrence.

Reporting of Accidents and Dangerous Occurrences

With a view to ensure prompt reporting of accidents and dangerous occurrences to comply with requirements/obligations under different statutes; and to inform the concerned authorities within the organization for keeping complete information of accidents for record and analysis and to take necessary preventive actions, a procedure for reporting of accidents dangerous occurrences has been framed. Separate procedures have been formulated for accidents causing injuries/ fatalities and for dangerous occurrences.