RISK ASSESSMENT REPORT

1. Risk Assessment and Risk Mitigation Measures

Identification of hazards in a power plant is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. Hence, all the components of a process/ system/ plant need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

The proposed power plant will utilize about 6.7 million tones of Indian coal annually. As coal is subject to spontaneous combustion it may catch fire given the slightest opportunity. This fire hazard is greatly influenced by the amount of airflow through the mass of coal.

Methodology

Risk assessment shall be carried out taking into account the maximum inventory of storage at site at any point in time. The risk contours should be plotted on the plant layout map clearly showing which of the proposed activities would be affected in case of an accident taking place. Based on the same, proposed safeguard measures should be provided. Measures to guard against fire hazards should also be provided.

A preliminary hazard identification and risk assessment was undertaken to quantify the possible fire and occupational health risks associated with the operation of the project at the designated location. The good engineering practices suggested by the Central Pollution Control Board for risk assessment in industries (CPCB document Probes/133/2009-10) and CPR-18E risk assessment procedures' guidelines which are widely accepted by the Ministry of Environment and Forests (MoEF&CC) India, have been adopted while assessing the residual risks associated with the operations of the project with specific reference to fire hazards, chemical exposure hazards, occupational hazards and natural hazards. As part of the risk assessment, a preliminary review on the hazardous materials and chemicals proposed to be handled at the site were reviewed and the storage capacities and design features of such hazardous materials were also reviewed while assessing the residual risks. Occupational health hazards such as exposure to dust emissions, thermal stress and work-zone levels were also studied. Based on the findings of the risk assessment study, a preliminary risk management plan has been developed as per the applicable rules and guidelines; wherever possible, good engineering and management practices are suggested to minimise any intolerable risks.

2. Construction Phase Safety Management Plan

General Safety Aspects

The possible safety hazards during the construction phase are primarily limited to material transport, construction and erection of material and structures and working at heights etc. The possible occupational safety hazards with the above mentioned activities are electrical hazards at the construction activity, falling from heights, slips and fall of equipment such as cranes etc.

In order avoid the occupational safety hazards, The Indian Codes and Standards (IS 18001: 2007, IS - CED 29(7778) and 15793:2007) on construction safety best practices shall be adopted by all the contractors and sub-contractors. All the sub-contractors shall have a written health and safety and environment policy. The principal contractor will be responsible for implementing and monitoring the occupational safety programs at the construction sites. Workers & Supervisors should use the safety helmet and other requisite Personal Protective Equipment according to job & site requirement. They should be trained to use personal protective equipment. No loose clothing should be allowed while working near rotating equipment or working at heights. Visitors should not be allowed access to construction sites unless accompanied by or authorized by a competent person and provided with the appropriate protective equipment. Where natural lighting is not adequate, working light-fittings or portable hand-lamps should be provided at workplace on the construction site where a worker will do a job. Emergency lighting should be provided for personnel safety during night time to facilitate standby lighting source, if normal system fails. Artificial lighting should not produce glare or disturbing shadows.

The following IS codes may be adopted for construction safety related activities:

- ❖ IS Code 3696: Safety code for scaffolds and ladders, (Part 1):1987-Scaffolds, (Part 2):1991- Ladders
- ❖ IS Code 3764:1992 - Code of practice for excavation work

- IS Code 4082:1996 - Recommendations on stacking and storage of construction materials and components at site
- IS Code 512:1969 - Safety code for piling and other deep foundations
- IS Code 5916:1970 - Safety code for construction involving use of hot bituminous materials
- IS Code 7205:1974 - Safety code for erection of structural steel work
- IS Code 7969:1975 - Safety code for handling and storage of building materials
- IS Code 13416 - Recommendations for preventive measures against hazards at work places: (Part 1):1992- Falling material hazards prevention and (Part 2):1992-Fall prevention and (Part 3):1994-Disposal of debris

3. Occupational Health Risks and Risk Mitigation Plan – Construction Phase

Heat Stroke

In the recent past, based on the information provided by IMD, Madhya Pradesh and Bihar are experiencing the heat waves in the month of May and June. The heat wave is caused in large part by sparser pre-monsoon season showers, which brought less moisture than normal to the area, leaving large parts of India arid and dry. The sudden end of pre-monsoon rain showers, an uncommon trend in India, has contributed to the heat waves. The peak temperatures in the Buxar region was reported t be as high as 48^{O}C. When a person works in a hot environment, the body must get rid of excess heat to maintain a stable internal temperature. It does this mainly through circulating blood to the skin and through sweating. When the air temperature is close to or warmer than normal body temperature, cooling of the body becomes more difficult. Blood circulated to the skin cannot lose its heat. Sweating then becomes the main way the body cools off. But sweating is effective only if the humidity level is low enough to allow evaporation and if the fluids and salts that are lost are adequately replaced. Heat stroke can occur when the body's system of temperature regulation fails and body temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict. Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g., a rectal temperature of 41°C (105.8°F). If body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of work load and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

In order to reduce the risk associated with heat exposure the following measures can be adopted:

- Avoid working for prolonged period during the hot sunny hours especially during 1 to 3pm during summer conditions,
- Adopted staggered times to avoid over exposure to direct sun,
- In the case the ambient temperatures exceed more than 45OC, the construction works in open areas may be suspended.

4. Safety Hazards during Operational Phase

Hazardous Operations

Unlike other process industries, power project does not handle any major flammable materials (Class A and Class B Flammable material) except small quantities of furnace oil for boiler start up conditions. Other hazardous materials that will be handled at the power plant will be small quantities of Chlorine used as biocide in the cooling tower. In general about 2 to 5ppm of Chlorine is doped in the cooling water circulation line for this purpose. Both Hydrochloric acid and Sodium Hydroxide will be used for regeneration of the De-Mineralization Plant resin beds. Two day storage tanks of capacity 2000 m^3 each with adequately designed dyke system will be installed in the DM plant area. Although coal is not a self igniting compound at ambient temperatures, prolonged exposure to heat during the hot summer days, may lead to partial ignition due to the presence of volatile compounds in the coal. Based on the preliminary analysis, the major fire hazards envisaged are from storage and handling of furnace oil at the Mill site.

Safety Aspects of Storage of Furnace Oil

A preliminary risk assessment study was undertaken to establish the possible heat radiation effects due to accidental fires at furnace oil storage tanks.

Two (2) nos. of 2000m^3 capacity fixed roof type LDO storage tanks will be provided for storage of LDO. One (1) no. of 100m^3 capacity fixed roof type LDO day oil tank will be provided for auxiliary boiler with a dyke designed for 100% containment. Furnace oil falls under Class 3 combustible material as per OISD standards and hence the possible fire hazards will be less significant. Hence, these fuels will undergo only pool fire scenario in the presence of any ignition source. Since the quantity of furnace oil proposed to be stored will be very small. In order to assess the heat radiation from the pool fire scenario of accidental spills from furnace oil (full bore rupture of the storage tank), consequence modeling was undertaken using USEPA Aloha software. For the purpose of the consequence modeling, it has been assumed that due to mechanical failure of the tank, entire inventory of the furnace will be retained in the dyke. In the presence of external fire such as electrical fire or vehicular exhaust sparks etc, the contents in the dyke will catch fire and release thermal energy. The predicted heat radiation levels due to pool fire of furnace oil pool fire scenario are presented in **Table 2**. Radiation contours are presented in **Figure 1.**

It may be inferred from the model heat radiation contours with 4.5kW/m2 would occur within the facility boundary and hence the overall impacts due to any fire accidents will be less significant. In addition there are no public roads and settlements located within the predicted heat radiation contour of 1.6 kW/m2, hence the impacts on the neighboring areas will be insignificant. As per the published literature (CP18E and CPCB Manual for fire risk assessment), the possible frequency of occurrence of such accidents will be less than 40 in one Million events. Hence, the overall risk due to handling of such a small quantity of furnace oil at the Mill site will be insignificant.

Table 1 Estimated Heat Radiation Levels due to Fire from Furnace Oil Tank Rupture

Heat Radiation Level (kW/m^2)	Possible Physical Effect due to Heat Radiation (ref)	Heat Radiation Distance for Furnace Oil Tank Fire (Pool Fire Scenario)
37.5	Sufficient to cause damage to process equipment	Within the dyke
25.0	Minimum energy required to ignite wood	Within the dyke
12.5	Melting of cables and plastic	<25m
9.5	Second degree burns in 20 seconds	<45m
4.5	Zero percent lethality, but may cause blisters	<80m
1.6	Will cause no discomfort on prolonged exposure	<110m

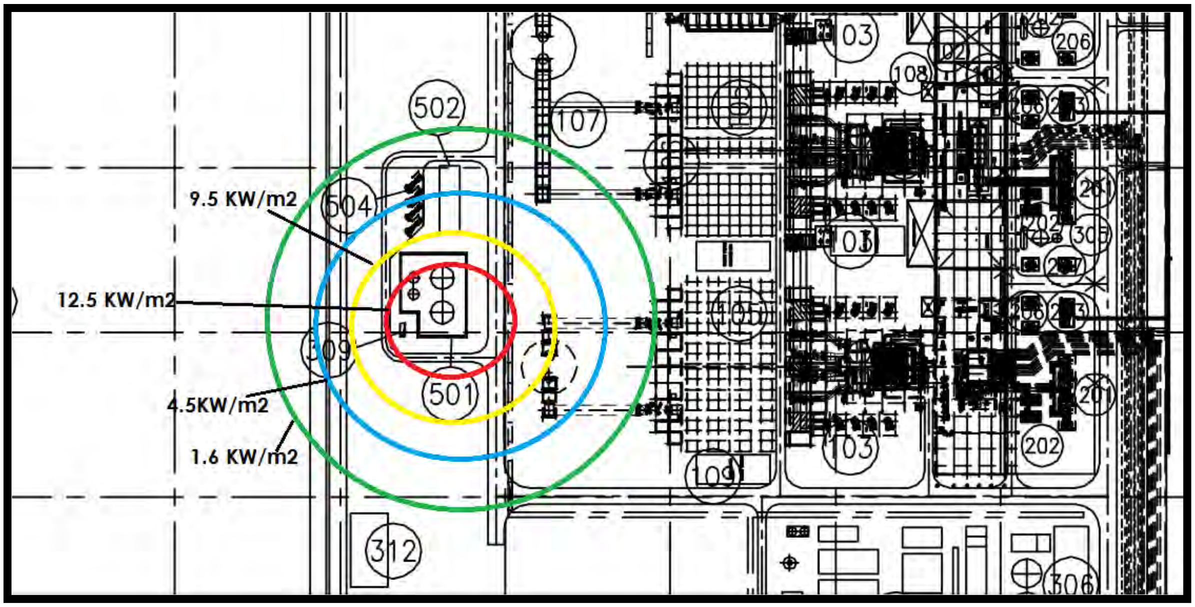

Figure 1 Consequence Distance – Heat Radiation Levels

The following safety measures will be adopted for handling of furnace oil.

- ❖ According to the OISD standards, an adequately design dyke with 110% of the largest tank volume, will be provided to retain the oil spills, if any,
- ❖ The fuel transfer pumps & motors will be of fire proof type and will be located outside the dyke area.
- ❖ A level indicator with alarm will be provided for the fuel tanks.
- ❖ Fuel unloading from the trucks will be taken up only in the presence of authorized supervisor.
- ❖ The transfer hose pipelines and truck discharge line will be connected to a temporary earth arrangement as per BIS codes to avoid any static electricity.
- ❖ A spill collection pit will be provided near the fuel tank dyke.
- ❖ As far as possible, plant office areas, common gathering points and canteen shall be located at least 100 m away from the fuel oil storage areas to avoid any exposure to heat radiation effects on the workers and employees.
- ❖ It has been recommended to provide a hand-held foam tender and fire water hydrant line in the vicinity of the storage tanks.

Risk Mitigation Measures for the Storage and Handling of Coal

Although coal fires are infrequent, there is a possibility of coal fires at the coal stock yards during the summer conditions due to burning of volatile compounds. Coal stock yard fires can be avoided by providing proper stacking design to prevent air movement inside the coal lumps, minimising the duration of coal storage at the site and water sprinkling operations to maintain adequate moisture. Power plants store, transfer, and use coal; therefore, careful handling is necessary to mitigate fire and explosion risks. Recommended measures to prevent minimise, and control fire hazards at proposed power plants include:

- Use of automated combustion and safety controls
- Proper maintenance of boiler safety controls
- Implementation of startup and shutdown procedures to minimise the risk of suspending hot coal particles (e.g., in the crusher) during startup
- Regular cleaning of the facility to prevent accumulation of coal dust (e.g., on floors, ledges, beams, and equipment)
- Removal of hot spots from the coal stockpile (caused by spontaneous combustion) and spread until cooled, avoid loading of hot coal into the pulverised fuel system
- Use of automated systems such as temperature gauges or carbon monoxide sensors to survey solid fuel storage areas to detect fires caused by self-ignition and to identify risk points
- For planned outages, operators should take every precaution to ensure that all idle bunkers and silos are completely empty and also verify by visual checks. Bunkers and silos should be thoroughly cleaned by washing down their interior walls and any interior structural members but not their horizontal surfaces. Idle bunkers and silos that contain coal/lignite should be monitored frequently for signs of spontaneous combustion by using CO monitors, infrared scanning, or temperature scanning.
- Fire fighting systems and fire hydrant systems shall be installed at all hazard prone areas such as coal stock yards, bunkers and silos as per the applicable fire safety standards

Risk Mitigation Measures for Storage of Chlorine Tonners

Chlorine Hazards and Consequence Modelling

Chlorine to the tune of 1 to 2 ppm will be dosed into the cooling water circulation line to avoid biofouling in the system. Considering about 25000 m^3/hr of water in circulation in the cooling tower, the maximum Chlorine consumption will be in the order of 1500 Kg/day. About 10 chlorine ton-containers (900 Kg each) will be stored a dedicated isolated and closed room near the cooling tower area. Chlorine tonners will be stored as per the BIS code IS: 4263-1967 (Code of Safety for Chlorine).

Chlorine is soluble in alkalis and only slightly soluble in water, approximately one (1%) percent at 9.4°C. Above this its solubility decreases with rise in temperature up to the boiling point of water at which it is completely insoluble. Neither liquid nor gaseous chlorine is explosive or flammable, but both react readily with many organic substances, usually with the evolution of heat and, in some cases, resulting in explosion. Chlorine gas is extremely irritating to the mucous membranes, the eyes and the respiratory tract. If the duration of exposure or the concentration of chlorine-is excessive, it will cause restlessness, throat irritation, sneezing and copious salivation. In extreme cases, lung tissues may be attacked resulting in pulmonary edema. Inhale lowest published toxic concentration TC_{L0} is 15 ppm and Inhale lowest published lethal concentration is 430 ppm. The physiological effects of various concentrations of chlorine gas are shown in **Table 2**.

Among HAZMAT releases accidents, a small amount of release, i.e. 1to 10 kg/min release, took up 38 percent of the total number of chlorine release accidents. Accidental releases of Chlorine will be subjected to dispersion and will be diluted several folds from the release location. The gases having higher density than air (Such as Chlorine) and other factors like low temperature, fine liquid droplets in the gas cloud make the clouds slump under gravity. The gas cloud moves along the direction of wind and becomes passive as the density of the cloud approaches ambient density. In the passive phase, dispersion is greatly affected by wind velocity and the stability of the weather condition. In the consequence analysis, use is made of a number of calculation models to estimate the physical effects of an accident (spill of hazardous material) and to predict the damage (lethality) of the effects.

For the purpose of the dispersion modeling, it is assumed that Chlorine will be leaking from a 900 Kg tonner in a span of 30 minutes through the nozzle with a release rate of 0.5 Kg/sec. Ideally occurrence of such scenarios will be very remote due to installation of early warning systems such as Chlorine sensors near the storage area. Various emergency control measures as stated in IS Code for safety for Chlorine will be adopted. However for the purpose of this risk assessment study an hypothetical scenario of worst case release has been considered. Stability D (Neutral) with a wind velocity of 2 m/sec will become the critical condition for maximum ground level concentrations during the winter evenings and nights. The Chlorine has release is modeled using Gaussian dispersion equations (non buoyant source) and the concentration Chlorine at the end of first one hour has been presented in **Figure 2**.

It can be noted that the maximum GLCs of 860 mg/m^3 is identified at 100m from the Chlorine tonner storage areas towards south east direction. At the facility boundary the GLC will be in the order of 20 mg/m^3. At the nearest village (downwind of the plant – South eastern direction is Village Kocharhi), which is located at about 1.5 Km from the Chlorine storage area will be in the order of 10 mg/m^3 to12 mg/m^3. Since the release of the emissions is instantaneous and the leaks will be identified and controlled within 30 minutes as per the guidelines of the Chlorine Institute, USA, the emissions will be ceased immediately. Hence the GLCs will be drastically reduced to less than 0.5 mg/m^3 within a span of four to five hours.

Table 2 Effect of Chlorine at Various Concentrations

Effects	**Concentration of Chlorine Gas in Air (ppm v/v)**	**Concentration of Chlorine Gas in Air (mg/m^3)**	**Estimated Distance of Impact due to release of Chlorine from a 900 kg tonner (m)**
Threshold of irritation	4	12	1500
Concentration causing immediate irritation of throat	15	46	530
Concentration causing cough (IDLH)[1]	30	93	360
Concentration dangerous for even short exposure	50	154	250

[1] *Immediately Dangerous to Life or Health Concentrations (IDLH) is based on the statement by International Labour Organization [1971] that exposure to 30 ppm will cause intense coughing fits, and exposure to 40 to 60 ppm for 30 to 60 minutes or more may cause serious damage*

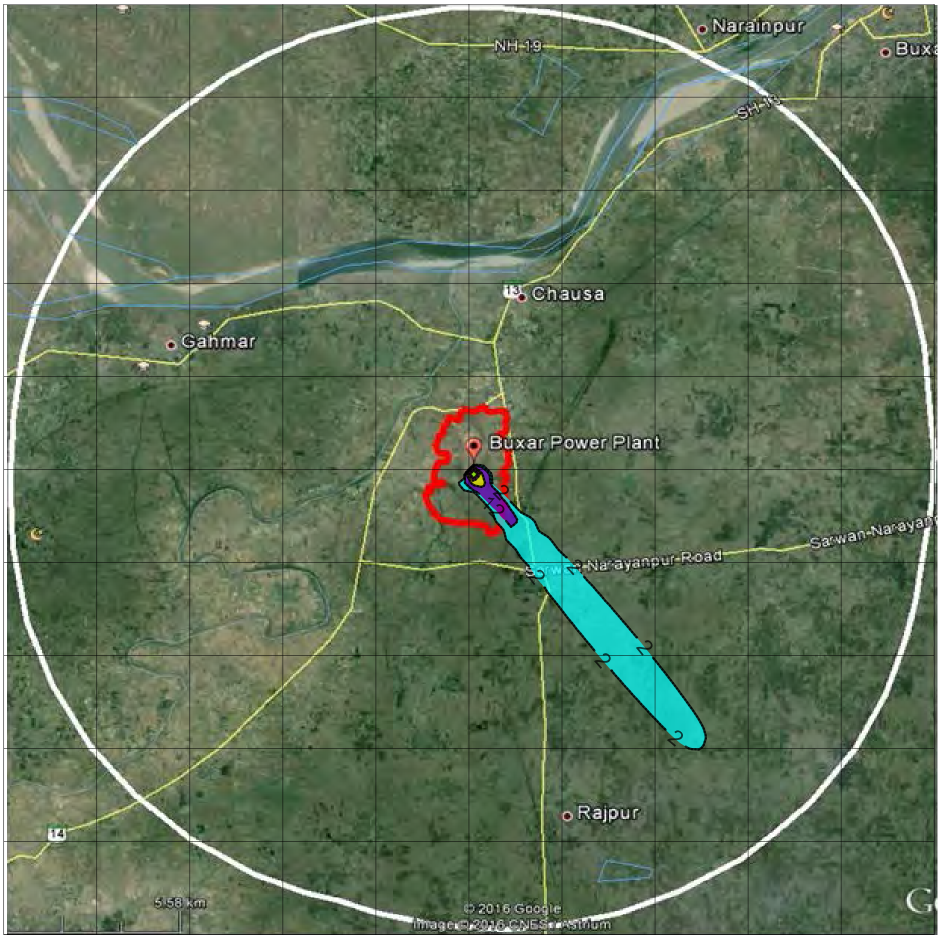

Figure 2: Dispersion Model of Chlorine Release from 900 Kg Tonner

Chlorine Safety procedures as per IS Code 4263-1967

- Cylinders (tonners) should be stored in an upright position. They should be secured to prevent from falling over. Full and empty cylinders should not be stored together. Ton containers should be stored on their sides. They should not be stacked or racked more than one high.
- Storage areas should be remote from, elevators gangways or ventilating systems.
- The storage area should be separate from that in. which other compressed gas containers are stored.
- The storage area should be dry, well-ventilated, clean of trash, and protected from external heat sources (steam pipes, etc). Sub-surface areas should be avoided for storing chlorine cylinders.

- The valves on cylinders and ton containers should be protected by a stout metal cap securely attached to the cylinder body. This cap should always be kept in place on all containers in storage and at all times except during evacuation of chlorine.
- Cylinders should never be lifted by means of the metal cap, nor should rope slings, chains or magnetic devices be used. Unloading platforms should preferably be at truck or car-bed level. The ton container should be handled with a suitable cradle with chain slings in combination with a hoist or crane having at least 2 metric tonnes capacity.
- Cylinders and ton containers being trucked should be carefully checked, clamped, or otherwise suitably supported to prevent shifting and rolling. They should not be permitted to drop, and no object should be allowed to strike them with force. They should not project beyond the sides or ends of the vehicles in which they are transported.
- If the gas discharge rate from a single container will not meet demand requirements, two or more may be connected to a manifold and discharged simultaneously, or a vaporizer may be used. When discharging through a manifold, care shall be taken that all containers are at the same temperature, particularly when connecting a new container to the manifold. If there is a difference in the temperature of the liquid chlorine, it will be transferred by distillation from the warm to the cool container, and the cooler container may become completely filled with liquid. If this should occur and the container valve remains closed, hydrostatic pressure may cause bursting. For this reason, extra precautions shall be observed when closing valves of containers connected to a manifold. Connection of cylinders or ton containers discharging liquid chlorine to a manifold is not recommended.
- A flexible connection between the container and the piping should be used; annealed copper tubing (9.5 mm outside diameter × 0.889 mm wall), suitable for 35.2 kg/cm2 service is recommended. A clamp and adapter connector is preferred; if a union connector is used, the threads on the connector shall match the valve outlet thread. (Valve outlet threads are straight threads, not standard taper pipe threads.) A new gasket (lead) should be used when making a connection.
- A suitable gas mask should be available to every employee involved with chlorine handling. Respiratory protective equipment should be carefully maintained and kept in clean, dry, light-proof cabinets properly protected by paraffined paper or polyethylene bags. No person wearing a respirator should enter a chlorine

contaminated area unless attended to by an observer who can rescue him in the event of respirator failure or other emergencies.

- Water shall never be used on a chlorine leak as it always makes the leak worse due to the corrosive effect. In addition, heat supplied by even the coldest water to a leaking container causes liquid chlorine to evaporate faster. A leaking container shall not be immersed or thrown into a body of water as the leak will be aggravated due to the corrosive effect and the container may float when partially full, allowing gas evolution and dispersion at the surface.
- Equipment and Piping Leaks—If a leak occurs in equipment in which chlorine is being used, the supply of chlorine shall be shut off and chlorine which is under pressure at the leak shall be disposed off safely. Leaks around valve stems usually may be stopped by tightening the packing nut or gland. If this does not stop the leak, the container valve shall be closed and the chlorine, which is under pressure in the outlet piping, shall, be disposed off. If a container valve does not shut off tight, the outlet cap or plug should be applied. In case of a valve leak on a ton-container, the container shall be rolled so that the valves are in a vertical plane with the leaking valve on top; this is important.
- As a regular part of chlorine storage and use, provisions shall be made for emergency disposal of chlorine from leaking cylinders or ton-containers. Chlorine may be absorbed in solutions of caustic soda or soda ash, or in agitated hydrated-lime slurries. Caustic soda is recommended as it absorbs chlorine more readily.
- A suitable tank to hold the solution should be provided in a convenient location. Chlorine gas should be passed into, the solution through an iron pipe or rubber hose properly weighted to hold it under the surface; the container should not be immersed.
- The proportions of alkali and water recommended for this purpose are given below.

Chlorine Container Capacity	**Caustic Soda and Water**		**Soda Ash and Water**		**Hydrated Lime and Water**	
kg	**Weight (kg)**	**Volume (L)**	**Weight (kg)**	**Volume (L)**	**Weight (kg)**	**Volume (L)**
45	58	182	136	450	58	566
68	90	270	220	680	82	815
900	1 160	3 680	2 720	9 050	1 160	11 50

5. Occupational Safety Management and Surveillance Program

The Ministry of Labour and Employment, Government of India has a nodal organization viz. Directorate General Factory Advice Service and Labour Institutes (DGFASLI) in dealing with Occupational Safety and Health issues in Industries. The Directorate General Factory Advice Service and Labour Institutes (DGFASLI) is the technical arm of the Ministry on matters connected with Occupational Health in the manufacturing and port sectors.

The Factories Act, 1948 provides for appointment of qualified Medical Practitioners and Certifying Surgeons to examine young persons engaged in dangerous manufacturing processes and to ensure medical supervision in case of illness due to the nature of manufacturing processes. The Factories Act, 1948 also provides for notification of certain occupational diseases as listed in the Third Schedule of the Act. As per Section 90 of the Factories Act, 1948, the State Govt. is vested with the powers to appoint a Competent Person to conduct inquiry into the causes of any accident or notifiable diseases.

The following measures needs to be implemented in the work places to enhance occupational health:

- Identify and involve workers in assessing workplace risks,
- Assess and consider employees' needs when planning and organising work,
- Provide advice, information and training to employees, as well as mechanisms for employee feedback such as a suggestion scheme,
- Occupational health surveillance and Occupational health audit, To develop a system of creating up to date data base on mortality, and morbidity due to Occupational diseases and use it for performance monitoring of the same and
- Extending support to the state government for effective enforcement of the health provisions stipulated under section 41F of the Factory Act by equipping them with work environment monitoring technologies

The occupational health safety system should be headed by a competent and qualified safety office that will be supported by a team of safety volunteers from each plant and department within the facility. The safety team will take up a detailed task based risk assessment studies and will develop task based safety procedures and work permit systems. The safety team should record the near misses in the plant and take necessary corrective action to minimize the occupational risks.

A dedicated occupational health centre shall be developed consisting the following facilities:

1. A full time doctor may be appointed to monitor the day-to-day occupational health aspects and also to provide medical advice to the workers, employees and residents of the colony,
2. Minimum facilities such as oxygen cylinder for emergency medical use, two bed clean room for first aid applications, first aid kits as per the Factories act,
3. ECG and X-ray facilities, (4). Peak Expiratory flow Meter to check the lung function.
4. As a part of the surveillance program, the following minimum medical expansion may be undertaken during the pre-employment phase: 1. General physical examination and blood pressure, 2. X-Ray of chest & ECG, 3. Sputum examination, 4. Detailed routine blood & urine examination, 5. Audiometry and 5. Spirometry.
5. As part of the routine and annual medical examinations on the persons working in the high noise generating areas, stress areas and dust exposure areas, a comprehensive surveillance program may be adopted. Some of the good management practices are suggested in Table 4 and 5.
6. Medical records - A record-keeping system for holding results of medical examinations and reports of symptoms will be needed as part of the health surveillance scheme. These are confidential medical records relating to individuals. As part of the health surveillance programme, workers should be informed of the confidential results of each assessment and of any implications of the findings, such as the likely effects of their continuing to work with vibration.

Table 3 Suggested Frequency of Medical Examination under Occupational Health Surveillance Program

Age (yrs)	Periodicity	Duration of Exposure	Periodicity
< 30 yrs	Once in five years	< 10 yrs	Once in five years
31-40	Once in four years	10 to 20	Once in four years
41-50	Once in three years	21-30	Once in three years
> 51	Once a year	> 31	Once a year

Table 4 Suggested Medical Tests under Occupational Health Surveillance Program

S.No	Disorder	Tests to be conducted
1	Heart Diseases	ECG, Blood for Lipid Profile, Stress Test, 2D-Echo and other

		required Tests
2	Anemia	Hb%, TC,DC, ESR & Stool for Occult Blood, Ova and Cyst
2	Lung Diseases	Sputum, X-Ray Chest, Spirometery
4	Diabetes	Random Blood sugar, Urine sugar, if positive, BSL-Fasting/PPBS diabetic profile
5	Hypertension	Blood Pressure reading, If required Renal profile + ECG and stress test.
6	Urine Examination	Routine and Microscopic

6. Fire Protection and Fire Fighting Systems

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:

    1. Multi-sensor type smoke detection system
    2. Photo electric type smoke detection system.
    3. Combination of both multi-sensor type and photo electric type smoke detection systems.
    4. Linear heat sensing cable detector.
    5. Quartzoid bulb heat detection system.
    6. 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.