PROCESS SAFETY MANAGEMENT

AND

RISK HAZARD ANALYSIS

BY

GORDON MCKAY PhD, DSc

4.1 Process Safety Management
1.0 PROCESS SAFETY MANAGEMENT

THE PROCESS SAFETY MANAGEMENT PROGRAMME

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PROCESS SAFETY MANAGEMENT

PLANNING A SAFETY MANAGEMENT PROGRAMME

The Need for Excellence in Process Safety Management

Accidents can occur with the operation of any process, as you can see from the examples of industrial losses chronicled previously. Employees, the public, and property are all at risk and can be affected by problems industry experiences with the design and or the operation of processes. Management is being held legally accountable for the effects of process accidents in nations throughout the world.

Most major process incidents result from errors or conditions which can ultimately be traced to breakdowns in management control. Examples include incomplete or obsolete operating or emergency procedures; unauthorised or inadequately designed equipment modifications; inadequate inspection maintenance programmes, job knowledge, or supervision; and failure to communicate essential process safety information. PHRs provide an opportunity for the discovery of these and other problems. All industries need cost-effective methods of hazard identification and analysis.

A Process Safety Management Programme (PSMP)

Process safety management is directed toward preventing process-related incidents which affect personnel, equipment, or off-site communities. Each person involved in transporting, storing, or processing materials is responsible for managing the hazards of the operation to avoid incidents, injury to personnel, and damage to equipment and the environment. Process safety management is everyone's job.

Personnel analysing plant processes for hazards need to know how to conduct thorough Process Hazard Review PHRs - both of processes in operation and of projects being designed. Process safety management is not housekeeping; it is the application of management controls to a process or system to identify, understand, document, and control process hazards. Process safety management's goal is to eliminate process-related injuries and incidents.

Process safety management focuses on providing controls over operating procedures and practices, training, inspection, and process modification-crucial factors involved in most major incidents-as well as focusing on in-depth PHR programmes. This seminar emphasises management control of operating processes and process change. The seminar assumes that safety programmes are in place to prevent personnel injury from general hazards, such as falls, trips, local hot surfaces, etc. (sometimes called "hard hat" safety). Therefore, these hazards are excluded from consideration here.

Legislative and Regulatory Activity

As a result of numerous catastrophes world-wide involving hazardous chemicals, many nations have created regulations concerning the safe use of these chemicals. In the 1970s, Europe led the world in this regard with the creation of such documents as the Seveso Directive.
Following the first issue of the Directive in 1982, European countries developed regulations with the objective of preventing major accidents. In the United Kingdom the equivalent legislation is called CIMAH Regulations - Control of Industrial Major Accident Hazards.

In the United States, several states (California, Delaware, New Jersey, and Texas) have implemented regulations addressing the manufacture, use, handling, and storage of hazardous chemicals. All of these regulations were implemented during the mid to late 1980s. Because states are beginning to pass specific laws, both state and local laws should be checked to see if they apply to your facility.

At the federal level, also during the mid to late 1980s, congress, EPA, and OSHA began to consider and develop legislative and/or regulatory proposals to prevent chemical releases with catastrophic potential. In November 1990, the President signed the Clean Air Act of 1990 (CAA) into law. The CAA has two sections that deal directly with prevention of chemical releases:

Section 304 Chemical Process Safety Management (OSHA)
Section 112(r) Prevention of Accidental Releases (EPA)

Section 304 - Chemical Process Safety Management (OSHA)

This section directs the Secretary of Labour, in coordination with the Administrator of EPA, to promulgate a Chemical Process Safety Standard to protect employees from hazards associated with accidental releases of highly hazardous chemicals in the workplace. The standard is to contain a list of highly hazardous chemicals, including toxic, flammable, highly reactive, and explosive substances.

Section 304 outlines 14 topics and/or elements to be addressed in the Standard.

Parallel and consistent with the Congressional activity, OSHA developed a regulatory proposal and published in the Federal Register on July 17, 1990, a notice of proposed rule-making, "Process Safety Management of Highly Hazardous Chemicals". This rule, 29 CFR 1910.119, was approved as modified and published February 24, 1992.

The OSHA rule applies to processes (operations) involving:-

- Toxic, reactive, and explosive chemicals at or above a specified threshold quantity for the 136 chemicals listed in the regulations.

- Flammable liquids or gases in one location in quantities of 10,000 pounds or more except for:-
  - Hydrocarbon fuels used solely for workplace consumption as a fuel. (Gasoline for vehicle fuelling is excluded.)
  - Flammable liquids stored in atmospheric boiling point without benefit of chilling or refrigeration unless they are connected to covered processes through piping are in close proximity.
• Manufacture of explosives.

• Manufacture of pyrotechnics, including fireworks and flares.

The OSHA rule does not apply to retail facilities, oil or gas well drilling or servicing operations, or normally unmanned remote facilities.

**Section 112(r) - Prevention of Accidental Releases (EPA)**

The objective of the regulations developed under subsection (r) is to prevent the accidental release and to minimise the consequences of a release of any substance listed or any other extremely hazardous substance. The primary focus of this EPA regulation is to protect the offsite population and the environment.

Subsection (r) directs the administrator (EPA) to promulgate an initial list of 100 substances which, in the case of an accidental release, are known to cause or may reasonably be anticipated to cause death, injury, or serious adverse effects to human health or the environment.

On January 19, 1993, the EPA published a proposed list of 100 toxics and 62 flammables. There was some overlap with the OSHA list, and the threshold quantities for many substances were different. There were also some new substances on the EPA list. Comments and testimony on this list have been reviewed by the EPA, and a draft of the entire regulation was published in the Federal Register in October 1993.

A Chemical Safety and Hazard Investigation board is established under 112(r)6 to investigate serious accidental releases, to recommend measures to reduce the likelihood or the consequences of accidental releases, and to establish by regulation, requirements for reporting accidental releases into the ambient air.

The administrator under 112(r)7Bi shall promulgate reasonable regulations and appropriate guidance to provide, to the greatest extent practicable, for the prevention and detection of accidental releases of regulated substances and for response to such releases. These regulations shall require the owner/operator to prepare and implement a risk management programme, which in turn shall include the following requirements:

• Registration (with the EPA) is required of all stationary sources that have any of the listed hazardous toxics and flammables (regulated substances) present in greater than the threshold quantities.

• Identification of the person who has overall site responsibility for the risk management programme. If delegated, the lines of authority must be defined.

• Hazard assessments for each regulated substance present in greater than the threshold quantity. The worst case scenario and most probable scenarios must be analysed for off-site effects on the population and environment. A five-year history of releases must be developed for each regulated substance.
• A prevention programme. The EPA programme closely parallels the OSHA PSRM elements, with the addition of one element, Management Systems.

• An emergency response programme to cope with the releases of any of the regulated substances.

• A Risk Management Plan (RMP) summarising all the above key elements, which must be submitted to the States Emergency Response Commission (ERC), Local Emergency Planning Board (LEPB), and the Chemical Safety and Hazard Investigation Board, and be made available to the public.

Compliance is required three years after promulgation of the regulation. (Except promulgation late in 1994 and compliance required late in 1997).
PROCESS SAFETY MANAGEMENT

STRUCTURING A PROCESS SAFETY MANAGEMENT PROGRAMME

Overview

Management commitment and leadership from the foundation of efforts to improve process safety. Although leadership and initiative are needed throughout all levels of an organisation, it is crucial that senior management provide visible support and encouragement.

Process safety management is closely tied to your organisation’s safety mission, philosophy, and principles. Management must believe in, back up, and actively implement process safety management, just as the line organisation must believe in, back up, and actively implement total safety management.

Management Leadership in Process Safety

Effective management commitment begins with the establishment of a company culture that places high value on safety, health, and the environment. Company culture is driven by its employees' understanding of the company’s goals, objectives, and policy.

Once the company policy is understood, management must demonstrate commitment to that policy by providing corporate and line management organisation to support process safety activity, and commit the necessary resources to make the policy a reality.

Top management must be visible in its support by personally participating actively in the process safety effort and communicating the need to continually strive for improvement in process safety.

Management must demand operating discipline and audit the organisation to ensure compliance.

Safety as a Line Organisation Responsibility

The ability of a company to manage the hazards in its processes successfully depends to a considerable degree upon how well its personnel accept safety as a line organisation responsibility. For a safety effort to be effective, the line organisation must accept safety as an integral part of every job, to the extent that each employee is responsible for the safety of running the operation. No other approach to safety has been as successful over the long term.

Specific safety management precautions the chemical industry can take are discussed in "Safety and Health Guide for the Chemical Industry", OSHA document 3091.

The Role of a Company Mission and Philosophy

The company mission and philosophy regarding the issues of safety, health, and the environment are extremely important because they provide the foundation for a process safety management system.
In every business operation, there are many objectives that often compete for the same resources. Managers, supervisors, operators, and mechanics must continually make decisions regarding priorities in areas such as production, quality, cost, personnel, and security, as well as safety, health, and the environment. Without leadership and guidance from top management, it is possible to have production priorities placed ahead of safety, for example. This is a highly undesirable situation and will lead to increased frequency of process incidents.

The company mission and philosophy must clearly state what the company's position is regarding the safety and health of its employees and members of the surrounding communities, as well as protection of the environment.

The mission and philosophy are the backbone of the principles, which in turn provide the basis for process safety management.

- **SAFETY MISSION**
  
  We must adhere to the highest standards for the safe operation of facilities and the protection of the environment, our people and customers, and the citizens of the communities in which we do business.

- **SAFETY PHILOSOPHY**
  
  We will not make, handle, use, sell, transport, or dispose of a product unless we can do so safely and in an environmentally sound manner.

- **SAFETY PRINCIPLES**
  
  - All injuries and occupational illnesses can be prevented.
  - Management is responsible for safety.
  - All operating exposures can be controlled.
  - Safety is an individual's responsibility and condition of employment.
  - It is necessary to train employees thoroughly to work safely.
  - Audits must be conducted.
  - All deficiencies must be corrected promptly.
  - It is essential to investigate all injuries, illnesses, and incidents with serious potential.
  - People are the most important element of the safety and occupational health programme.
  - Off-the-job safety is an important part of the safety effort.
PROCESS SAFETY MANAGEMENT

ELEMENTS OF A PROCESS SAFETY MANAGEMENT PROGRAMME

Definition

Application of management controls to operations involving hazardous materials in a way that process hazards are identified, understood, and controlled so that process related injuries and incidents can be eliminated.

Focuses on These Resources

1.0 Process Technology
2.0 Facilities
3.0 Personnel

Process Safety Management Programme

Process Technology Facilities Personnel

Process safety management consists of 14 elements within three management resource areas.

1.0 PROCESS TECHNOLOGY
   1.1 Process Safety Information
   1.2 Process Hazards Analysis
   1.3 Operating Procedures and Safe Practices
   1.4 Management of Change

2.0 FACILITIES
   2.1 Quality Assurance
   2.2 Prestart-up Safety Reviews
   2.3 Mechanical Integrity
   2.4 Management of Change

3.0 PERSONNEL
   3.1 Training and Performance
   3.2 Contractors
   3.3 Incident Investigation and Reporting
   3.4 Management of Change
   3.5 Emergency Planning and Response
   3.6 Auditing
Each element is discussed in the following way:

1. The principle involved is defined; its importance in process safety management is established.

2. The essential features of each principle are presented as a checklist.

These 14 elements, when implemented satisfactorily, achieve process control through hazard identification, risk analysis and assessment, risk mitigation, hazard management, and emergency action.
1.0 PROCESS TECHNOLOGY

1.1 PROCESS SAFETY INFORMATION

Principle

The Process Safety Information (PSI) package provides a description of a process or operation. It provides the foundation for achieving an identification and understanding of the hazards involved - the first steps in the process safety management effort. The PSI package generally consists of three parts:

- Hazards of materials
- Process design basis
- Equipment design basis

Features

HAZARDS OF MATERIALS

- List of all pertinent hazard data for each chemical used.
  - Physical data.
  - Thermal and chemical stability data.
  - Reactivity data.
  - Hazardous effect of inadvertent mixing of different materials that could foreseeably occur.
  - Chronicle and acute toxicity data - oral, inhalation, skin.
  - Exposure limits including Permissible Exposure Limits (PEL).
  - Corrosivity data relative to equipment.

- All hazard information is communicated and made readily available to all employees (i.e., permanent, temporary, contract) either involved in the process or potentially exposed to the hazards of the material.

PROCESS DESIGN BASIS

- Process documentation describes the basis for safe operation of a process; it defines both the boundaries of safe operation and testing limits of process variables. The process design basis must be documented, maintained, and communicated to employees who have responsibility for start-up of new facilities and to employees who are involved in ongoing operations.
- Block flow diagram or simplified process flow diagram.
- Maximum intended inventory of hazardous substances.
- The process steps as shown in a process flow diagram and the limits of these steps, including maximum, normal, minimum conditions.
- The procedure used to update process documentation

EQUIPMENT DESIGN BASIS

- The equipment design basis.
- Material and equipment lists should be included, as well as a drawing schedule (listing).
- These equipment design basis files are kept up to date through the management of change system. Information is changed as the process is modified.

The employer shall document that equipment complies with recognised and generally accepted good engineering practices. For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the employer shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.
1.0 PROCESS TECHNOLOGY

1.2 PROCESS HAZARDS ANALYSIS

Principle

Process hazards analysis is used to methodically identify, evaluate, and control hazards in the process. A PHA consists of two parts: a consequence analysis (hazard assessment) and a process hazards review (PHR). The completed PHA is used to follow up accepted recommendations and to communicate to affected personnel.

Features

Decide to Conduct a Process Hazards Analysis.

- New facilities
- Existing processes
- Changes to technology and facilities
- Shutdown and/or dismantlement
- Meet regulatory requirements

Select a Process Block to Analyse.

- Prioritise the process blocks on the site and begin with the process whose potential hazards appear most severe.
- Keep the size of the block to be analysed manageable (time from team selection to review report should not exceed four months).
- Analyse periodically all process blocks containing hazardous chemicals (at least every five years, as per OSHA).

Conduct a Consequence Analysis.

- Estimate a range of potential release quantities including the worst case, usually expressed as release rates, which might occur as a result of failure of engineering or administrative controls.
- Estimate downwind effects.
- Estimate the impact of the consequence on on-site and off-site people and the environment.
Conduct a Process Hazards Review (PHR).

- Employ a multidisciplined team.
- Address the hazards of the process and the engineering and administrative controls applicable to the hazard and their interrelationships.
- Use a proven review method:
  - Design Review.
  - What If and/or Checklist.
  - Index.
  - Hazard and Operability Study (HAZOP).
  - Failure Mode and Effect Analysis (FMEA).
  - HAZAN.
- Document the findings and recommendations of the review.
- Present the findings and recommendations to management.

Address the Findings and Recommendations.

- Develop and document a follow-up system for implementing the action plan in a timely manner, and document the resolution.
- Communicate the action plan to operating, maintenance, and other employees whose work assignments involve the process analysed and/or are affected by the recommendations or actions.
1.0 PROCESS TECHNOLOGY

1.3 OPERATING PROCEDURES AND SAFE PRACTICES

Principle

Operating procedures provide a clear understanding of parameters for those who are operating the process. They also clearly explain the consequences of operation outside process limits and describe steps to be taken to correct and or avoid deviations.

Safe practices provide a carefully planned system of procedures and/or permits involving check and authorisations prior to doing nonroutine work in process areas.

Feature

Operating Procedures:-

- Must be developed and documented for each process.
- Must be consistent with the PSI package.
- Must be properly prepared, controlled, approved, and authorised.
- Must have a straightforward organisational format and be clear to the user.
- Need a comprehensive safety, fire protection, occupational health, and environmental control section that analyses and/or illustrates:-
  - Properties and hazards of chemicals.
  - Procedures for opening process equipment.
  - Special precautions to prevent personnel exposure (administrative and engineering controls and personal protective equipment).
  - Control measures to be taken if physical contact or airborne exposure occurs.
  - Spill and release mitigation procedures.
  - Description of special/unique hazards.
  - Quality control of raw materials and intermediates and control of hazardous chemical inventory levels.
• Define the proper steps from raw material to finished product for the following phases:
  
  - Initial start-ups.
  - Normal shutdown.
  - Start-ups following a turnaround for maintenance or changes or from an emergency shutdown.
  - Normal operation.
  - Emergency operations including shutdowns and who may initiate these procedures.
  - Temporary operations as the need arises.

• Show the process limits: maximum, minimum, preferred.

• Describe instrument controls including alarm and interlock set points.

• Outline the consequences of deviation, where adverse safety, fire protection, health, and environmental considerations are present.
  
  - Document the steps to avoid or correct deviations.
  - Describe safety systems and their functions.

• Keep the operating procedures "evergreen" (up to date).

• Ensure through auditing and periodic review that operating procedures are mutually consistent with field practice, technology, and facility changes. The employer shall certify annually that these operating procedures are current and accurate.

• Must be readily accessible to people who operate and maintain the process.

Safe Practices:

• Apply to both site and contractor employees.

• Take the form of nonroutine (not part of operating procedures) work procedures and permits (i.e., hot work permit).
• Usually are related to mechanical or cleaning work being performed on the process.

• Are based upon recommendations resulting from investigation of process incidents and near misses, general industry practice and standards, or upon regulations.

• Include a work permit/authorisation provision.
1.0 PROCESS TECHNOLOGY

1.4 MANAGEMENT OF TECHNOLOGY CHANGE

Principle

Process changes potentially invalidate prior hazard assessments and create new hazards; accordingly, all process changes to the documented technology must be reviewed.

(Process changes are changes to ingredients, equipment design basis, or process design basis as found in documented technology).

Features

- Document authorised changes - Employer should establish and implement written procedures to manage changes (except for "replacement in kind") to ensure that the following considerations are addressed prior to any change.

- Purpose for change, technical basis for change, description of change, impact of change on safety, health, and environmental considerations, including acknowledgement of whether or not a PHR is required.

- Modifications to operating procedures or practices.

- Employees involved in operating a process, and maintenance and contract employees whose job tasks will be affected by a change in the process shall be informed of and trained in the change prior to start up of the process or affected part of the process.

- Necessary time period for change (time and/or quantity).

- Update of Process Safety Information.

- Approval and authorisation requirements - to include operations, technical, and maintenance personnel.

- Document trial results.

Where there is a trial period or test period for an authorised change, a concluding document should be issued in a timely manner.
2.0 FACILITIES

2.1 QUALITY ASSURANCE

Principle

Quality assurance efforts focus on ensuring that process equipment is:

- Fabricated in accordance with design specifications.
- Assembled and installed properly.

Features

- Design basis and criteria are documented and communicated to the vendor, operating, and maintenance personnel as part of the equipment design basis (see Process Safety Information element).

- Sites shall establish a quality assurance programme to assure that critical equipment handling hazardous materials as it is fabricated is suitable for the process application and installed consistent with design specifications and manufacturer's recommendations. The quality assurance programme shall include:
  - Written quality control procedures regarding the fabrication stage for equipment in critical service to assure that the equipment as fabricated and delivered meets design specifications.
  - Appropriate checks and inspections to assure that critical equipment is installed properly (and consistent with design specifications and vendor's instructions).
  - Inspections of critical service equipment and components are carried out in the vendor's shop during fabrication.
2.0 FACILITIES

2.2 PRESTART-UP SAFETY REVIEWS

Principle

The prestart-up safety review provides a final check of new and modified equipment to confirm that all appropriate elements of process safety have been addressed satisfactorily, and the facility is safe to operate.

Features

Prestart-up safety reviews

- Performed on new or modified facilities when the modification is significant enough to require a change in the process safety information.

- Confirm that prior to the introduction of hazardous chemicals to a process all elements of PSM have been appropriately addressed.

- Are conducted with a multidisciplined team.

- Develop an appropriate prestart-up checklist(s) relevant to the particular process being reviewed.

- Assign responsibilities to appropriate personnel for checklist review follow-up to ensure resolution of recommendations prior to start-up.

- Confirm that the facility is safe to start-up (may be contingent upon completion of recommendations).

- Document prestart-up review, signed by each member of review team and properly authorised.
2.0 FACILITIES

2.3 MECHANICAL INTEGRITY

Principle

A comprehensive maintenance programme is necessary to ensure that the soundness of process equipment is maintained from the time of initial installation throughout the life of the facility.

Features

- Establishes written maintenance procedures to ensure mechanical integrity on an ongoing basis.

- Trains mechanical personnel in an overview of the processes and in the procedures applicable to their job tasks.

- Establishes quality control procedures for maintenance materials, spare parts, and equipment.

- Ensures that ongoing reliability engineering analysis is conducted for equipment critical to process safety.

- Establishes a productive/preventive maintenance programme.

- Makes appropriate use of consultants when problems are encountered to ensure that mechanical integrity is maintained and often enhanced.
2.0 FACILITIES

2.4 MANAGEMENT OF SUBTLE FACILITY CHANGE

Principle

Changes to facilities within the documented technology (e.g., process safety information) that are not replacement in kind, must receive appropriate review and authorisation prior to implementation.

Features

- A clear understanding is established with all personnel of what constitutes a change.

- The difference between a "change to the documented technology" and a "change within the documented technology" is explained and understood.

- Written procedures to manage change to facilities are well known and utilised, including a Management of Facilities Change document.

- All changes to facilities that are not replacement in kind receive review for impact on safety and health by knowledgeable personnel and are authorised by responsible management.

- PSM requirements are established before authorisation, including the need for a PHA, and are completed prior to implementation of the modification.

- Operating procedures are modified if required and personnel trained in any changes prior to implementation of the modification.
Workshop: Nitrobody Distillation Process Equipment

Process Equipment

Situation

You are an operations superintendent responsible for the nitrobody distillation process, distilling 2-chloro-4-nitrotoluene. This process has been incident free for 10 years. The need for distilled nitrobody now exceeds still capacity. A second still is proposed for the additional capacity needed. The proposed still has been routinely used for nitrobody distillations and has identical distillation columns but different heating systems. A test authorisation is proposed.

Problem

Would you require a process hazards review before authorising this test? If your answer is “yes”, what questions would you expect to raise in the review?
Workshop: Nitrobody Distillation

What Happened?

The test distillation column was destroyed when an explosion occurred during the second campaign of nitrobody distillation.

What Was Not Considered

Differences between stills were not analysed. The test still system allowed distillation to dryness. The test still supplied 400 psig (superheated) steam versus the existing still's 220 psig (saturated). A test authorisation and a process safety review (meeting this course's process safety management requirements) would have prevented the incident.
3.0 PERSONNEL

3.1 TRAINING AND PERFORMANCE

Principle

Properly trained and performing personnel are a requirement for keeping process equipment and machinery operating safely. Employees must also be physically able, mentally alert, and capable of using good judgment to properly follow prescribed practices.

All other elements of process safety management can be in place - but without properly trained and performing personnel, the chances of safe process operation are greatly diminished.

Features

- An inventory of the basic skills necessary to perform a given job is developed.
- Training policies shall be developed and implemented.
- The site's training policy and programme should:
  - Forecast and budget (time and money) for personnel training requirements.
  - Include the following basic elements of effective training:
    1. Classroom training.
    2. Field training – to complement the classroom training and to show “how” and “where”.
    3. Hands-on demonstration by the student.
       Note: Use of simulators may be advantageous and appropriate for automated processes.
    4. Qualification testing (including but not limited to written testing). The employer must verify that the employee understood the training.
- Provide refresher training to each employee at least every three years.
- Provide for periodic auditing and assessment of operator performance to ensure compliance with established procedures.
- Include documented “criteria” for qualified instructors.
• Ensure that the training records include a description of the material covered and the identity of the person doing the training. The employer shall ascertain that each employee involved in operating a process has received and understood prescribed training. Training records shall be maintained.

• Provide specific training and drilling in emergency response on a periodic basis.

• Establish programmes designed to ensure that personnel handling hazardous materials are fit for duty and are not compromised by external influences, including alcohol and drug abuse.
3.0 PERSONNEL

3.2 CONTRACTORS

Principle

All tasks must be completed safely and performed in accordance with established procedures and/or safe work practices, consistent with the principles of good PSRM (Process Safety Risk Management), whether the tasks are completed by site personnel or by contract personnel.

Features

The key responsibilities of the site and the contractor are summarised below.

The site shall:-

1. Obtain and evaluate information regarding the contractor's safety performance and programmes as part of the selection process.

2. Establish clear lines of communication between the site contract administrator and the contractor.

3. Inform contractor of the known potential fire, explosion, or toxic release hazards related to the contractor's work and the process (for contractors working on or near process containing hazardous substances).

4. Inform contractor of any applicable safety rules and procedures of the facility, including safe work practices for the control of hazards and entry into process areas.

5. Explain to the contractor the applicable provisions of the Emergency Response and Control Plan.

6. Maintain a contract employee injury and illness log related to the contractor's work in process areas and review the contractor's safety performance on a periodic basis.

7. Periodically evaluate the contractor's performance in fulfilling his/her responsibilities as outlined below.

The contractor shall:-

1. Ensure that each contract employee has the necessary job skill training and is qualified to safely perform the contracted work.

2. Ensure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the process.
3. Ensure that each contractor employee receives and understands training regarding:
   - Site safety rules.
   - Applicable safe work practices of the facility.

4. Document that each contract employee has received and understood the instruction and training required above. Training records shall include:
   - Identity of the contract employee.
   - Date of training.
   - The material covered.
   - The means used to verify that the employee understood the training.
   - The identity of the person doing the training.

5. Ensure that each contract employee follows the safety rules and applicable safe work practices of the facility.

6. Establish a programme to ensure that contract personnel who work in process facilities handling hazardous substances are fit for duty and are not compromised by external influences (see Training and Performance elements).

7. Advise the employer of any unique hazards presented by the contractor's work, or any hazards found by the contractor's work.
3.0 PERSONNEL

3.3 INCIDENT INVESTIGATION

Principle

Serious and serious potential incidents are likely to recur unless positive steps are taken. Aggressive and persistent investigation of all serious and serious potential incidents is necessary to continually improve safety performance.

Features

- Have an incident investigation procedure in place before incidents occur. What, Who, How etc.

- Incident investigation should be initiated as promptly as possible.
  - Essential to capture information before it evaporates.
  - Team should be multidisciplined.
  - Investigation of catastrophic or potentially catastrophic releases of highly hazardous chemicals must begin no later than 48 hours after the incident.

- Incident investigation reports should be produced at a minimum.

- A system must be established to ensure follow-up and closure to investigation report.

- Incident reports are reviewed with all operating, maintenance, and other personnel (including contractors) whose work assignments are within the facility where the incident occurred.

- Incident reports of catastrophic or potentially catastrophic releases of highly hazardous chemicals must be retained for at least 5 years.
3.0 PERSONNEL

3.4 MANAGEMENT OF PERSONNEL CHANGE

Principle

A minimum level of collective experience and knowledge is required of the operating, maintenance, and technical group assigned to a process area in order to provide a solid base for decisions which can affect process safety.

Features

- Develop and implement criteria and guidelines for maintaining minimum levels of specific, direct process experience, knowledge, and skill in the process groups.

- Provide training to newly assigned personnel to chemical processes involving hazardous materials. Such training shall address:
  - Principles and essential features of process safety management.
  - Process safety information specific to the newly assigned operation.

- Ensure that personnel newly assigned to processes involving hazardous materials acquire and demonstrate a minimum degree of proficiency and knowledge of the process technology versus defined requirements.

- Provide additional temporary measure in the even excessive experience and knowledge are lost, such as the temporary assignment of qualified personnel.
3.0 PERSONNEL

3.5 EMERGENCY PLANNING AND RESPONSE

Principle

In-depth planning for potential emergencies is required so that effective response by site with the community can mitigate the impact on people and the environment.

Features

- Use consequence analyses.
- Develop a written Emergency Response and Control Plan (ERCP) for the entire site to provide for mitigation the potential consequences arising out of the consequence analysis. The plan must address both small and large releases. The plan is to be developed in conjunction with local community emergency response organisations and should address the following subject areas:-
  - Notification of and coordination of effort with appropriate emergency response organisations.
  - Notification of affected personnel.
  - Notification of appropriate regulatory agencies and LEPC.
  - Escape and evacuation routes and plans.
  - Personnel accounting.
  - Rescue operations, including medical assistance.
  - Designation of primary and alternate Emergency Control Centres.

The written ERCP must also address actions to terminate any (small or large) release of hazardous material and to bring under control any resulting fires and/or explosions. Such a plan should address:-

- Emergency shutdown procedures, including isolation, venting or purging as appropriate.
- Activation of emergency systems, such as water sprays or deluge systems.
- Acceptable emergency repair procedures and/or service.
- Activation of site fire brigade and/or notification of local fire department.
- Shutdown of adjacent facilities as appropriate.
- Barricading of affected facilities.
- Activation of spill cleanup procedures.

The plan must define the person(s) or positions responsible for implementation and coordination of the plan.

* Train site personnel in the prompt and efficient implementation of the above emergency plans.

- Conduct emergency drills at appropriate frequencies and involve local emergency response organisations in site drills at appropriate frequencies.
3.0 PERSONNEL

3.6 AUDITING

Principle

Auditing provides a measurement of compliance with the established process safety management programme. Field observations yield data for determining performance against established standards.

Features

- All elements of the process safety management programme are periodically audited by site management.
- Positive feedback is included on significant strengths as well as corrective feedback on areas needing improvement.
- Frequencies are established for all audits and are followed.
- The line organisation, from top to bottom, provides the heart of the auditing programme.
- Audits outside the line organisation are done by safety professionals or a site process safety committee.
- Checklists for each of the elements of PSM are used for completeness of audits.
- Findings of noncompliance are promptly addressed and corrected.
- OSHA compliance audits are performed at least every three years to verify that procedures and practices are adequate and being followed.
  - Certification of audit completion required.
  - Done by a team having at least one person knowledgeable in the process audited.
  - A report of findings prepared.
  - Response to the deficiencies promptly documented.
  - The correction of deficiencies is documented.
  - The two recent audit reports and correction of deficiencies are retained.
PROCESS SAFETY MANAGEMENT

HOW DOES A PROCESS SAFETY MANAGEMENT PROGRAMME WORK?

Introduction

Process safety management will succeed only if management lays the proper safety foundation. As stated previously, the most technologically advanced site in the world will not be completely safe unless the individuals managing it and those individuals working there are committed to keeping the site free from accidents.

Site Safety Management

How is process safety managed at a manufacturing site? Managing process safety is everyone's responsibility. The operator running the process unit and the mechanic who maintains the process in working conditions are the key players, although the manager is also crucial in the process safety management scheme. In its application, process safety management becomes a way of life. Management must recognise the need for process safety management training of all personnel working with processes. The graphic on the following page illustrates the “safety communication pathway”, a sound and effective approach to safety management.

After the safety organisation is set, subcommittees of a Central Safety and Health Committee (CSHC), for which the site manager is the chairperson, may be formed to decentralise the safety administration effort. Here we explore the role of an important CSHC subcommittee-the Process Safety Management Committee.

Process Safety Management Committee (PSMC)

Subcommittees' by complementing the line organisation of a site, contribute significantly to the effectiveness of the site's safety effort. Representing specific areas of interest, these subcommittees serve as adjuncts to the CSHC by relieving that committee of many details of safety administration and providing for broader employee participation in the safety effort.

A senior member of technical supervision on the site, possibly a process engineering supervisor who has a technical degree, should chair the PSMC.
HOW IS SAFETY MANAGED AT A MANUFACTURING SITE

(A TYPICAL APPROACH)
Function

The PSMC helps the site manager establish process safety guidelines, recommended training for site personnel in process safety, and audit the site's performance in all of the essential elements of process safety management.

One of the more time consuming functions of the subcommittee is tracking the performance of the various PHR teams on the site. The PHR team is created separately from the PSMC to conduct a searching review of a specific part of the plant process.

The PSMC should receive a copy of all PHR team findings and recommendations and of the line organisation's action plan.

Because the PSMC is part of the document flow for PHRs, auditing of this safety element (Process Hazards Analysis) will not consist of a sampling of reviews - all reviews will be audited. The other elements of the PSMP should be sampled at least once a year by the PSMC. Following each audit, a report detailing strengths and weaknesses should be presented to the CSHC.
PROCESS SAFETY MANAGEMENT

HOW THE ELEMENTS FIT TOGETHER

General

Once the elements of a process safety management programme are understood, it becomes the job of site and company management to provide the emphasis and priority to the effort until all personnel associated with the operation believe “IT’S A WAY OF LIFE”. Here is where good communication becomes an essential feature of an excellent programme.

The illustration on the following page depicts a series of important building blocks forming a pyramid. The foundation begins as discussed earlier, with the company mission/philosophy. The procedural and basic technical elements of the programme are built on that base, ensuring firm knowledge of the process through the process technology package, hazards reviews, operating procedures, equipment test and inspection programmes, and an emergency response procedure. At this point, our structure contains all the documented perceptions of how things are to be. It reflects current codes, regulations, laws, and is in accordance with the PSM programme. It describes a well thought out path for safe handling, storing, processing, and manufacturing of hazardous and highly toxic materials.

The next building block provides for the training of personnel. The training not only informs personnel of procedures, showing the “hows” and “whats”, but ensures that they have a thorough understanding of the "whys" involved. Once the training is complete, we have personnel who know what is expected of them and know why it is necessary.

The basic blocks are now in place, but the programme is far from complete. Dedication and commitment must be achieved through an important supervisory responsibility - setting standards of performance. This includes standards for every aspect of safety management - housekeeping, filling out log sheets and check sheets, keeping procedures up to date, etc. Two way communication is critical. The standards of performance must be clearly communicated to site personnel. In return, feedback from these personnel must define problems they foresee in meeting or exceeding the desired standards of performance. The result of this two way communication will be an improved basis for proceeding, whether it be a procedure, programme, or technology document.

The next block is Auditing and Feedback. If we have done a good job in constructing our programme, the feedback will be positive encouragement for a job well done. It will further enable the administrators of the programme to identify areas for emphasis.

At the top of the pyramid is the goal of Process Safety Excellence.
PROCESS SAFETY MANAGEMENT

- Process Safety Excellence
- Auditing and Feedback
- Setting Standards of Performance ("Operating Excellence")
- Training
- Emergency Response
  - Quality Assurance
  - Equipment Tests and Inspection Programs
  - Operating Procedures
  - Process Hazards Reviews
  - Process Safety Information
- Company Mission/Philosophy
PROCESS SAFETY MANAGEMENT

OBJECTIVES OF THE PSMP - OPERATING EXCELLENCE

Principle

The manufacture, use, and handling of hazardous materials requires the dedication and commitment by those individuals managing and handling such materials to “complete each and every job the right way every time”.

Characteristics of an Organisation That Has Achieved Operating Excellence

- Management based upon “leadership by example”, i.e., management's actions match management's words.
- High degree of employee involvement in each element of process safety management.
- Open and active lines of communication - up and down the organisation.
- Strong sense of teamwork throughout the organisation.
- Common shared values by member of the organisation regarding process safety; i.e., people are carrying out tasks the right way because they not only understand management's conviction and commitment but they also share the same beliefs and “buy-in” regarding the values and benefits that arise from always carrying out each task the right way.
- Examples of jobs being stopped, processes being shut down to “do the job the right way”.
- Absence of shortcuts by all members of an organisation, from the plant manager to operators and mechanics.

The Importance of Achieving Operating Excellence

Operating excellence is a descriptive term used to describe an organisation whose members have developed a deeply rooted dedication and commitment to carry out each task the right way and every time.
These 14 elements, when implemented satisfactorily, achieve process control through hazard identification, risk analysis and assessment, risk mitigation, hazard management, and emergency action.

PROCESS SAFETY MANAGEMENT MODEL
PROCESS SAFETY MANAGEMENT

THE IMPORTANCE OF OPERATING EXCELLENCE

EXAMPLES WHERE POOR OPERATING ACTIONS WERE A MAJOR CONTRIBUTING FACTOR IN THE CAUSE OF THE INCIDENT

FLIXBOROUGH: FIRE AND EXPLOSION = 28 FATALITIES

- Plant modification rushed to bypass disabled reactor.
- Scaffolding quickly rigged to support 20 inch pipe connection.
- Bypass assembly:-
  - Not tested for strength.
  - Violated industry and manufacturer's recommendations.

SEVESO: EXPLOSION = TOXIC RELEASE

- Production run scheduled to end 6 a.m. Saturday - normal closing time of plant for weekend.
  1. Only 15 percent of solvent distilled off at end of batch versus 50 percent specified.
  2. No water added to cool reaction to 50-60 C versus 3000 litres specified.
  3. 15 minutes stir time instead of “stir till fully cooled”.
  4. Operators left at 6 a.m. instead of remaining till temperature equalled 50-60C.

- Exothermic decomposition - 6.5 hours later

BHOPAL: TOXIC RELEASE OF MIC = ABOUT 3000 FATALITIES

- Scrubbing system - not operative
- Flare system - not operative.
- Cooling system for storage tank - not fully operative.
- High temperatures and pressure - ignored.
- Instruments - poorly maintained, not reliable.