ENVIRONMENTAL IMPACT ASSESSMENT FOR RISK ASSESSMENT AND MANAGEMENT PLAN OF CEMENT

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1. ABSTRACT

Hazard analysis involves the identification and quantification of various hazards (unsafe conditions) that exist in the plant. On the other hand, risk analysis deals with the identification and quantification of risks, the plant equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant. Risk analysis follows an extensive hazard analysis. This include an identification and assessment of any risks, the affected populations are manage to safe as a result of hazards exposure. This needs a thorough experience of failure possibility, credible accident scenario, vulnerability of populations etc. Most this type of informations are too difficult to assess or generate. Consequently, the risk analysis is often confined to maximum credible accident studies. In the sections below, the identification of various hazards, probable risks in the cement plant and power plant, maximum credible accident analysis and consequence analysis are advised which gives a broad assessment of risks includes the cement and captive power plant. Based on the risk estimation disaster management plan has also been prepared.

Keywords: *Hazard analysis, risk analysis, probable risks, accident analysis, disaster management etc.*

2. INTRODUCTION

Environmental Impact Assessment is most critical environmental policy instruments. It helped in the identification, evaluation and interpretation of any potential for negative impacts prior to decision making **(Clark and Canter, 1997; Partidario and Pinho, 2000; Kvaerner, *et.al.*, 2006)** Public hearing and related input, constitute integral parts of this evaluation. In Principle, the EIA should lead to the discarding of environmentally unacceptable action and the mitigations until an acceptable level is reached of the environmental effects of proposed activities **(Fischer and Davies, 1973; Fischer, 1974; Collison, 1980; Beanland and Duinker, 1983; Hyman, *et.al.*, 1988; Rathore, 1988; Sadler, 1996 & Morrison-Saunders, and Therivel,, 2006).**

Hazard Identification

For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals. Identification and quantification of hazards in plant is of primary significance in the risk analysis.

Disaster Management Plan (DMP)

Disaster Management Plan is essential for an Industry which requires lot of plan combine with various strategies which must be completed in a specific short time and in pre-set sequence to complete effectively and efficiently with any type of disaster, emergency or in accident with an objective to restore the loss of men, and kind of material, plant/machinery etc.

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

- Assessment of various types of expected disasters specifically on the different type of the industrial unit;
- Assessment of different groups, agencies and departments etc. necessary for management with a specific disaster effectively;
- Prepared - by intensive training - of different teams/groups within the unit to effective with a special disaster and keep them in readiness;
- Assessment of an early detection system for the disasters;
- Proper development of a specific reliable instant information/communication system; and
- Development organization and mobilization of all concerning departments/ organizations/ groups and agencies instantly when requires.

3. MATERIAL & METHOD

The hazard potential of oil and estimation of consequences in case of their accidental release during storage, transportation and handling has been identified and risk assessment has been carried out to quantity the extent of damage and suggests recommendation for safety improvement for the proposed facilities. Risk mitigation measures based on MCA (**Maximum Credible Accident**) analysis and engineering judgments are incorporated in order to improve overall system safety and mitigate the effects of major accidents. An effective disaster management plan to mitigate the risks involved has been prepared. This plan defines the responsibilities and resources available to respond to the different types of emergencies envisaged. Training exercises will be held to ensure that all personnel are familiar with their responsibilities and that communication links are functioning efficiently.

Assessment for the Study

Risk includes the presence or severity occurrence of some accidents includes of an event or frequency of events. The risk assessment study covers the following:

- Assessment of potential hazard areas;
- Assessment of representative failure cases;
- Assessement of the fruitful scenarios for fire (radiation thermal) and excess energy;
- Develop the all damage potential of the specific identified hazardous events and the specific impact zones from the accidental scenarios;
- Develop the overall specific suitability of the main site from minimization of hazard and disaster mitigation point on view;
- Develop specific ideas and view on the lowering of the worst accident possibilities; and
- Development of specific Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational Health and Safety plan.

Hazard Assessment and Evaluation

An assessment of suitable design to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities and safeguards.

Fire Explosion and Toxicity Index (FE&TI) Approach

The assessment of degree of hazard potential is prepared based on the mathematical value of F&EI as per the reported criteria given below:

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

Damage Criteria

The fuel storage and the supply pipelines may lead to fire and explosion hazards. The vapors of these fuels are supposed to toxic.

Fuel Storage

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

Risk Associated with Coal/Pet-coke Handling Plant - Dust Explosion

Coal and Coke dust when flow in air and ignited would explode. Coal/Pet-coke Crusher House and conveyor systems are most susceptible to this hazard. To be explosive, the dust mixture should have:

- Particles present in the air with minimum size (The size is 400 microns);

- Dust concentrations must be reasonably uniform; and
- Minimum explosive concentration for Coke dust (33% volatiles) is 50 grams/m^3.

Dust extraction failure and suppression systems may cause to abnormality and increase the density of coal dust to the limits of explosion. Sources of heat present is incandescent bulbs with the glasses of bulk head fittings missing, electric equipment and cables, friction, spontaneous combustion in accumulated dust.

In the system dust explosions may found without any warnings with highest explosion pressure upto 6.4 bar and another dangerous feature of dust explosions is that it sets off another secondary explosions after the presence of the initial explosion of dust. Many times, the successive explosions are more injurious than primary ones. The dust explosions are powerful enough to destroy specific structures, kill or injure concerned people and set dangerous fires likely to damage a high portion of the coke Handling Plant including collapse of its steel structure, which may cripple the life line of the power plant.

Radiation contours in case of failure of furnace oil storage tank

Emergency Planning For Disaster Due To Fire

Coal/Pet-coke storage, cable rooms, changeable unit, auxiliary unit, oil contained, coal/Pet-coke bunkers including all conveyor lines etc., within the site are the likely areas for which plan is outlined to deal with any eventuality of fire. Stores, workshop, canteen and administration building have also been included.

Classification of Fires

The various classes of fire, explanation of the classes of fire and method of fighting the different classes of fire are given in table.

Classes of fire

Class	Explanation	Method of Fire	Fire Fighting
A	Solid – Carbonaceous inflammable material	Fire involving wood, paper, coal, Pet-coke, cloth and other material	Water
B	Liquid	Fire involving oil, kerosene etc.	Foam or dry powder chemical extinguisher
C	Special	Electrical fire	DCP or CO_2 extinguisher
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4. RESULT & DISCUSSION

Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out to assess the hazards associated with storage and the processes of the cement plant. The potential risk areas in the plant are given in **Table 4.1 & 4.2**

Fire Damage

Fire damage are tabulated in **Table 4.3**

Effect of Thermal Radiation on Population

The radiation of 1.6 kW/m^2 represents the safe radiation intensity for human population even for long exposures. In case of pool fire of tank the safe distance i.e. distance of occurrence of 1.6 kW/m^2 is observed to be 124 m and falls within the plant boundary. **Table 4.4**

Table 4.1 Primary hazard analysis for process area & storage areas

Sr. No.	Blocks/Areas	Capacity/ Quantity	Hazards Identified
1	Coal Handling Plant including Bunker area	2X 10,000 tonnes	Fire and/or Dust Explosions
2	Boilers	2x85 TPH	Fire (mainly near oil burners), steam; Explosions, Fuel Explosions
3	Kiln	4500 TPD	Fires in - a) Lube Oil systems b) Cable galleries c) Short circuits in

Sr. No.	Blocks/Areas	Capacity/ Quantity	Hazards Identified
			i) Control Rooms ii) Switchgears
4	Power Transformers	Upto 600 MVA (200 MVA single phase units)	Explosion and fire.
5	Switch-yard Control Room	-	Fire in cable galleries and Switchgear/Control Room.

Table 4.2 Primary hazard analysis for the whole site

PHA Type	Particular of Plausible Hazard	Recommendation	Provision
Environ-mental factors	If there is any leakage and eventuality of source of ignition.	--	Electrical wiring cables & fittings are as per the standards specified. All motor starters are flame proof.
	Nature of chemical is Highly inflammable and this can causes fire hazard in the storage facility.	Fire protection objects are well-designed including dry power, protein foam, CO_2 extinguisher shall be provided.	Fire extinguisher of big and small size were provided in all fire hazard places. In addition to the above, fire hydrant network is also provided.

Table 4.3 Damage due to incident radiation intensities

Sr. No	Incident Radiation (kW/m^2)	Type of Damage Intensity	
		In People	In Equipment
1	37.5	100 percent lethality in 1 min. 1% lethality in 10 sec.	Process equipment damage
2	25.0	50% Lethality in 1 min. Significant injury in 10 sec.	Minimum energy required to ignite wood at indefinitely long exposure without a flame
3	19.0	--	Thermal radiation intensity are allowed maximum on unprotected thermally adjoining equipment
4	12.5	1% lethality in 1 min.	Minimum energy to ignite with a flame; melts plastic tubing
5	4.5	Duration is more than 20 sec., causes pain. Blistering is un-likely (First degree burns)	--
6	1.6	No discomfort causes on long exposures	--

Source: World Bank–Techniques for Industrial Hazards Assessing.

Table 4.4 Radiation exposure and lethality

Radiation Intensity (Unit kW/m^2)	Exposure Time (Unit seconds)	Lethality (Percentage)	Degree of Burns
1.60	–	0.00	No Discomfort even after long exposure
4.50	20	0.00	I^{st}
4.50	50	0.00	I^{st}
8.00	20	0.00	I^{st}
8.00	50	<1	III^{rd}
8.00	60	<1	III^{rd}
12.00	20	<1	II^{nd}

Radiation Intensity (Unit kW/m^2)	Exposure Time (Unit seconds)	Lethality (Percentage)	Degree of Burns
12.00	50	8	IIIrd
12.50	–	1	–
25.00	–	50	–
37.50	–	100	–

Need for a Fire struggle Group

A small amount of fire may cause into loss of various machines and conveyors and the damage by fire may be of the order of few 5.0 crores. This type of losses can be neglected by preventing and controlling of the fire instantly for which fire-fighting group prepared.

Fire struggle with Water

Adequate and authentic arrangement is needed for controlling the fire with water is given below.

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

Water Line Arrangement

Water lines shall be provided at coal/Pet-coke handling area along the conveyors and around the stockyards, transformers, oil tanks, coal/Pet-coke crusher house etc. Water lines shall also be provided around other infrastructures in the plant like administration building, canteen, stores and other plant equipment. The system shall be designed in conformity with the recommendations of the Tariff Advisory Committee (TAC) of Insurance Association of India. Also a reserve water level shall be maintained in the sump as per TAC requirements.

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

Fire struggle with Fire Extinguishers

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

Soda Acid Fire Extinguishers; CO_2 Extinguishers; Dry Powder Chemical Extinguishers; Foam Extinguishers; Fire buckets; and 50-mm spray hoses up to 150-m length. Appropriate types of fire extinguishers shall also be provided at conveyor drive heads, crusher house, control rooms, in machines like stacker and reclaimer, electrical yard, sub-station and other infrastructure facilities within the premises.

In the transformer yard, automatic fire detecting and quenching system shall be provided for each transformer. This system comes into operation whenever the temperature of surrounding air exceeds 80°C and spray water over the transformer to prevent spreading of fire and quench the same.

In order to stop fire in cable spale, all the power and control site of cables of FRLS type (Fire Resistant Low Smoke) must be used. In addition fire detecting and Fire Alarm Systems shall be installed in the cable galleries.

Specific Emergencies Anticipated

Fire consequences can be disastrous, since they include high quantities of fuel either stored or in dynamic inventory in pipe lines or in nearby areas. Toxic releases can affect persons working around. Primary hazard Analysis has given a indices for consequence estimation. Estimation can be made by using various pool fire, tank fire consequence calculations. During the study of Risk Assessment, the nature of damages are assessed and probability of repeat of such hazards are also drawn up.

Sucessive Emergency Preparedness Plan

The task for preparing the Off-Site Emergency Plan implement with the district collector, however the off-site plan prepared with the view and help of the local district authorities. The proposed plan will be based on the following guidelines. Off-site emergency plan implement on the on-site as emergency plan. When the consequences of an emergency situation has pass beyond the plant site, it becomes a off-site emergency. Off-site emergency is administrated by the the public administration. However, the factory management mostly provide the public administration management team with the technical information relating to the severity and probable consequences on the adjoining population.

The off-site plan in detail must be based on the events, which are most frequent, but other less likely events, which have severe consequence, will also be considered. Audient, which have very frequent consequences yet have a small chances of occurrence, shall also be considered during the assessement of the plan. However, the key character of a good off-site emergency plan is comparatively flexibile in its implementation to check the casualities other than those specially included in the preparation of the plan.

The specific roles of the various parties who is involve in the management of an off-site plan must prepare as per norm. Depending on local situation, the responsibility for the off-site plan must be either fluctuate with the works management or, with the local authority. Either way, the plan shall identify an emergency co-coordinating officer, who must take the overall management of the off-site plan. As with the on-site plan, an emergency control center shall be setup within which the emergency co-coordinating officer can operate.

Occupational Health and Safety

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

The industrial planner, therefore, has to prepare plan and take the concrete steps to normalise the impacts of the process of industrialization and to assure proper occupational health, safety including fire plans. All these related activities may be classified and assessed under formatiobn and erection, and operational management and maintenance. The proposed safety plan is given below:

Occupational Health

Occupational health requires attention both during preparation and erection, operation and maintenance phases within site. However, the various problem change both in magnitude and in variety of the above phases.

The occupational health related problems envisaged at appropriate stage can mainly be owing to constructional accident and site noise. To overcome these hazards, in addition to arrangements to minimize it within TLV's, personal protective equipment shall also be supplied to workers.

The various problem of occupational health, in the management of operation and maintenance is owing to noise hearing losses. Suitable personnel protective equipment shall be given to employees. The working personnel shall be given in the following appropriate personnel protective equipment.

Crash Helmets, Welders equipment for eye and face protection, Industrial Safety Helmet, Face shield with replacement acrylic vision, Zero power goggles having cut type filters on both sides with blue color glasses, Cylindrical type earplug, Leather apron, Safety belt/line man's safety belt, Aluminium made fiber glass fix proximity suit with hood and gloves, Ear muffs, Boiler suit, Canister Gas mask, Self contained breathing apparatus, Leather hand gloves, Asbestos hand gloves, Acid/Alkali proof rubberized hand gloves, Canvas cum leather hand gloves with leather palm, Electrically tested electrical resistance hand gloves, Industrial safety shoes with steel toe, Electrical safety shoes without steel toe and gum boots. Full fledge hospital facilities shall be made available round the clock for any type of casuality arising out of activity, if any. All working personnel shall be medically checked at least once or twice in each year and at the lost of his tenure of service.

Safety Plan

Safety plan must follow the things during construction and operation phases are of quite concern. The preparedness of site for the presence of repeatable disasters is known as emergency plan. The disaster in proposed plant is possible due to leakage of fuels, collapse of structures and fire/explosion etc.

Safety Organization

A qualified and experienced safety officer shall be appointed. The responsibilities of the safety officers include assessement of the hazardous conditions and unsafe activities of persons and advise on corrective actions, conduct safety audit, organize training programs for specific persons and provide professional expert advice on various problems related to the safety and health. Advise to follow and accountable to ensure obedience of Safety Rules/ Statutory Provisions. In the majority to employment of safety officer by power plant, every contractor, who employs more than 250 workers, must also employ one safety commondent to ensure safety of the concerned person, in accordance with the conditions of contract.

Safety Circle

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

Safety Training

A full-fledged training center shall be set up at the plant. Safety training must be provided by the Safety commondent with the help of team members associated with industry, Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labors shall also be provided safety training. To create safety awareness safety films shall be shown to workers and leaflets etc.

5. CONCLUSION

The hazard potential of leak detection operation (LDO) and estimation of consequences in case of their accidental release during storage, transportation and handling has been identified and risk assessment has been carried out to quantify the extent of damage and suggest recommendation for safety improvement for the facilities. Risk mitigation measures based on Maximum Credible Accident (MCA) analysis and engineering judgments are incorporated in order to improve overall system safety and mitigate the effects of major accidents. An effective Disaster Management Plan (DMP) to mitiogate the risks involved has been prepared. This plan defines the responsibilities and resources available to respond to the different types of emergencies envisaged. Training exercise will be held to ensure that all personnel are familiar with their responsibilities and that communication links are functioning effectively. **Barrett and Therivel (1991)** have suggested that an ideal EIA applies to all projects that have direct and indirect impacts on environment and gives optimum solution to the proposed project to reduce its impacts if possible, which led to decision making. **Thompson (1990)** evaluated 24 EIA methodologies (such as matrices and various types of checklists) in terms of how they addressed impact significance determination. Wide variations were noted, with none of the methodologies providing a comprehensive framework, along with instructions, for determining the significance of anticipated impacts.

6. REFERENCES

Clark, R., Canter. 1997, Environmental Policy and NEPA , Past , Present and Future Boca FL: St. Lucie Press.

Partidario, M., Pinho, P. 2000, Guia de apoio ao novo regime de Avaliação de Impacte Ambiental, Ministério do Ambiente e do Ordenamento do Território.

Kvaerner, J., Swensen, G., Erikstad, L. 2006, Assessing environmental vulnerability in EIA-The content and context of the vulnerability concept in an alternative approach to standard EIA procedure. Environmental impact assessment Review 26:511-527.

Fischer, D. W., Davies, G. S. 1973, An approach to assessing environmental impacts, Journal of Environmental Management, 1(1), pp. 207-227.

Fischer, D. W. 1974, "Environmental Impact Assessment an instrument of public policy for controlling economic growth". Intern. J. Environmental Studies, pp. 223-242.

Collison, I. 1980, Vertical distribution of foraminifera off the coast of Northumberland, England. J. Foramin. Res. 10, 75- 78.

Beanland, G. E., Duniker, P. N. 1983, "An ecological frame work for Environmental Impact Assessment in Canada". Institute for resources and Environmental studies Dahousie University, Halifax, Nova Scotia.

Hyman, E. L., Stiftel B., Moreau, D. H., Nichols, R. C. 1988, Combining facts and values in environmental impact assessment. Theories and techniques. Social impact assessment series, vol. 16. London: West view Press.

Rathore, C. S. 1988, "An ecosystem approach based model for Environmental Impact Assessment". Ph.D. thesis, A.P.S. University, Rewa (M.P.).

Sadler, B. 1996, Environmental assessment in a changing world: Evaluating practice to improve performance, Ottawa ON, Candian Environment Assessment Agency.

Morrison-Saunders, A., Therivel, R. 2006, Sustainability integration and assessment, Journal of Environmental Assessment Policy and Management, 2006. 8(3): p. 281-298.

Barrett, B. F. D., Therivel, R. 1991, Environmental policy and impact assessment in Japan, Rout-ledge,Chapman and Hall,New York,1991,p.149.

Thompson, M. A. 1990, Determining impact significance in EIA: a review of 24 methodologies. Journal ob Environmental Management 30:235-250.