CHAPTER 6
ADDITIONAL STUDIES

RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

6.0 Introduction

It is imperative to conduct risk analysis for all the projects where hazardous materials, either as raw material or the product are handled. The risk assessment is carried out here as a few hazardous materials will be handled in the cement plant of M/s Valley Strong Cement.

The following have been addressed as part of the risk analysis.

- Introduction
- Hazard Identification and Risk Analysis
- Risk Reducing Measures

The Introduction deals with the objective and methodology of carrying out the risk analysis.

Hazard Identification and Risk Analysis discusses about the various types of hazards associated with the operation of the Plant due to process, storage & handling, human errors, electric failures and natural calamities. It also presents the calculated frequencies of occurrence of different accident scenarios for the identified potential hazard occurrence in the plant and the details of consequence modeling/ analysis for the identified potential accidents/disaster scenarios in the plant.

Risk Reducing Measures based on the calculated frequencies and consequences.

6.1 Objective

The principal objective of the study is to identify the potential hazards from the proposed facility and estimate the effects of the hazards on people and property within the vicinity of the plant premises.

The consequences resulting due to accidental release of toxic & flammable gases and leakage of fuels, will provide data for developing strategies to prevent accidents right

from design to operational phase. This will also generate information for formulating a meaningful Disaster Management Plan (DMP).

A risk analysis is defined as an assessment of the likelihood of a release of HAZMAT (hazardous materials) and the consequences that may result, based on information gathered during the hazard identification and vulnerability analyses. Risk analysis requires evaluation of existing base and local community plans, response capabilities, and previous incidents.

In order to determine the risk factor at each facility as the base, the following information was evaluated:

- Procedures for storing, handling, shipping, and transferring of HAZMAT;
- Facility information including: physical features and location of storm and sanitary sewer systems;
- Site measures for managing and controlling HAZMAT releases; and,
- Base emergency response and preparedness programs.

6.2 Methodology

The Risk Analysis Study carried out under the following task heads:

System Study

The system description covers the plant description, storage & handling of fuels / chemicals, etc.

Hazard Identification

The hazards associated with the proposed Cement Plant have been discussed in terms of material & process hazards.

Frequency of Hazard Occurrence

Based on the available international statistics and in-house risk database, the frequencies of occurrence for the different accident scenarios were determined. The frequencies derived from the historical database have been checked with the possible hazard scenario identified during hazard identification.

Consequence Analysis

Based on the identified hazards, accident scenarios and the frequency of occurrence, consequence modelling was carried out for calculating the spreading distances (zone of influence) or risk distance for Pool fires and Explosions etc.

Risk Reducing Measures

Necessary risk reducing measures have been suggested based on the consequence scenarios.

6.3 Hazard Identification and Risk Analysis

The main hazard potentials in the proposed Cement Plant Facility are categorized as below:

- **Material hazards;** High Speed Diesel (HSD), Light Diesel Oil (LDO), as an auxiliary fuel for start-up and flame stabilization, and coal as raw materials used in the proposed Cement Plant .
- **Process hazards** due to loss of containment during handling of hazardous materials or processes resulting in fire, explosion, bursting of cyclones due to high pressure in the pre-heater circuit, etc
- **Mechanical hazards** due to "mechanical" operations such as welding, maintenance, falling objects etc. - basically those NOT connected to hazardous materials.
- **Electrical hazards:** electrocution, high voltage levels, short circuit, etc.

Out of these, the material and process hazards are the one with a much wider damage potential as compared to the mechanical and electrical hazards, which are by and large limited to very small local pockets.

6.3.1 Material Hazards

High Speed Diesel (HSD), used as an auxiliary fuel, which is inflammable. In addition to that, the raw material used in Cement plant is Coal.

Table 6.1: Proposed Storage Facilities

Fuel Tank	No. of tanks	Capacity KL	Diameter in m
High Speed Diesel (HSD)	1	2 KL	ϕ 3

Some of the important properties indicating the hazardous nature of the chemicals are given below.

Table 6.2: Properties of Raw Materials and Product

Chemical	Flash point °C	Auto Ignition °C	Flammability		Boiling point °C	TLV ppm	NFPA		
			LFL%	UFL%			Nf	Nh	Nr
High Speed Diesel (HSD)	32	-	1.1	5.9	366	Not listed	2	0	0

* NFPA: National Fire Protection Association

6.3.2 Process Hazards

The likely process hazard shall be pressurization in pre-heater cyclones which may develop build ups due to deposition of raw material inside. The modern process of cement manufacture envisages introduction of low pressure cyclones.

6.3.3 Hazard Intensity Classification

The hazard intensities of the chemicals that are to be handled in the Plant (as per NFPA codes) are presented below.

Table 6.3: Hazardous Intensity

Health Hazard	Fire Hazard	Reactivity Hazard
4 Materials which on very short exposure could cause death or major injury, even with prompt medical attention.	4 Materials which will rapidly vaporize at atmospheric pressure and normal temperature, or which are readily dispersed in air and which will burn readily.	4 Materials which are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3 Materials which on short exposure could cause death or major injury even though prompt medical treatment is given.	3 Liquids and solids that can be ignited under almost all temperature conditions.	3 Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
2 Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.	2 Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	2 Materials which are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form explosive mixtures with water.
1 Materials which on exposure would cause irritation but only minor residual injury, even if no treatment is given.	1 Materials that must be preheated before ignition can occur.	1 Materials which are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.
0 Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.	0 Materials that will not burn.	0 Materials which are normally stable, even under fire exposure conditions, and which are not reactive with water.

6.3.4 FIRE AND EXPLOSION INDEX

Fire, Explosion and Toxicity Indexing is a rapid ranking method for identifying the degree of hazard. In preliminary hazard analysis, chemical storages are considered to have Toxic and Fire hazards. The application of FETI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information.

- Respective Material Factor (MF),
- General Hazard Factors (GHF)
- Special Process Hazard Factors (SPH)

are computed using standard procedure of awarding penalties based on storage handling and reaction parameters.

The application of FETI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information.

It can be used to classify separate elements of plant within an industrial complex. Before indexing is done, the plant is divided into plant elements. Depending upon the material in use, material factor is decided upon. A number of parameters, such as exothermic reactions, handling hazards, pressure of system, flash point, operating temperature, inventory of flammable material, corrosive property, leakage of points and toxicity are taken into consideration in determining a plant/ equipment /operation hazard. A standard method of awarding penalties and comparing the indices is used. However, this method does not give absolute status of the equipment or section. But it can comparatively identify hazards among others.

The DOW Fire and Explosion Index is a measure of how hazardous the process is

Table 6.4: Fire & Explosion Index

Degree of Hazard	Fire and Explosion Index
Light	0-60
Moderate	61-96
Intermediate	97-127
Heavy	128-158
Severe	>159

Dow Indexing is a process based on indexing of hazards.

The risk categories can be expressed in terms of the Risk Index.

Table 6.5: Risk Index

Category	Risk Index
Acceptable Region	< 0
Low Risk	0
Moderate Risk	0.67
Significant Risk	1.33
High Risk	2
Unacceptable Region	> 2

Table 6.6: PHYSIOLOGICAL EFFECTS OF THRESHOLD THERMAL DOSES

THRESHOLD DOSE (kj/m^2)	**EFFECT**
375	3rd degree burn
250	2nd degree burn
125	1st degree burn
65	Threshold of pain, no reddening or blistering of skin caused

Note:

- 1st degree burn- Involves only epidermis. Example sunburn. Blisters may occur.
- 2nd degree burn- Involves whole of epidermis over the area of burn plus some portion of dermis area.
- 3rd degree burn- Involves whole of epidermis and dermis. Sub cutaneous tissues may also be affected.

Table 6.7: DAMAGE DUE TO INCIDENT RADIATON INTENSITY

Incident Radiation Intensity (KW/m^2)	**Type of Damage**
62.0	Spontaneous ignition of wood and sufficient to cause damage to process equipment.
37.5	Minimum energy required igniting wood at infinite long exposure (non piloted).
32.0	Maximum flux level for thermally protected tanks
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
8.0	Maximum heat flux for un-insulated tanks.
4.5	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds. However blistering of skin (1st degree burns) is likely.
1.6	Will cause no discomfort to long exposure.
0.7	Equivalent to solar radiation.

HEAT RADIATION HAZARDS DUE TO STORAGE OF HSD

Heat Radiation intensity (KW/m^2)	Distance (m)
37.5	1
32	1
25	1
12.5	2
9.5	2
4.5	3
1.6	5
0.7	7

6.3.5 Conclusions and Principal Recommendations

HSD as Fuels

- The firewater cooling system and Foam facilities are proposed to provide with Foam system as per OISD-117 [Oil Industry Safety Directorate] for fuel storage tanks.
- It is proposed and suggested that the adjacent tanks shall thermally be protected by firewater and foam system for fuel tanks.
- The storage tanks are to be provided with fixed foam conveying system with foam pourers and all around fire fighting facilities with hydrants and foam cum water monitors as per OISD-117 norms. This enables tank cooling in case of fire. It is therefore, important that cooling of the adjoining product storage tanks is done, promptly, in case of tank fire on any of the product storage tanks. It is also important to cool the storage tank so that tank shell does not give away. The above provisions for safety are adequate.

These risks must be controlled by the development of a safe system of work, which can be defined as the set of controls necessary to minimize the risks associated with the work.

Furthermore, it is recommended that additional measures for safety be taken.

These measures include inspecting all other piping and appurtenances for damage and corrosion to prevent the unexpected leakage of HSD, LDO and Petrol establishing an Emergency Plan, Employee Emergency Plans and Fire Prevention Plans."

Recommendations:

- Store in tightly closed containers in a cool, well-ventilated area away from WATER, HEAT, COMBUSTIBLES (such as WOOD, PAPER and OIL) and LIGHT.
- Store away from incompatible materials such as flammable materials, oxidizing materials, reducing materials, strong bases.
- Use corrosion-resistant structural materials and lighting and ventilation systems in the storage area.
- Wood and other organic/combustible materials should not be used on floors, structural materials and ventilation systems in the storage area.
- Use airtight containers, kept well sealed, securely labeled and protected From damage.
- Use suitable, approved storage cabinets, tanks, rooms and buildings.
- Suitable storage may include glass bottles and carboys.
- Storage tanks should be above ground and surrounded with dikes capable of holding entire contents.
- Limit quantity of material in storage. Restrict access to storage area.
- Post warning signs when appropriate. Keep storage area separate from populated work areas. Inspect periodically for deficiencies such as damage or leaks.
- Have appropriate fire extinguishers available in and near the storage area.

The following measures are suggested for reducing the risk involved in pipeline systems.

Preventive Maintenance:

Routine inspection of equipment/facilities at the unit.

Instruments:

All the instruments like pressure, temperature transmitters/gauges and alarms switches and safety interlocks should be tested for their intended application as per the preventive maintenance schedule. Similarly, the emergency shutdown system should be tested as per the preventive maintenance schedule.

6.4 Risk Mitigation Measures

The materials handled at the proposed installation are inflammable and reactive substances and based on the consequence analysis; the following measures are suggested as risk mitigation measures.

- The storage area, process area as well as road tankers loading/unloading areas where there is maximum possibility of presence of flammable hydrocarbons in large quantities, it should be ensured that combustible materials are not placed here such as oil filled cloth, wooden supports, oil buckets etc. to reduce the probability of secondary fires in case of release.
- Hydrocarbon, smoke and fire detectors should be suitably located and linked to fire fighting system to reduce the response time and ensure safe dispersal of vapours before ignition can occur.
- Tank fires result in little damage at ground levels. Damage at tank height is such as to damage adjacent tanks. Hence tank cooling provisions, particularly upper sections of the tank must be ensured to prevent explosion. Foam for arresting roof fires must be started immediately.
- Pool fires resulting from tanker/pump/pipeline leakage are dangerous since the liquid pool becomes unconfined. Training in fire fighting, escape action, operation of emergency switches etc. is vital.
- Pump loading line failures have also a possibility of causing major damage. Strict inspection, maintenance and operation procedures are essential for preventing escalation of such incidents.
- Emergency procedures should be well rehearsed and state of readiness to be achieved.

6.5 DISASTER MANAGEMENT PLAN

6.5.1 GENERAL

A major emergency in a plant is one, which has the potential to cause serious injury or loss of life. It may cause extensive damage to property and serious disruption both inside and outside the plant. Sometimes, it would require the assistance of outside agencies.

Emergency may be caused by a number of different factors, e.g. plant failure, and it will normally manifest itself in three basic forms, viz fire, explosion or toxic release.

6.5.2 Definition of Disaster

A Disaster is called when following one or the other or more incidents occur

i. Risk of loss of human lives-ten or more in one single situation
ii. A situation which goes beyond the control of available resource of the plant
iii. Loss of property as a consequence of the incident is over Rs. 1 Crore and/or bears a potential to the above

iv. A situation apparently may not have much loss but its long-term severity can affect loss of life, production and property.

Disaster occurs due to

i). Emergencies on account of:

- Fire
- Explosion
- Spillage of toxic chemicals
- Electrocution

ii) Natural calamity on account of:

- Flood
- Earth quake / Cyclone / Storm / Cloud burst / Lightning

iii). External factor on account of

- Food poisoning
- Sabotage

Objectives:

- To identify type of major disaster that may occur in the proposed cement plant.
- To collect data on type of disasters, which has happened already in similar plants
- To prepare an action plan to handle disaster.

6.5.3 Identification and Assessment of Hazards

This stage is crucial to both on site and off site emergency planning and requires to systematically identifying what emergencies could arise in the plant. These should range from small events, which can be dealt with by plant personnel without outside help to the largest event for which it is practical to have a plan. Experience has shown that for every occasion that the full potential of an accident is realized, there are many occasions when some freak event occurs or when a developing incident is made safe before reaching full potential.

Most major hazards or accidents in a cement plant fall within the following categories:

- Handling of coal
- Passage of gases within pre-heater cyclones
- Handling of fine dust
- Handling of hot clinker
- Handling of cement
- Packing areas

The assessment of possible incidents in respect of the above should produce a report indicating

- The worst events considered
- The route to those worst events
- The time scale to lesser events along the way
- The size of lesser events if their development is halted
- The relative likelihood of events
- The consequences of each events

6.5.4 Disaster Preventive Measures

It is not easy to control any disaster if contingency plans are not available. For effective control of disaster adequate manpower, technical know- how, alertness and internal help are the prime requirements. It is always better to take preventive measures to avoid any disaster. In the proposed plant following prevention measures will be taken to prevent disaster:

i) Design, manufacture and construction of all plant and machinery's and buildings will be as per national and international codes as applicable in specific cases and laid down by the appropriate statutory authorities.

ii) Provision of adequate access ways / walk ways for the movement of equipment and personnel are kept.

iii) Minimum two numbers of routes for escape during disaster are provided and a separate escape route plan is in place.

6.5.5 GUIDELINES FOR DMP

6.5.5.1 Formulation of DMP and Emergency Services

M/s VSCL shall formulate a Disaster Management Plan for better and safe management of the cement plant. The DMP is related to the final assessment and it is the responsibility of the plant management document including the following elements.

- Assessment of the size and nature of the events foreseen and the probability of their occurrence.
- Formulation of the plan and liaison with authorities, including the emergency services.
- Procedures for raising the alarm and communications both within and outside the works.
- Appointment of key personnel and their duties and responsibilities, especially for works incident controller and works main controller.

- Emergency control center
- Action on-site
- Action off-site

The plan is prepared to set out the way in which designated people at the site of the incident can initiate supplementary action either inside or outside the works at an appropriate time. An essential element of the plan must be the provision for attempting to make safe the affected unit, for example by shutting it down. On a complex site, the plan includes the full sequence of key personnel to be called in from other sections or from off site.

The following management systems at various stages of manufacturing of cement will be followed:

- **Handling of coal**

The coal at the cement plant is received through trucks and is stored in stock yard. The possible hazards are envisaged due to failure of truck and slipping of truck during unloading.

During summer season, there is a chance of coal catching fire due to high temperatures. To handle this situation effective sprinkling systems will be provided all round the coal stockyards.

- **Handling of Hot clinker**

The hot clinker will be transported by chain conveyors to the top of the silo. During this operation, there is a possibility of spill out of hot clinker.

Proper care of the conveyor system and the bund wall for the clinker stockpile will be provided

- **Handling of cement**

Cement is the fine dust which requires proper care in handling, storage and packing to avoid any health hazards.

The company will provide a management system in cement plant to avoid / minimize the disasters as detailed below:

6.5.6 ALARM SYSTEMS

- On receiving the message of ‘Disaster’ from Disaster Controller, fire station control room attendant sounds SIREN Wailing TYPE FOR 5 MINUTES.
- On receiving the message of “Emergency Over” from Emergency controller the fire station control room attendant gives All Clear Signal by sounding siren straight for two minutes.

- The feature of the alarm system is explained to one and all to avoid panic or misunderstanding during disaster.

Action to be taken on hearing the warning signal

On receiving the message of "Disaster" the following action takes place.

- All the coordinator should report to the Disaster Control Room, even if, not contacted by the cell
- The commanding officer and sub-commanding officer report to the place of the accident
- The process unit persons remain ready in their respective units for crash shut down on the instruction from the co-ordinator
- The person from other selection reports to the respective officer
- The concerned section (Civil Engineering services, Mechanical project etc) take immediate action to remove contractors personnel outside the plant gate
- The resident of action of the township will remain alert

6.5.7 APPOINTMENT OF PERSONNEL AND DEFINTION OF DUTIES

6.5.7.1 Functions of Health Safety and Environment Officer

- To declare " Disaster Emergency " after consulting the Sr. Officer available and inform Fire Station Control Room to sound the sirens accordingly and arrange to convey the message in public address system
- To report to DCD immediately
- To receive message from the Central Control Room
- To take decision in consultation with the commanding Officer of different services and convey them to the disaster point
- To be responsible for planning and provision of assistance from township and from local authorities
- To keep decision of the Disaster Controller on any matter to meet the objective of disaster control plan will be final

6.5.7.2 Function of Officer In–charge:

Disaster Controller will entrust this officer whose functions are to be as follows:

- To be responsible for the operation of DCD and for the dispatch of messages.
- To decide on the priority of dispatch of messages.
- To keep liaison with all activities and give up to date and accurate appreciation of the situation.
- To be responsible for the efficient organization of the Disaster Control Room.

6.5.7.3 Functions of Disaster / Emergency controller of Various Services:

The commanding officers of the various services and their functions are:

- To report to the control post immediately on hearing “Disaster Siren”.
- To report Disaster Controller posted with the up-to dated information regarding manpower and material available concerning their respective services.
- To advise Disaster Controller on all matters arising out of disaster.
- To assist Disaster Controller for provision of material and man power concerning his services.
- To convey message to his services team through communication centre after consulting Disaster Controller.
- To consult between them selves on matters related to more than one services and to decide on the action to be taken.

6.5.7.4 Casualty Services

The commanding officer of casualty services will be medical officer.

a. Functions:

- First services by first-aid parties on the spot.
- Ambulance services for transport of casualties from the spot to the township hospital and from township hospital to outside, if required.

b. Procedure for Treatment

On getting a signal from the Disaster Control Desk or information on telephone or hearing siren, the sub- commanding officer of the casualty services will report to the clinic and doctors on call duty and first aid personnel will report to disaster control room. The Ambulance with driver will report to the Disaster Control Room. First aid parties will render first aid to casualties at the place of occurrence and those requiring further treatment would be transported to the nearest hospital by ambulance.

In case of extra help from outside or within Company medical officer would contact Co-coordinator (Planning) for help in areas such as:

- Extra medical helps from neighboring hospital or main hospital.
- Evacuating the casualties.
- Essential assistance in first aid.

c. First Aid

It is necessary to give first aid to the persons injured in the disaster. There are two first aid posts to meet the workload, one post is near the Disaster Control Room and the

other post is in the township hospital. At each post, first-aid parties shall be kept in rotating shifts of 8 hours.

d. Rescue Services

The responsibility of effective working Rescue and Repair services are with Co-ordinator (Services) and Sub-emergency controlling officer.

e. Repair Services

- To take up quick repairs of the damaged machinery
- To take up repair of damaged building roads and culverts.
- To maintain essential public utility services viz. water, electricity and sewages system.

f. Fire Fighting Services

Fire officer will be the commanding officer of the fire fighting services. Additional strength for fire fighting which is beyond the control of the station will come from security and maintenance personnel and if required from outside fire stations.

g. Functions

- To co-ordinate fire fighting activities.
- To enforced all regulations for prevention of fire
- To request neighboring industries and District Authority for rendering services of their fire fighting crew under mutual aid schemes, if necessary.

h. Traffic Control

The free movement of the fire vehicle and ambulance at the scene of fire / emergency is very important and therefore, the security personnel on the duty ensures that all the roads at the scene of fire /emergency are kept clear and free from obstruction. Persons arriving by motor transport at the scene of fire / emergency are not allowed to park their vehicle within 100 meters of fire, near fire hydrants, at road junction and at access roads. The ignition key should be left in the vehicles.

i. Supply Services.

A senior person heads supply services from stores department.

j. Functions:

- Responsible for planning, organizing and procuring necessary Equipment/ material.
- Responsible for storage of equipment / materials at accessible location and for quick distribution on demand.
- Obtain the requirement of equipments / materials from commanding officers of various services for their respective services.
- Co-ordinator with commanding officer of Depot and Transport services for transport required for distributing of equipments / materials in consultation with DCR.

k. Salvage service

The salvage services are under charge of a group under guidance of emergency control officer.

l. Welfare Services

Management of plant is having a senior manager who acts as the Commanding Officer of all support services. Vacant building will be used for housing those injured. For this purpose necessary material will be brought from near by market also if situation warrants.

m. Security Services

Chief security officer acts as central officer for securities services.

n. Functions:

- Security services are primarily responsible for the security of the plant.
- Emergency Controller in consultation with co-ordinator (external services) will keep a close liaison with local police and district authorities.
- Controls the vehicular traffic inside the plant.
- Assists fire fighting services in fighting fire.
- Assists in transporting injured people.
- Assists local police in patrolling in township and work out adequate arrangement for protection of property.

One jeep and motorcycle are always kept as reserve to cope up with emergency demand and for any further aggravate disaster.

o. Functions

To shut down the unit (s) affected and which may cause further disaster.

p. Public Relation Services

The officer–in–charge of public relation services looks after this job.

Function

- To consult Emergency controller before communication, if required with outside agencies.
- PRO acts as the official spokesman for the plant with outside agencies.
- PRO arranges for photography and filming of the whole disaster as photographer and filming of such incident are of immense value for the purpose of investigation, training and education.

q. CONTINGENCY PLANS

The following plan shall be followed.

Fire and Explosion

- Plant fire fighting is activated
- Disaster Controller along with Commanding Officer takes overall charges of the situation
- Emergency controller assesses the situation for possible after effect of the fire in the plant and the surrounding areas likely to get affected
- Emergency controller Informs local authority to send fire tenders if required
- Emergency controller Informs the people of likely affected area through communication system to leave the area and move to other area earmarked, if necessary
- Controls the traffic and law and order
- Arranges medical aid and for the affected people
- Emergency controller arranges inspection of affected area to get the first hand knowledge of damages occurred.