Management of Major Hazards

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Atomic Energy Regultory Board

About AERB

- Atomic Energy Regulatory Board was constituted on November 15, 1983 by the President of India by exercising the powers conferred by the Atomic Energy Act to carry out certain regulatory and safety functions under the Act.
  - The mission of the Board is to ensure that the use of ionizing radiation and nuclear energy in India does not cause undue risk to health and the environment
  - Currently, the Board consists of a full-time Chairman, an ex-officio Member, three part-time Members and a Secretary
  - AERB has 7 technical divisions, 2 regional centres and a Safety Research Institute

Major Hazard & Major Accident

- Major Hazard
  - The storage and use of flammable, explosive or toxic chemicals having potential to cause death or serious injury to a large number of people, or cause extensive damage to property or environment
- Major Accident (MSIHC Rules)
  - an incident involving loss of life inside or outside the installation, or ten or more injuries inside and/or one or more injuries outside or release of toxic chemicals or explosion or fire or spillage of hazardous chemicals resulting in on-site or off-site emergencies or damage to equipment leading to stoppage of process or adverse affects to the environment

Management Responsibility

- We need to have answers for

A) Do toxic, explosive or flammable substances in our facility constitute a major hazard? [Identifying Major hazard]

B) Which failures or errors can cause abnormal conditions leading to a major accident? [Hazard Identification]

C) What can management do to prevent these accidents happening? [Hazard Control]

D) If a major accident occurs, what are the consequences of a fire, an explosion or a toxic release for the employees, people living outside the facility or the environment? [Consequence Analysis]

E) What can be done to mitigate the consequences of an accident [Mitigation Measures & Emergency Preparedness]

Identifying Major Hazard

- Based on the list of chemicals (684) and associated threshold quantities specified in the MSIHC Rules, 1989
- Based on the toxic, flammable or explosive properties and their threshold quantities specified in the MSIHC Rules
- Type of industries based on common experience

Typical MAH Installations

- Petrochemical works and refineries
- Chemical works and chemical production plants
- LPG storage and terminals
- Stores and distribution centres for chemicals
- Large fertiliser stores
- Explosive factories
- Works in which chlorine is used in bulk quantities

Hazard Identification

- Comparitive Methods
  - These methods identify deviations from codes of practice or standards / and the deviations are potential hazards
  - Examples: Checklist, Safety Audit, Hazard Indices
- Fundamental Methods
  - Fundamental methods are a structured way of stimulating a group of people to apply foresight in conjugation with their knowledge to the task of identifying the hazards mainly by raising a series of questions. These methods have the advantage that they can be used for new process whether or not the standards are available.
  - Examples: HAZOP, FMECA, What if?, etc
- Logic Diagram Methods
  - Sequential inductive / deductive logics are used to identify potential hazards
  - Examples: Fault Tree Analysis, Event Tree Analysis, etc

Typical causes of Major Accidents

- Equipment / Component failure
- Human & Organizational errors
- Deviations from normal operating conditions
- External events
  - Natural &
  - Human-induced
- Malevolent acts

Major Hazard Control

- To be addressed in the total life cycle of plant
  - Siting — Availability of resources
  - Design — Intrinsic safety, Passive & Active systems
  - Operation — Operation & Maintenance practices, Procedures,Mitigation,etc.
  - Decommissioning

Equipment / Component Failures

- Failures are caused by inappropriate design to withstand internal pressures, external forces, corrosive media and extreme temperatures
- Component failures- pump, compressor, stirrer, pipeline, vessel
- Control Systems failures- pressure and temperature sensors, level controllers, control units, flow meters
- Safety Systems failures- pressure relief, safety valves, flare towers, neutralization mechanisms
- Construction/Fabrication failures- welds, flanges, gaskets, electrical wiring

Human & Organisational errors

- Operator error
- Disconnected interlocks(frequent trips)
- Mix-up of hazardous substances
- Communication error
- Incorrect repair or maintenance
- Unauthorized work

The reasons for the above errors can be lack of training, awareness or over load / work which are organizational

Deviation from Normal Conditions

- Failure in monitoring of process parameters
- Failure in utilities (cooling water, nitrogen, electricity, etc)
- Failure to follow shutdown / start-up procedures
- Formation of impurities, residues, etc.
- Failure in supply of chemicals (manual)

Safe Operation

- Proper equipment, component and system design considering static & dynamic loads, corrosion, external events, etc.
- Safety Systems
- Technical specifications for operation
- Maintenance & monitoring
- Inspection & repair work

Safety Systems

- Systems preventing deviations from permissible operating conditions.
  - Pressure relief systems
  - Temperature, Pressure or Flow sensors
  - Systems preventing overflow
  - Safe shutdown systems
  - Emergency shutoff systems
- Systems preventing failure of safety-related components
  - Diverse systems
  - Redundant systems
- Alarm systems

Technical Specifications for Operation

- ***Safety Limits***, which are the limits of the operating parameters that should never be exceeded. These limits are based on the design of the plant.
- ***Limiting Safety System Settings***, which are the limits at which safety devices like relief valves etc. are set to act / operate.
- ***Limiting conditions of Operation***, which are the operational limits allowed for the plant parameters, which are adhered to in order to ensure safe operation of the plant.
- ***Surveillance***, which ensures that the systems which monitor and ensure that the plant operates with in the limits are in place and available.

Maintenance & Monitoring

- Monitoring & maintenance plan
  - Monitoring of safety related operating conditions, both in the control room and on-site
  - Monitoring of safety related systems
  - Monitoring of safety related utilities
  - Maintenance interval and type of maintenance
- Qualification and experience of persons doing maintenance and surveillance

Inspection & Repair

- Inspection & Repair plan
  - Periodicity and coverage of inspections
  - Operating conditions to be adhered to while plant safety inspections and repair work.
  - Procedures for repair work
- Qualifications required for personnel performing inspections and repair
- Quality requirements and supervision for repair work

Prevention of human and organisational errors

- Using different sized connections for different materials
- Proper labelling and packaging
- Safety related interlocks
- Clear marking of switches, displays etc on control panels
- Proper communication devices
- Safe guarding against inadvertent human actions
- Training of personnel

Training

- A plant can not be designed to operate free of human intervention. Personnel can have positive or negative influence on the safe operation of the plant, irrespective of the technical measures provided to ensure plant safety. To enhance the positive attributes and influence of this intervention, the selection and training of personnel should include relevant information covering:

Mitigation of Consequences

- Physical measures
  - Water spray systems (to cool tanks or to extinguish fires)
  - Collecting tanks, bunds, dikes etc
- Administrative / procedural measures
  - Set up and train fire brigade / incident response teams
  - Provide antidotes in event of release of toxic substances

Emergency Planning

- Objective
  - localise the emergency and if possible eliminate it
  - minimise the effects of the accident on people and property
- not a substitute for maintaining safety standards in design or operation of the plant
- May involve rescue, first-aid, evacuation, rehabilitation, and prompt information to the people affected
- Onsite (Management) & Offsite (Authorities)

Summary

- In view of potential adverse effects of handling of hazardous chemicals on people and environment, it is important to identify major accident hazards.
- MSIHC rules can be used as basis for identifying such installations.
- The next step is the major hazard control which involves specific identification of hazards in the plant, the causes for failures of equipment / systems which may lead to accidents, the requirements for safe operation of the plant.

Summary

- Provision of mitigation systems to reduce the consequences should also be adopted if chance of failure further exists despite the implementation of other hazard control methods.
- Emergency planning in case of major accident is essential since possibility of accident cannot be ruled out, but emergency plan should not be a substitute for maintaining safety standards.