PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS

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This presentation covers the Occupational Safety and Health Administration's standard, 29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals. The slides summarize the elements of the standard. They may be used in junior and senior level chemical engineering courses. As a former OSHA compliance officer and supervisor, I can attest to the fact that upon graduation, your students will be expected by their employers to be at least aware that the standard exists. Those new graduates who are familiar with the content of the PSM standard and have had some practice in applying it in laboratory situations will be more sought after than those who are not.

The process safety management (PSM) standard was written as a performance rather than as a specification standard. A specification standard tells the employer the exact conditions that must be met in order to be in compliance with an OSHA regulation, e.g. the value of the Permissible Exposure Limit. Because of the diversity of industries and processes covered by the PSM standard, it is not possible to delineate exact specifications that will provide a safe workplace. Instead, the PSM standard gives the requirements that must be met when using highly hazardous chemicals. General procedures are specified, e.g. a process hazard analysis, but the exact methodology to be used is not specified. The employer is responsible for identifying and using the one most suitable for the process involved.

A table showing where PSM principles may be utilized in examples in chemical engineering courses follows the slides. The SACHE Committee has already published nine sets of process safety-related problems, solutions, and reference material suitable for use as homework or class examples. Your department should already have copies of those publications. The Committee has also published numerous case studies illustrating where disasters have occurred when process safety principles were not fully realized or ignored.

After this table, there is an abstract of the Summary and Explanation of the standard taken from the preamble to the standard. When an OSHA standard is published in the Federal Register, there generally is a preamble that contains information about the background leading to the development of the standard, risk and economic assessments, a summary and explanation section, etc. The importance of the summary and explanation section is that it describes the standard in layman's, rather than legal, terms. The material included here has been reproduced directly from "Process Safety Management of Highly Hazardous Chemicals 29 CFR 1910.119," OSHA Office of Training and Education, Des Plaines, IL (April 1993).

More information on OSHA, regulations, publications, training materials, etc. may be obtained at www.osha.gov.

Process Safety Management of Highly Hazardous Chemicals

HIGHLIGHTS

Applications--covers processes involving listed (highly hazardous) chemicals at specified quantities (see Appendix A) and flammable liquids or gases in quantities of 10,000 pounds or more (except products used solely for heating or fuel). Rules covering pyrotechnic and explosives manufacture incorporate the PSM provisions by reference.

Process Safety Information--requires compilation of written process safety information including hazard information, process technology and information on equipment in the process.

Employee Involvement--requires developing a written plan of action regarding employee participation; consulting with employees and their representatives on the conduct and development of process hazard analyses and on the development of other elements of process safety management required under the rule; providing to employees and their representatives access to process hazard analyses and to all other information required to be developed under the rule.

Process Hazard Analysis--specifies that hazard analyses must be conducted for each covered process using compiled process safety information in an order to be determined by the employer. At least twenty-five percent of initial process hazard analyses must be completed by May, 1994; 50 percent by May, 1995; 75 percent by May, 1996; and 100 percent by May, 1997. Process hazard analyses completed after May, 1987, which meet the requirements of this standard, may be used to comply with this standard. Process hazard analyses must be updated and revalidated at least every five years. Records must be maintained of the most recent analyses.

Process Hazards Analysis Methods--The employer must choose an appropriate method. The standard mandates what-if; checklist; what-if checklist; hazard and operability study (HAZOP); failure mode and effects analysis (FMEA); fault tree analysis; or an equivalent method.

Contents--must address: hazards of the process; previous hazardous incidents; engineering and administrative controls; consequences of failure of engineering and administrative controls; facility siting; human factors; and evaluation of effects of failure of controls on employees.

Procedure--team performing analysis must have expertise in engineering and process operations and must include one employee with experience and knowledge specific to the process and someone knowledgeable in the specific process hazard analysis methodology used by the team.

Follow-up--must establish a system to address hazard analysis findings and recommendations; assure timely resolution; document actions planned; complete actions as soon as possible, in accordance with a written schedule; notify affected operating, maintenance and other employees of planned actions.

Operating procedures--must be in writing and provide clear instructions for safely operating processes; must include steps for each operating phase, operating limits, safety and health considerations and safety systems. Procedures must be readily accessible to employees, must be reviewed as often as necessary to assure they are up to date and must cover special circumstances such as lockout/tagout and confined space entry.

Training--mandates training covering specific safety and health hazards, emergency operations and safe work practices. Initial training must occur before assignment or employers may certify that employees involved in the process as of May 26, 1992, have the required knowledge, skills and abilities to safely perform duties and responsibilities specified in the operating procedures. PSM calls for refresher training at least every three years and requires written documentation of training.

Contractors--identifies responsibilities of employer regarding contractors involved in maintenance, repair, turnaround, major renovation or specialty work, on or near covered processes. The employer must: consider safety records in selecting contractors; inform contractors of potential process hazards; explain the facility's emergency action plan; develop safe work practices for contractors in process areas; evaluate contractor safety performance; and maintain an injury/illness log for contractors working in process areas. PSM requires contractors to train their employees in safe work practices and document that training, assure that employees know about potential process hazards and the employer's emergency action plan, assure that employees follow safety rules of facility, advise employer of hazards contract work itself poses or hazards identified by contract employees.

Pre-startup Safety Review--mandates a safety review for new facilities and modified sites to confirm integrity of equipment; to assure that appropriate safety, operating, maintenance and emergency procedures are in place; and to verify that a process hazard analysis has been performed.

Mechanical Integrity--requires written procedures, training for process maintenance employees and inspection and testing for process equipment including pressure vessels and storage tanks; piping systems; relief and vent systems and devices; emergency shutdown systems; pumps; and controls such as monitoring devices, sensors, alarms and interlocks. PSM calls for correction of equipment deficiencies and assurance that new equipment and maintenance materials and spare parts are suitable for the process and properly installed.

Hot Work--mandates a permit system for hot work operations conducted on or near a covered process.

Management of Change--specifies a written program to manage changes in chemicals, technology, equipment and procedures which addresses the technical basis for the change, impact of the change on safety and health, modifications to operating procedures, time period for the change and authorization requirements for the change. The standard requires employers to notify and train affected employees and update process safety information and operating procedures as

necessary.

Incident Investigation--requires employer to investigate as soon as possible (but no later than 48 hours) incidents which did result or could have resulted in catastrophic releases of covered chemicals. The standard calls for an investigation team, including at least one person knowledgeable in the process (a contractor employee, if appropriate), to develop a written report on the incident. Employers must address and document their response to report findings and recommendations and review findings with affected employees and contractor employees. Reports must be retained for five years.

Emergency Planning and Response--requires employers to develop and implement an emergency action plan.

Compliance Audits--calls for employers to certify that they have evaluated compliance with process safety requirements at least every three years and specifies retention of the audit report findings and the employer's response. Employers must retain the two most recent audit reports.

Trade Secrets--similar to trade secret provisions of the hazard communication standard requiring information to be available to employees from the process hazard analyses and other documents required by the standard. PSM permits employers to enter into confidentiality agreements to prevent disclosure of trade secrets.

Process Safety Management of Highly Hazardous Chemicals; Explosives and Blasting Agents

57 FR 6356
February 24, 1992

This document is an abstract of Section III of the Final Rule, "Summary and Explanation of the Final Rule" (57 FR 6359).

No attempt has been made to discuss every detail of the regulation. The page numbers of major paragraphs are provided throughout this document to facilitate further reading.

Process Safety Management of Highly Hazardous Chemicals

57 FR 6356
February 24,1992

Summary and Explanation of the Final Rule

Purpose (p. 6363)

The section contains requirements for preventing or minimizing the consequences of "toxic, reactive, flammable, or explosive chemicals." Additionally, the standard is intended to address the hazards to employees from toxicity, fire or explosion.

(a) Application (p. 6363)

Coverage under ***paragraph (a)(1)*** is triggered by a specified threshold quantity of an ***Appendix A*** toxic or reactive highly hazardous chemical being used in a single process. The presence of a threshold quantity of a highly hazardous chemical in a process is to be at one point in time and not aggregated over a period of time. Appendix A is a compilation of highly hazardous chemicals that could cause a serious chemical accident, by toxicity or reactivity, and a consequent potential danger to employees in a workplace.

The Appendix A list has been drawn from a variety of relevant sources which include: the New Jersey "Toxic Catastrophe Prevention Act," the State of Delaware's "Extremely Hazardous Substances Risk Management Act," the World Bank's "Manual of Industrial Hazard Assessment Techniques," the Environmental Protection Agency's "Extremely Hazardous Substance List," the European Communities Directive on major accident hazards of certain industrial activities (82/501/EEC, sometimes called the Seveso Directive), the United Kingdom's "A Guide to the Control of Industrial Major Accident Hazards Regulations 1984," the American Petroleum Institute's RP 750, "Management of Process Hazards," the National Fire Protection Association's NFPA 49, "Hazardous Chemicals Data," and the Organization Resources Counselors, Inc.'s "Recommendations for Process Hazards Management of Substances with Catastrophic Potential."

Every chemical listed in Appendix A is on at least one list compiled by these agencies and organizations. Most of the chemicals are on several lists and not every list contains the same chemicals or quantities. OSHA included those toxic and reactive chemicals it believes are most significant in potentially becoming a

catastrophic event. OSHA has also sought to develop a reasonable listing of threshold quantities which, when used in a process, would invoke coverage of the standard.

Those Appendix A highly hazardous chemicals which are highly reactive or explosive-type chemicals have been drawn from chemicals listed in the National Fire Protection Association (NFPA) document, NFPA 49, "Hazardous Chemicals Data" and cross-referenced with other sources mentioned above. The Agency decided to include substances with the two highest or most dangerous reactivity ratings from NFPA 49 because these chemicals present the most severe exposure potential to workers. These substances, which are rated 3 or 4 by NFPA 49, are those which are capable of undergoing detonation or explosive decomposition. These are the substances which can generate the most severe blast or shock wave, and can cause fragmentation of piping, vessels and containers, as well as causing serious damage to buildings and structures. The minimum threshold quantities for the highly reactive chemicals covered by the standard have been determined by calculating the amount of material needed to propagate a blast wave that creates an overpressure of 2.3 psi (15.85 kPa) to a flat surface perpendicular to the direction of the blast wave at a distance of 100 meters from the point of origin.

The toxic chemicals contained in Appendix A were drawn from the various resource documents discussed above.

Under section 302 of the Superfund Amendments and Reauthorization Act (SARA) also known as the Emergency Planning and Community Right-to-Know Act (42 U.S.C. 11001 et seq.), EPA was required to publish a list of extremely hazardous substances with threshold planning quantities which would trigger planning in states and local communities (52 FR 13378). EPA's EHS list is quite extensive (more than 300 hazardous substances) and serves as an emergency response planning list directed toward addressing hazards to the public and the environment.

Section 304 of the Clean Air Act Amendments (CAAA), paragraph (b), List of Highly Hazardous Chemicals, mandates that:

> The Secretary (of Labor) shall include as part of such standard (Chemical Process Safety Standard) a list of highly hazardous chemicals, which include toxic, flammable, highly reactive and explosive substances (Emphasis added).

The paragraph further indicates that the Secretary may include those chemicals listed by the Environmental Protection Agency under section 302 of the Emergency Planning and Community Right to Know Act of 1986. The CAAA did not anticipate that even EPA would adopt the whole EHS list for the purpose of prevention of accidental chemical releases. Section 301(r) indicated that EPA's first list must contain no less than 100 substances which may be from the EHS list. EPA's 301(r) list is not a planning tool but rather a list that requires covered plants to develop comprehensive Risk Management Plans.

While OSHA considered this list, it does not consider all of the substances on the EHS list to present a potential catastrophic situation for employees in workplaces within its jurisdiction. Therefore, OSHA believes it has acted reasonably and appropriately in evaluating a variety of chemical lists including the EHS list in order to identify those highly hazardous chemicals which present a potential catastrophic threat to employees. These events typically include toxic releases, fires and explosions as opposed to potential environmental threats such as spillage of a pesticide.

OSHA believes that its review of available literature for the development of its list of highly hazardous chemicals and its technical approach is an appropriate method to determine which toxic chemicals should be included on its list.

Paragraph (a)(1)(i) triggers coverage of those processes using chemicals in quantities listed in Appendix A.

Paragraph (a)(1)(ii) includes processes involving flammable liquids or gases in quantities of 10,000 pounds or more.

OSHA believes that assessing the variables and assumptions inherent in determining whether five tons of gas or vapor could be released (temperature,

pressure, rate of release, etc.) using undefined "credible release scenarios," would be an unnecessary burden on employers and compliance personnel. More importantly, depending on these variables, substances might sometimes be covered and sometimes not be covered, a potentially confusing situation. Therefore, OSHA decided to use a worst case approach and assume that the entire five ton quantity of a highly hazardous chemical could be released into gas or vapor.

Paragraph (a)(1)(ii)(A) clarifies the intent not to exclude from coverage hydrocarbon fuels used for process related applications such as furnaces, heat exchangers and the like at facilities covered:

> "Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating or gasoline used for vehicle fueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard."

Paragraph (a)(1)(ii)(B) concerns flammable liquids stored or transferred which are kept below their atmospheric boiling point without benefit of chilling or refrigeration. An OSHA standard already regulates the treatment of the exempted flammable liquids (§1910.106, flammable and combustible liquids). The paragraph includes language from OSHA's standard for flammable and combustible liquids, §1910.106, "atmospheric tank" and "boiling point," and paragraph (b) provides a definition for these terms.

OSHA is convinced that the hazards associated with the manufacture of explosives and pyrotechnics also have the potential of resulting in a catastrophic incident, and pose a significant risk to employees and that the manufacture of explosives and pyrotechnics should be covered. The Agency decided to incorporate the provisions of the process safety management standard into 29 CFR 1910.109, "Explosives and Blasting Agents." This has the effect of referencing in one place the specific and significant OSHA requirements pertaining to explosives and blasting agents. §1910.109 has been revised to add a new paragraph, (k)(2), that requires the manufacture of explosives to comply with the provisions contained in §1910.119. Another new paragraph, (k)(3), that requires the

manufacture of pyrotechnics, including fireworks and flares, to comply with the provisions contained in §1910.119, has been added.

Paragraph (a)(2). With respect to the exclusion of retail facilities and normally unmanned remote facilities, OSHA believes that such facilities do not present the same degree of hazard to employees as other workplaces covered. Therefore, a comprehensive process safety management system in addition to other applicable OSHA standards addressing flammable and combustible liquids, compressed gases, hazard communication, etc., for retail facilities and unmanned remote facilities is not required.

Certainly, highly hazardous chemicals may be present in both types of work operations. However, OSHA believes that chemicals in retail facilities are in small volume packages, containers and allotments, making a large release unlikely. In normally unmanned remote facilities called "normally unoccupied remote facilities" in paragraph (b), the likelihood of an uncontrolled release injuring or killing employees is effectively reduced by isolating the process from employees. OSHA believes that the present OSHA standards contained in subpart H, such as §1910.101, compressed gases, and §1910.106 flammable and combustible liquids and in part 1910, subpart Z, toxic and hazardous substances, adequately address the chemical hazards presented in these work operations.

Oil and gas well drilling and servicing operations are excluded because OSHA had already undertaken rulemaking with regard to these activities (48 FR 57202). OSHA believes that oil and gas well drilling and servicing operations should be covered in a standard designed to address the uniqueness of that industry and believes that a separate standard dealing with such operations is necessary.

The standard for process safety management is appropriate for batch processing. The Chemical Manufacturers Association (CMA) stated during rule making:

> "CMA does not believe that facility owners/operators with batch processes should be exempted from complying with the proposed PSM standard. The key question is whether the hazardous material is present in an amount at or above the threshold quantity. If the answer to this question is yes, then the provisions of the proposed standard should apply... supports

applying the provisions of the proposed standard to any facility (batch or continuous) where the threshold quantities are exceeded."

OSHA agrees that the key question for coverage is whether the highly hazardous chemical is present in an amount at or above the threshold. However, OSHA also acknowledges concerns regarding the potential difficulty of conducting a separate process hazard analysis for each variation of a batch process. OSHA has accepted suggestions concerning the development of a generic process hazard analysis which is representative of similar batches. Accordingly, OSHA has included information in Appendix C on conducting process hazards analyses for batch operations.

Descriptions of catastrophic events described in the background section of the standard are examples of what could happen upon the release of a highly hazardous chemical and in no way reflect all incidents which have occurred or which have the potential to occur.

OSHA has developed what it considers to be a reasonable and appropriate coverage of processes involving highly hazardous chemicals and further believes that those chemicals in their threshold amounts have the potential for a catastrophic release. OSHA believes its listing of highly hazardous chemicals fully meets the intent of the Clean Air Act Amendments (CAAA) which require OSHA to promulgate "a chemical process safety standard designed to protect employees from hazards associated with accidental release of highly hazardous chemicals in the workplace" and which require the standard include a "list of highly hazardous chemicals which includes toxic, flammable, highly reactive and explosives substances."

(b) Definitions (p. 6371)

Definitions of terms as they are used in the final rule:

Atmospheric tank means a storage tank which has been designed to operate at pressures from atmospheric through 0.5 p.s.i.g. (pounds per square inch gauge, 3.45 Kpa).

Boiling point means the boiling point of a liquid at a pressure of 14.7 pounds per square inch absolute (p.s.i.a.) (760 mm.). For the purposes of this section, where an accurate boiling point is unavailable for the material in question, or for mixtures which do not have a constant boiling point, the 10 percent point of a distillation performed in accordance with the Standard Method of Test for Distillation of Petroleum Products, ASTM D-86-62, may be used as the boiling point of the liquid.

Catastrophic release means a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals, that presents serious danger to employees in the workplace.

Facility means the buildings, containers or equipment which contain a process.

Highly hazardous chemical means a substance possessing toxic, reactive, flammable, or explosive properties and specified by paragraph (a)(1) of this section.

Hot work means work involving electric or gas welding, cutting, brazing, or similar flame or spark-producing operations.

Normally unoccupied remote facility means a facility which is operated, maintained or serviced by employees who visit the facility only periodically to check its operation and to perform necessary operating or maintenance tasks. No employees are permanently stationed at the facility. Facilities meeting this

definition are not contiguous with, and must be geographically remote from all other buildings, processes or persons.

Process means any activity involving a highly hazardous chemical including any use, storage, manufacturing, handling, or the on-site movement of such chemicals, or combination of these activities. For purposes of this definition, any group of vessels which are interconnected and separate vessels which are located such that a highly hazardous chemical could be involved in a potential release shall be considered a single process.

Replacement in kind means a replacement which satisfies the design specification.

Trade secret means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Appendix D contained in §1910.1200 sets out the criteria to be used in evaluating trade secrets.

OSHA has added definitions for "atmospheric tank" and "boiling point" which are already in use in the §1910.106 standard for flammable and combustible liquids in order to clarify the exemption from coverage for flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration.

OSHA has defined "catastrophic release" leaving out any reference to "outside the immediate workplace" since OSHA only has jurisdiction to assure workplace safety.

The term "process" when used in conjunction with the application statement of the standard establishes the intent of the standard. The intent of the standard is to cover a "process" where the use, storage, manufacturing, handling or the on-site movement of a highly hazardous chemical exceeds the threshold quantity at any time. Interconnected and nearby vessels containing a highly hazardous chemical would be considered part of a single process and the quantities of the chemical

would be aggregated to determine if the threshold quantity of the chemical is exceeded.

Vessels located at more remote distances must be evaluated by the employer to determine if they would interact during an incident, and if such a reasonable condition exists these vessels would be included in the process. Where a dike is used around a liquid storage vessel to fully contain released material and prevent it from interacting with another vessel outside the dike, and neither vessel by itself contains the threshold quantity, then this physical barrier would be considered acceptable in making the two vessels remote from each other.

The term "on-site movement" should clarify that transportation falling under DOT jurisdiction is not covered.

OSHA believes that the definition of process reflects the intent of the Clean Air Act Amendment {CAAA} that the standard be designed to protect employees from hazards associated with accidental releases of highly hazardous chemicals in the workplace.

Based on comments, OSHA has decided to add a definition for "replacement in kind" to clarify the types of changes which are not intended to be included in paragraph (l), management of change. The definition means a replacement which satisfies design specifications.

Numerous commentators expressed concerns regarding trade secrets. For example, the Chemical Manufacturers Association (CMA) remarked:

> "CMA also recommends that OSHA adopt the definition for "trade secret" as found within the Hazard Communication Standard (HCS)...The final standard should also incorporate Appendix D from the HCS."

OSHA has decided to include the definition for trade secret from §1910.1200, Hazard Communication in paragraph(p).

(c) Employee Participation (p. 6372)

OSHA asked during rulemaking if the presence of an employee representative on the teams would assist in developing a cooperative participatory environment and the necessary flow of information from management to employees and from employees to management. Several rulemaking participants supported the concept of having an employee representative on both the process hazard analysis team and the incident investigation team.

The issue of employee participation in process safety management received even greater attention after the Clean Air Act Amendments (CAAA) were signed. The CAAA contains a requirement in section 304(c)(3) that the employer "consult with employees and their representatives on the development and conduct of hazard assessments and the development of chemical accident prevention plans and provide access to these and other records required under the standard."

After analysis of the CAAA and the rulemaking record on this issue, OSHA has concluded that it is important for one member of each team be an employee who is knowledgeable about the process. This employee may very well be an employee representative; or, an employee representative may be participating on a team because of some expertise that the individual can contribute to the team. However, OSHA does not believe it necessary or appropriate to mandate team membership on the basis of organization affiliation (i.e., union membership), nor does the Agency believe that this was the intent of the CAAA.

OSHA believes that the intent of the CAAA demands a broader approach to employee participation and believes that employers must consult with employees and their representatives on the development and conduct of hazard assessments (OSHA's process hazard analyses) and consult with employees on the development of chemical accident prevention plans (the balance of the OSHA required elements in the process safety management standard). And, as prescribed by the CAAA, OSHA is requiring that all process hazard analyses and all other information required to be developed by this standard be available to employees and their representatives.

OSHA believes that the provision which requires broad and active employee participation in all elements of the process safety management program through consultation will enhance the overall program. OSHA also believes that the CAAA requirements demand that an employer carefully consider and structure the plant's approach to employee involvement in the process safety management program. Consequently, OSHA is requiring the employer to address this issue to ensure active consideration of the appropriate method of employee participation in the implementation of the process safety management program at the workplace. Thus, OSHA has included a specific requirement that an employer develop a plan of action on how the employer is going to implement the employee participation requirements.

Paragraph(c)(1):

"Employers shall develop a written plan of action regarding the implementation of the employee participation required by this paragraph."

Paragraph(c)(2):

"Employers shall consult with employees and their representatives on the conduct and development of process hazard analyses and on the development of the other elements of process safety management in this standard."

Paragraph(c)(3):

"Employers shall provide to employees and their representatives access to process hazard analyses and to all other information required to be developed under this standard."

(d) Process Safety Information (p. 6374)

The employer shall develop and maintain certain important information about a covered process such as information about the hazards and characteristics of the chemicals used, information about the process technology and how it works and information about the process equipment. The compilation of information concerning process chemicals, technology and equipment provides the foundation for identifying and understanding the hazards involved in a process and is necessary in the development of a complete and thorough process hazard analysis, as well as other provisions including management of change, operating procedures, and incident investigations, etc.

OSHA has decided to allow the compilation of process safety information to occur on a schedule consistent with the schedule for conducting process hazard analyses as described in paragraph (e)(1). It is necessary to assemble the process safety information specified in order to conduct an adequate process hazard analysis. Therefore it is reasonable to allow the collection and compilation of process safety information on a given process to be completed before a process hazard analysis on that process is begun.

Paragraph (d)(1) pertains to the hazards of the highly hazardous chemicals in the process. The information shall include: toxicity information; permissible exposure limits; physical data; reactivity data; corrosivity data; thermal and chemical stability data; and the hazardous effects of inadvertent mixing of different materials that could foreseeably occur. Most of the information may already be available from the material safety data sheet (MSDS). MSDSs would be acceptable in meeting this requirement to the extent that the required information is available on the MSDS.

Paragraph (d)(2) requires that the employer develop and maintain information pertaining to the technology of the process itself.

Paragraph (d)(2)(i) specifies the required information and includes the following: a block flow diagram or simplified process flow diagram; process

chemistry; maximum intended inventory; safe upper and lower limits for such factors as temperatures, pressures, flows or compositions; and the consequences of any deviation in the process including those affecting the safety and health of employees.

Paragraph (d)(2)(ii) indicates that it might be difficult to obtain technical information for older existing processes. Therefore, it allows employers to develop such material from a hazard analysis conducted in accordance with paragraph (e). OSHA believes that a properly conducted process hazards analysis should systematically identify technical information regarding the process and allow for adequate estimation of safe parameters for the process.

Paragraph (d)(3) pertains to the equipment in the process. Since the equipment used in a process can have a significant adverse impact on the facility and employee safety, OSHA wants to assure that the equipment is appropriate for the operation and that it meets appropriate standards and codes such as those published by the American Society of Mechanical Engineers, the American Petroleum Institute, etc.

Paragraph (d)(3)(i) requires that information be compiled concerning equipment used in the process including: materials of construction; piping and instrument diagrams (P&IDs); electrical classification; relief system design and design basis; ventilation system design; design codes employed; material and energy balances for processes built after the effective date of this standard; and safety systems (such as interlocks, detection, monitoring and suppression systems).

Paragraph (d)(3)(ii) requires that the employer document that the process equipment being used is consistent with recognized and generally accepted engineering practices.

Paragraph (d)(3)(iii) requires that where existing equipment was designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the employer must ascertain that the equipment is

designed, installed, maintained, inspected, tested and operated in such a way that safe operation is assured.

There are many instances where process equipment has been in use for many years. Sometimes the codes and standards to which the equipment was initially designed and constructed are no longer in general use. For this type of situation, OSHA wants to ensure that older equipment still functions safely, and is still appropriate for its intended use. OSHA is not specifying the method for this documentation. Under this approach the employer would be permitted to use any of several methods such as: documenting successful prior operation procedures; documenting that the equipment is consistent with the latest editions of codes and standards; or performing an engineering analysis to determine that the equipment is appropriate for its intended use, and that the equipment is "designed, maintained...and operating in a safe manner rather than "operating in such a way that safe operation is assured."

OSHA believes that the provisions concerning process safety information meet the requirements in section 304(c)(1) of the CAAA. In this section OSHA must require employers to:

> (1) Develop and maintain written safety information identifying workplace chemical and process hazards, equipment used in the processes, and technology used in the processes.

(e) Process Hazard Analysis (p. 6375)

Paragraph (e)(1) requires employers to conduct an initial process hazard analysis on facilities covered by the standard in order to identify, evaluate and control the hazards of the process. By properly performing a hazard analysis, the employer can determine where problems may occur, take corrective measures to improve the safety of the process and preplan the actions that would be necessary if there were a failure of safety controls or other failures in the process. In addition, an employer shall select a process hazard analysis method which is appropriate to the complexity of the process being analyzed.

OSHA anticipates that employers will be able to readily explain their plans for completing process hazard analyses and their reasoning for prioritizing which processes will be addressed first. Therefore OSHA is requiring that employers determine and document the priority order for conducting process hazard analyses based on such considerations as the extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process. This requirement is written flexibly in recognition of the fact that different processes will require different considerations for prioritization.

A phase-in period for process hazard analyses may be necessary, particularly, for facilities with multiple covered processes. However OSHA believes that plants with a limited number of processes, with simple processes, or which have already completed a number of process hazard analyses, should complete process hazard analyses as soon as possible. In recognition that time will also be needed to compile the information required in paragraph (d), process safety information, which is needed to conduct a process hazard analysis, OSHA has adopted a schedule that requires at least 25% of the process hazard analyses to be completed each year, starting with the second year after the effective date of the standard. These provisions are listed in ***paragraphs (e)(1)(i) through (e)(1)(iv).***

Paragraph (e)(1)(v) grandfathers process hazard analyses completed after May 26, 1987. They must meet the requirements contained in paragraph (e) and

will have to be updated and revalidated, based on their completion date, in accordance with the requirements in paragraph (e)(6).

Paragraph (e) (2) proposes performance oriented requirements with respect to the process hazard analysis so that an employer would have flexibility in choosing the type of analysis that would best address a particular process. An employer may use one or more of listed methodologies to perform a process hazard analysis. The methodologies include: what-if; checklist; what-if/checklist; failure mode and effects analysis (FMEA); hazard and operability study (HAZOP); fault tree analysis; or an appropriate equivalent methodology.

While many commenters indicated that OSHA should require methodologies recognized by the American Institute of Chemical Engineers, OSHA has decided against doing so since it agrees with those participants who believed that any methodology should be allowed as long as it meets the specified criteria described in paragraph (e). Therefore OSHA has added the additional paragraph to its list of acceptable methodologies allowing employers to use other appropriate methodologies capable of adequately addressing and analyzing the elements.

Nonmandatory *Appendix D*, Sources of Further Information, provides more thorough information to employers seeking assistance in conducting process hazard analyses.

Paragraph (e)(3) lists what a hazard analysis must address.

Paragraph (e)(3)(i) requires that employers address the hazards of the process.

Paragraph (e)(3)(ii) includes a requirement for employers to identify any previous incident which had a likely potential of catastrophic consequences in the workplace. This provision is responsive to the Clean Air Act Amendments, section 304(c)(2), wherein OSHA must require employers to perform a workplace hazard assessment (OSHA's process hazard analysis), including, as appropriate, identification of potential sources of accidental release, an identification of any

previous release within the facility which had a likely potential for catastrophic consequences in the workplace, estimation of workplace effects of a range of releases, and an estimation of the health and safety effects of such ranges on employees.

> *Paragraph (e)(3)(iii)* requires that the process hazard analysis address: "Engineering and administrative controls applicable to the hazards and theirinterrelationships, such as the appropriate application of detection methodologies to provide early warning of releases. (Acceptable detection methods might include process monitoring and control instrumentation with alarms, and detection hardware such as hydrocarbon sensors)."

It should be noted, however, that detection methodologies is being used only as an example and there may be many other interrelationships that must be covered to comply with this provision for a particular process.

Paragraph (e)(3)(iv) requires employers to examine the failure of engineering and administrative controls.

Paragraph (e)(3)(v) requires that facility siting be considered during process hazard analyses.

Paragraph (e)(3)(vi) requires that employers address human factors in the process hazard analysis. Human error is but one, albeit important, cause for chemical process accidents.

Paragraph (e)(3)(vii) requires a qualitative evaluation of the possible safety and health effects of failure of engineering and administrative controls on employees in the workplace. This evaluation is for the purpose of guiding decisions and priorities in planning, for prevention and control, mitigation and emergency response.s hazard analysis.

Paragraph (e)(4) requires employers to conduct a process hazard analysis using a team approach. OSHA believes that it is imperative that the analysis be

performed by competent persons, knowledgeable in engineering and process operations, and that those persons be familiar with the process being evaluated. Some employers may have a staff with expertise to perform a process hazard analysis. This staff will already be familiar with the process being evaluated. However, some companies, particularly smaller ones, may not have the staff expertise to perform such an analysis and may need to hire an engineering or consulting company. OSHA believes it is important to note that in all situations, the team performing the process hazard analysis must include at least one employee from the facility who is intimately familiar with the process.

OSHA also believes that a team approach is the best approach for performing a process hazard analysis. This is because no one person will possess all of the knowledge and experience necessary to perform an effective process hazard analysis. Additionally, when more than one person is performing the analysis, different disciplines, opinions, and perspectives will be represented and additional knowledge and expertise will be contributed to the analysis. An added requirement is that one team member must be knowledgeable in the specific process hazard analysis methodology being used.

In ***paragraph(e)(5)***, the employer must assure that the recommendations resulting from the process hazard analysis are "resolved" in a timely manner and that the resolution is documented. In this way, when a team recommendation is incorrect, the employer can analyze it and then document in writing why the recommendation is not being adopted or is being adopted with modification. In conjunction with this change OSHA believes that when an employer decides that a recommendation requires action, the employer should develop a written schedule of the actions which are to be completed. It is OSHA's intention that the actions to be taken as a result of the process hazard analysis recommendations be completed as soon as possible. In most cases, OSHA believes that employers will be able to complete these actions within a one to two year timeframe, but notes that in unusual circumstances longer completion periods may be necessary.

Paragraph (e)(6) requires that the process hazard analysis be updated and revalidated at least every five years after the completion of the initial analysis,

using the process hazard analysis team to assure that the analysis is consistent with the current process. OSHA believes that this five year update and revalidation interval is a reasonable timeframe, particularly in consideration of the long life span, without change, of many processes.

Paragraph (e)(7) requires that employers retain the process hazard analysis and their updates and revalidation for the life of the process.

OSHA believes that the process hazard analysis provisions meet the requirements contained in section 304(c)(2), (4), and (5) of the Clean Air Act Amendments. The requirements state that the OSHA standard must require employers to:

> (2) Perform a workplace hazard assessment (OSHA's Process Hazard Analysis) including, as appropriate, identification of potential sources of accidental release, an identification of any previous release within the facility which had a likely potential for catastrophic consequences in the workplace, estimation of workplace effects of such range on employees.
>
> (4) Establish a system to respond to the workplace hazard assessment findings, which shall address prevention, mitigation, and emergency responses.
>
> (5) Periodically review the workplace hazard assessment and response system.

(f) Operating Procedures (p. 6379)

Paragraph (f)(1) contains provisions requiring the development and implementation of written operating procedures. The procedures are to provide clear instructions for safely conducting activities involved in covered processes and they must be consistent with the process safety information. To have an effective process safety management program, OSHA believes that tasks and procedures directly and indirectly related to the covered process must be appropriate, clear, consistent, and most importantly, communicated to employees. Many different tasks may be necessary during a process, such as initial startup, handling special hazards, normal operation, temporary operations and emergency shutdown. The appropriate and consistent manner in which the employer expects these tasks and procedures to be performed consistent with the facility's operating procedures is sometimes referred to as standard operating procedures.

It is important to have written operating procedures so employees working on a process do a given task in the same manner. There is less likelihood that incidents will occur if written operating procedures are developed so even a new employee or one who is relatively inexperienced will respond to a given event in a preconsidered and prescribed manner. It is also important that the procedures be written so that they can be communicated to employees in the most effective manner possible. Such written procedures comprise the employer's policy with respect to what is to be accomplished, and how it is to be accomplished safely. This will ensure that employees will perform like tasks and procedures in a consistently safe manner, and employees will know what is expected of them. These procedures must also be available for ready reference and review during production to make sure the process is operated properly.

Paragraph (f)(1)(i) requires that the operating procedures address steps for each operating phase, including initial startup, normal operation, temporary operations, emergency operations, normal shutdown, and startup following turnaround or emergency shutdown including the requirement that the employer assign shutdown responsibility to a qualified operator to ensure a safe and timely shutdown.

Paragraph (f)(1)(ii) requires that the operating procedures address the process operating limits, including the following: consequences of deviation; steps required to correct and/or avoid deviation; and safety systems (including detection and monitoring equipment) and their functions.

Paragraph (f)(1)(iii) requires that the operating procedures address safety and health considerations regarding the process, including the following: properties of, and hazards presented, by the chemicals used; precautions necessary to prevent exposure; control measures to be taken if physical contact or airborne exposure occurs; safety procedures for opening process equipment (such as pipe line breaking); quality control for raw materials and control of hazardous chemicals inventory levels; and any special or unique hazards.

Paragraph (f)(1)(iv) requires the consideration of safety systems and their functions.

Paragraph (f)(2) requires that a copy of the operating procedures be readily accessible to employees who work in or maintain a process. This requirement assures that a ready and up-to-date reference is available to employees when needed. It will also form a foundation for training which employees need under this rule.

Paragraph (f)(3) requires a review of the operating procedures to assure that they reflect current operating practices and any changes to the process or facility. Since it is extremely important to the safe operation of covered processes that operating procedures remain current and accurate, OSHA has added a precaution to guard against the use of outdated or inaccurate operating procedures by requiring that an employer verify annually that the operating procedures are current and accurate.

Throughout the rulemaking OSHA has expressed its concern regarding the control of hazardous activities within a facility and whether it should require employers to issue permits for hazardous activities in addition to those for which hot work permits were required. It had been suggested that issuing permits

would provide greater control of hazardous activities at a facility and would also facilitate a better coordination of contractor activities.

The Organization Resources Counselors (ORC) recommended and others concurred:

> "The addition of a new paragraph to...provide for the development and implementation of an on-going mechanism to ensure that all workers performing non-routine work are informed of existing hazards, appropriate precautions, and emergency procedures....
>
> The objectives of these requirements are, first, to insure that those persons operating high hazard processes are cognizant of any non-routine work (i.e., maintenance, construction, sampling or other activity) that is occurring in the process. The second objective is to insure that those in responsible control of the facility are also in control of such non-routine work so as to insure that the work does not undermine the safe control of the process. The third objective is to provide information to those workers performing non-routine work regarding the hazards and necessary precautions attendant to that work.
>
> Ordinarily, in chemical plants, maintenance and construction activities are supervised by persons other than those in direct control of the process. Implementation of these practices will insure that control over all activity in high hazard plants remains with those who manage the production units while they are in operation."

OSHA agrees that this approach will provide significant safety to employees impacted by on-going work activities.

Paragraph (f)(4) therefore requires the employer to develop and implement safe work practices to provide for the control of hazards during work activities.

OSHA believes that the provisions concerning operating procedures included in the standard meet the requirements of sections 304(c)(6) and (7) of the CAAA which state that the OSHA standard must require employers to:

> (6) Develop and implement written operating procedures for the chemical process including procedures for each operating phase, operating limitations, and safety and health considerations.

(7) Provide written safety and operating information to employees and training employees in operating procedures, emphasizing hazards and safe practices.

(g) Training (p. 6380)

The implementation of an effective training program is one of the most important steps that an employer can take to enhance employee safety. The Agency believes that an effective training program will help employees understand the nature and causes of problems arising from process operations, and will increase employee awareness with respect to the hazards particular to a process. OSHA is convinced that an effective training program will significantly reduce the number and severity of incidents arising from process operations, and can be instrumental in preventing small problems from leading to a catastrophic release.

In its analysis of the rulemaking record, the Agency identified three broad topics that were addressed by rulemaking participants in relation to the proposed provision concerning initial training (*Paragraph (g)(1)*). These topics were: the application of the proposed provision (to whom the training applies); OSHA's approach (including the amount and method of training, and the content of the training program); and, grandfathering of training (the recognition of training received by employees prior to promulgation of this standard).

Application. Several rulemaking participants remarked that the training coverage for "employees involved in a process" was too broad, and could be misinterpreted to mean contractor employees and maintenance employees, in addition to the operating employees that they assumed that the proposed provision was meant to address. They suggested that this proposed paragraph be renamed "Operator Training" and the applicability of this proposed paragraph be clarified; or, they suggested addressing training for all employees in this proposed paragraph, including training for contractor employees and maintenance employees. When OSHA proposed that this provision apply to employees "involved in a process," it intended for this provision to apply to only those employees, including managers and supervisors, who are actually involved in "operating" the process. While most OSHA standards, by their terms, apply to all employees in a particular situation and contract employees are considered "employees" in the broad sense of the word, this standard distinguishes in the training requirements between contract employees and direct hire employees. This was done primarily

for emphasis and in recognition of the fact that in some segments of industry covered by the process safety management standard, contractors make up a substantial portion of on-site workers. OSHA wanted to focus attention on that situation and did so by imposing separate but similar training objectives for direct hire and contract employees. This is the reason that training requirements for contractor employees and maintenance employees were addressed in separate paragraphs in the proposal.

OSHA agrees with rulemaking participants that this intent was not clear in the proposed rule. Therefore, the phrase "involved in a process" is being replaced with the phrase "involved in operating a process" in paragraph (g)(1) of the final rule. This is intended to cover all direct hire employees not involved in maintenance. This paragraph is not intended to be limited to equipment operators. OSHA believes that this change together with other changes made to the training requirements for contractor and maintenance employees (addressed in paragraphs (h) and (j), respectively), will clarify the Agency's intent.

Approach. A few rulemaking participants disagreed with OSHA's performance-oriented approach with respect to training, and contended that the proposed training requirements were inadequate and should be strengthened. For example, USWA and the International Chemical Workers Union recommended specific subjects that an effective training program should include, and suggested that a stratified approach to training be used by OSHA in the final rule. This stratified approach would consist of a minimum number of hours of training for two categories of employees: employees who have the potential to affect imminent danger situations and employees who have the potential to be affected by but not affect any imminent danger situations.

A few other rulemaking participants also suggested that OSHA specify a minimum number of training hours in the final rule. However, the vast majority of rulemaking participants supported a performance-oriented approach to training. They asserted that there were several levels of complexity of operations among the various covered processes and experience and skill levels vary widely among employees. As a result, a specified number of training hours might be too

little for some employees, and more than is actually needed by other employees.They contended that the employer should evaluate the complexity of operation, experience, and skill levels of employees. With this information, the employer would be able to determine the content of the training program as well as the amount and frequency of training that would best assure that employees will be able to perform their job tasks in a safe and effective manner.

After analysis of the rulemaking record, OSHA has concluded that a performance-oriented approach to training is appropriate. The Agency believes that employers can determine the amount of training and the content of the training program that best reflects the operation's complexity and the experience and necessary skill level of their employees.

> *Paragraph (g)(1)(i)* requires that:
> "Each employee presently involved in operating a process, and each employee before being involved in operating a newly assigned process, shall be trained in an overview of the process and in the operating procedures as specified in paragraph (f) of this section. The training shall include emphasis on the specific safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks."

Previous training should be recognized if the employer certifies in writing that employees have the required knowledge, skills, and abilities to safely carry out their duties and responsibilities, particularly since employees must still be provided with refresher training in accordance with paragraph (g)(2).

Paragraph (g)(1)(ii) allows grandfathering of initial training under certain circumstances, as follows:

> "In lieu of initial training for those employees already involved in operating a process on May 26,1992, an employer may certify in writing that the employee has the required knowledge, skills, and abilities to safely carry out the duties and responsibilities as specified in the operating procedures."

Paragraph (g)(2) requires refresher training to be provided to each employee at least every three years.

> The rule reads as follows:
> "Refresher training shall be provided at least every three years, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures in the process. The employer, in consultation with the employees involved in operating a process, shall determine the appropriate frequency of refresher training."

Paragraph (g)(3) requires the employer to document that employees have received and successfully completed the required training. It also requires to identify the employee and the date of the training.

The purpose of this provision is to assure that employees not only receive training but, also, that they understand and can demonstrate what they have learned in order to perform their job tasks safely. This is especially important where, as here, comprehensive training and the understanding of the training plays such a crucial role in the risk reduction associated with the process safety management rule.

Based on the rulemaking record, OSHA believes that its performance-oriented approach with respect to the certification of training is appropriate and it recognizes that any one of several methods, or combination of methods, can be effective in verifying that employees understand the training that they have received. Employers are therefore free to devise the method that works best in their establishment to ascertain that employees have understood their training. Additionally, the Agency believes that it is important that the training documentation contain the name of the person conducting the training.

Section 304(c)(9) of the Clean Air Act Amendments mandated that this standard contain a provision requiring employers to "train and educate employees and contractors in emergency response in a manner as comprehensive and effective as that required by the regulation promulgated pursuant to section 126(d) of the

Superfund Amendments and Reauthorization Act" (SARA). That section of SARA requires that workers receive a specified minimum number of hours of training unless the worker "has received the equivalent of such training."

It is the Agency's position that the training requirements contained in paragraph (g), together with the requirements pertaining to emergency planning and response contained in paragraph (n) (particularly the training requirements mandated by §1910.38(a)), provide "equivalent training" to the training required for emergency response under section 126(d) of SARA. In addition, those employees who would be involved in emergency response must meet the training requirements in §1910.120, Hazardous Waste Operations and Emergency Response, referenced in paragraph (n), which is directly responsive to section 126(d) of SARA.

(h) Contractors (p. 6384)

This paragraph attempts to distinguish between the many types of contract workers who may be present at a job site and indicates the type of contract worker that the special training provisions of the regulation are attempting to cover. Among the many categories of contract labor that may be present at a particular job site, it is important to appreciate the differences among them. For example, contractors may actually operate a facility for an owner (who may own the facility but have little to do with the daily operation). In this case the contractor is the employer responsible for the covered processes and would obviously be treated as the "employer." Some contractors are hired to do a particular aspect of a job because they have a specialized area of expertise of which the host employer has little knowledge or skill (for example, asbestos removal). Other contractors work on site when the operation has need for increased manpower quickly for a short period of time, such as those involved in a turnaround operation. While paragraph (h)(2) sets forth the duties of the host employer to contract employers, the extent and the depth of these duties will depend to some degree on the category of contractor present. For example, should a contract employer provide employees to operate a process, then those employees would obviously have to be trained to the same extent as the directed hire employees "involved in operating a process" under paragraph (g).

Generally speaking, OSHA standards cover all employees including contract employees. In something of a break with tradition, the process safety management rule has separate provisions covering the training of contract employees. This was done primarily for emphasis since contract employees make up a significant portion of some segments of industries covered by the final rule. This is not to say, however, that paragraph (h) is the only section of the process safety rule that applies to contractors. As already indicated, under appropriate circumstances, all of the provisions of the standard may apply to a contractor (i.e., a contractor operated facility). After all, employees of an independent contractor are still employees in the broadest sense of the word and they and their employers must not only follow the process safety management rule, but they must also take care that they do nothing to endanger the safety of those working

nearby who work for another employer. Moreover, the fact that this rule has a separate section that specifically lays out the duty of contractors on the job site does not mean that other OSHA standards, lacking a similar section, do not apply to contract employers.

OSHA agreed with several commenters who suggested further strengthening of the contractor provisions in the final standard. For example, the Associated Builders and Contractors (ABC) asserted:

> "We urge OSHA to expand and strengthen Subparagraph (h) of the proposed rule to clearly assign responsibility to the plant manager and the contractor with respect to the training and supervision of contract worker. Subparagraph (h) should specifically state that the contractor is responsible for training and supervising its own employees to ensure that they perform their jobs safely and in accordance with the facility's safety rules. The standard should address safety in the selection of contractors, requiring facility owners to obtain and assess the safety performance records of contractors during a pre-bid, qualification round. Similarly, facility owners should conduct periodic reviews of contractors' safety records throughout the performance of the contract and verify contractors are fulfilling their responsibility to provide appropriate health, safety and craft training.
>
> Safety is a shared responsibility. The facility owner hires the contractor for their expertise and contracts for supervisory personnel, as well as skilled tradesmen. The contractor has been selected for their ability to do the job correctly and safely which requires providing personnel with appropriate craft and safety training for each task. Consequently, the contractor is in the best position to train and supervise its own employees.
>
> Communication between plant management and contractors is essential for a safe workplace. The facility owner must provide the contractor with sufficient information to enable the contractor to educate their employees about existing chemicals, potential hazards and site specific safety and health procedures. The contractor must provide its employees with site specific and task specific safety training. Owners may require the contractor to provide additional training on specified topics, and in some instances, may provide funding for the additional training. The facility owners should monitor the contractor's training of employees and audit the contractor's performance."

OSHA would like to direct interested persons to *Appendix D*, Sources of Further Information, which lists several sources of helpful assistance to employers who use contractors.

Contractors providing incidental services are adequately covered under the 29 CFR 1910.1200, Hazard Communication standard. Therefore, the contractor application provision better reflects OSHA's intent regarding which contractors will be covered by the standard.

Paragraph (h)(1), Application, reads as follows:

> "This paragraph applies to contractors performing operating duties, maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process area. It does not apply to contractors providing incidental services which do not influence process safety, such as janitorial work, food and drink services, laundry, delivery or other supply services."

The provisions concerning employer responsibilities read as follows:

Paragraph (h)(2), Employer responsibilities:

> *(i)* The employer, when selecting a contractor, shall obtain and evaluate information regarding the contract employer's safety performance and programs.
>
> *(ii)* The employer shall inform contract employers of the known potential fire, explosion, or toxic release hazards related to the contractors work and the process.
>
> *(iii)* The employer shall explain to contract employers the applicable provisions of the emergency action plan required by paragraph (n) of this section.
>
> *(iv)* The employer shall develop and implement safe work practices consistent with paragraph (f)(4) of this section, to control the entrance, presence and exit of contract employers and contract employees in process areas covered by this section.

(v) The employer shall periodically evaluate the performance of contract employers in fulfilling their obligations as specified in paragraph (h)(3).

(vi) The employer shall maintain a contract employee injury and illness log related to the contractor's work in process areas.

Paragraph (h)(2)(i) requires that an employer, when selecting a contractor, obtain and evaluate information regarding a contractor employer's safety performance and programs. OSHA believes that an employer should be fully informed about a contract employer's safety performance. Therefore the Agency is requiring an evaluation of a contract employer's safety performance (e.g., an employer's experience modification rate) and safety programs. OSHA believes that evaluating safety performance and programs is an important measure in preserving the integrity of processes involving highly hazardous chemicals. OSHA anticipates that the requirement will provide employers an opportunity to assure that they are not introducing additional hazards to their processes; and will give employers an opportunity to request that contract employers improve their safety performance or make other adjustments to their safety programs in order to enhance the safety of all employees working in processes involving highly hazardous chemicals. The rule, being performance oriented, does not require that employers refrain from using contractors with less than perfect safety records. However, the employer does have the duty to evaluate the contract employer's safety record and safety programs. Where the evaluation indicates some gaps in the contract employer's approach to safety, the employer may need to be more vigilant in the oversight and may need to develop and implement more stringent safe work practices to control the presence of contractors in covered process areas (see (h)(2)(iv)).

Paragraphs (h)(2)(ii) and (iii) require the communication of basic process hazard and emergency information to contract employers.

Paragraph (h)(2)(iv) references safe work practices; see discussion in paragraph (f), operating procedures.

Paragraph (h)(2)(v) requires employers to periodically evaluate the performance of contract employers in fulfilling their obligations.

Paragraph (h)(2)(vi) requires a log of injuries and illnesses to be kept by the employer. An employer should be informed of all of the injuries and illnesses occurring in processes involving highly hazardous chemicals at the plant regardless of whether they be the employer's employees or the contractor's employees.

Paragraph (h)(3), Contract Employer Responsibilities, includes the following provisions:

> *(i)* The contract employer shall assure that each contract employee is trained in the work practices necessary to safely perform his/her job.
>
> *(ii)* The contract employer shall assure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the process, and the applicable provisions of the emergency action plan.
>
> *(iii)* The contract employer shall document that each contract employee has received and understood the training required by this paragraph. The contract employer shall prepare a record which contains the identity of the contract employee, the date of training, and the means used to verify that the employee understood the training.
>
> *(iv)* The contract employer shall assure that each contract employee follows all applicable work practices and safety rules of the facility including the safe work practices required by paragraph (f)(4) of this section.
>
> *(v)* The contract employer shall advise the employer of any unique hazards presented by the contract employer's work, or of any hazards found during the contract employer's work.

Paragraphs (h)(3)(i) and (ii) require the communication of basic process hazard and emergency information by the contract employer to the contract employees.

Paragraph (h)(3)(iii) requires the contract employer to document that each contract employee has received and understood required training.

Paragraph (h)(3)(iv) requires that contract employers assure that their employees follow the rules of the facility.

Paragraph (h)(3)(v) requires that contract employers inform the plant employer of the hazards presented by the contractor's work, and also that the contractor informs the employer of any hazards found during the contractor's work.

Section 304 the Clean Air Act Amendments (CAAA) states that the OSHA standard must require employers to:

> (8) Ensure contractors and contract employees are provided appropriate information and training.
>
> (9) Train and educate employees and contractors in emergency response in a manner as comprehensive and effective as that required by the regulation promulgated pursuant to section 126(d) of the Superfund Amendments and Reauthorization Act.

OSHA believes that the contractor provisions contained in the standard meet the requirements contained in section 304(c)(8) and (9) of the CAAA in a manner as comprehensive and effective as that required by the regulation promulgated pursuant to section 126(d) of the Superfund Amendments and Reauthorization Act for the reasons described in the preamble discussion regarding section 126(d) of the Superfund Amendments in paragraph (g), Training.

(i) Pre-startup Safety Review (p. 6388)

The standard requires the employer to perform a pre-startup safety review for new facilities and for modified facilities when the modification necessitated a change to the process safety information.

It is not the intent to require a pre-startup safety review for each facility that may be modified slightly; it is necessary for modified facilities only when the modification is significant enough to require a change in the process safety information.

Paragraph (i)(1) requires that:

> "The employer shall perform a pre-startup safety review for new facilities and for modified facilities when the modification is significant enough to require a change in the process safety information."

Paragraph (i)(2) requires that the pre-startup safety review confirm that construction is in accordance with design specifications, (*(i)(2)(i)*); safety, operating, maintenance, and emergency procedures are in place and adequate (*(i)(2)(ii)*); process hazard analysis recommendations have been addressed and actions necessary for startup have been completed (*(i)(2)(iii)*); and, operating procedures are in place and training of each operating employee have been completed (*(i)(2)(iv)*).

OSHA wants to assure that a process hazard analysis is performed for new facilities before start-up, and that recommendations resulting from the process hazard analysis have been addressed before startup. Any actions necessary before startup in modified facilities will be addressed by the requirements contained in paragraph (l) pertaining to management of change.

(j) Mechanical Integrity (p. 6388)

Paragraph (j)(1) contains requirements for maintaining the mechanical integrity of process equipment. It specifies certain process equipment including pressure vessels and storage tanks; piping systems (including piping components such as valves); relief and vent systems and devices; emergency shutdown systems; controls, alarms, and interlocks; and pumps to which the standard applies. Any of this equipment could have a significant impact on the safety of a process that is covered by this standard if the equipment was improperly designed or installed or, if such equipment did not function as intended.

The goal of the mechanical integrity provisions is to ensure that highly hazardous chemicals covered by the standard are contained within the process and not released in an uncontrolled manner. The equipment listed in paragraph (j)(1) constitutes process equipment that the Agency considers critical in achieving this goal.

Process equipment will vary from process to process. This is the reason that the Agency did not propose that the employer determine the equipment "critical" to the process. Equipment considered critical to a process by one employer may not necessarily be considered critical to a different process by another employer. As a result, there could be confusion with respect to which equipment is subject to the requirements contained in paragraph (j).

The Agency believes that there is certain equipment, critical to process safety, that is common to all processes. This is the equipment specified in paragraph (j)(1). It is the position of OSHA that at least the equipment specified in the standard must be subject to the requirements contained in paragraph (j). However, if an employer deems additional equipment to be critical to a particular process, that employer should consider that equipment to be covered by this paragraph and treat it accordingly.

All process equipment within a plant is not necessarily associated with Appendix A materials or flammable liquids or gases. Paragraph (j)(1) is intended to cover only that equipment associated with a process that is covered by this standard.

Paragraph (j)(2) pertains to written procedures with respect to mechanical integrity.

Paragraph (j)(3), Training for Process Maintenance Activities, states :

> "The employer shall train each employee involved in maintaining the on-going integrity of process equipmentin an overview of that process and its hazards and in the procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner."

Paragraph (j)(4), Inspection and Testing:

Paragraph (j)(4)(i) requires inspections and tests to be performed on specified process equipment because of the potential safety and health hazards that could result if the equipment malfunctioned.

> ***Paragraph (j)(4)(ii)*** requires that:
> "Inspection and testing procedures shall follow recognized and generally accepted good engineering practices."

This provision is a performance-oriented requirement that provides flexibility for the employer to choose the frequency which provides the best assurance of equipment integrity. The phrase "recognized and generally accepted good engineering practices" includes both appropriate internal standards and applicable codes and standards.

> ***Paragraph (j)(4)(iii)*** requires that :
> "The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturers' recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience."

Since OSHA permits inspection and test procedures to follow recognized and generally accepted good engineering practices, the Agency believes that different

information should be included in the record to identify the inspections and tests that were performed, and the results of those tests and inspections.

Therefore, ***paragraph (j)(4)(iv)*** reads as follows:
"The employer shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test; the name of the person who performed the inspection or test; the serial number or other identifier of the equipment; the inspection or test that is performed; and, the results of the inspection or test."

Paragraph (j)(5), Equipment Deficiencies, reads as follows:
"The employer shall correct deficiencies in equipment that are outside the acceptable limits defined by the process safety information in paragraph (d) before further use, or in a safe and timely manner when necessary means are taken to assure safe operation."

Paragraph (j)(6) pertaines to quality assurance of mechanical equipment.

Paragraph (j)(6)(i) reads as follows:
"In the construction of new plants and equipment, the employer shall assure that equipment as it is fabricated is suitable for the process application for which it will be used."

Paragraph (j)(6)(ii) requires appropriate checks and inspections to be performed as necessary to assure that equipment is installed properly and consistent with design specifications and manufacturer's instructions.

Paragraph (j)(6)(iii) requires that:
"The employer shall assure that maintenance materials, and spare parts and equipment are suitable for the process application for which they will be used."

(k) Hot Work Permit (p. 6392)

The employer is required to issue a permit for all hot work operations. The purpose of this provision is to assure that the employer is aware of the hot work being performed, and that appropriate safety precautions had been taken prior to beginning the work. The permit should remind the person performing the work of the steps necessary to perform the work safely; and if the hot work is performed on or near a covered process, then a permit should be required regardless of who is present.

Paragraph (k)(1) requires that:

> "The employer shall issue a hot work permit for hot work operations conducted on or near a covered process."

Paragraph (k)(2) requires the permit to document that the fire prevention and protection requirements contained in 29 CFR 1910.252(a) had been implemented prior to beginning the hot work operations; indicate the date authorized for the hot work; and identify the equipment or facility on which the hot work was to be performed. It also requires the permit to be kept on file until completion of the hot work.

(l) Management of Change (p. 6393)

One of the most important and necessary aspects of a process safety management program is appropriately managing changes to the process. This is because many of the incidents that the Agency has reviewed resulted from some type of change to the process. It is necessary to thoroughly evaluate any contemplated changes to a process to assess the potential impact on the safety and health of employees and to determine what modifications to operating procedures may be necessary.

Paragraph (l)(1) requires the employer to establish and implement written procedures to manage changes (except for "replacement in kind") to process chemicals, technology, equipment, and procedures; and changes to facilities that effect a covered process. A definition for "replacement in kind" is included in paragraph (b) of this section.

Paragraph (l)(2) contains several considerations that must be addressed prior to any change:

- *(i)* The technical basis for the proposed change;
- *(ii)* Impact of change on safety and health;
- *(iii)* Modifications to operating procedures;
- *(iv)* Necessary time period for the change; and
- *(v)* Authorization requirements for the proposed change.

Paragraph (l)(3) requires that employees involved in the process be informed of and trained in the change in the process as early as practicable prior to its implementation. All employees whose job tasks will be impacted by a change must be informed of and trained in those changes with respect to what affect such changes will have on their job tasks. Otherwise, contract employees or maintenance employees who are unaware of the change, may unwittingly cause an incident by doing their job tasks as they have in the past. OSHA believes this training requirement to be important for maintenance and contract employees as well as those employees involved in operating a process. This information and training provision applies to operating employees as well as to maintenance and contract employees whose job tasks will be affected by the change. The

requirements contained in this provision must be completed before start-up and not necessarily before implementation of the change.

Paragraph (l)(4) requires that if a change covered by this paragraph results in a change to the process safety information, that such information be appended and/or updated in accordance with paragraph (d) of this section.

Paragraph (l)(5) requires that if a change covered by this paragraph results in a change to the operating procedures, such procedures shall be appended and/or updated in accordance with paragraph (f) of this section.

(m) Incident Investigation (p. 6394)

Requirements for incident investigation are included because a crucial part of any process safety management program is the thorough investigation of any incident that resulted in, or could reasonably have resulted in a catastrophic release of a highly hazardous chemical in the workplace. Such investigations are extremely important for identifying the chain of events leading to the incident and for determining causal factors. Information resulting from the investigation will be invaluable to the development and implementation of corrective measures and for use in subsequent process hazard analyses.

Proposed paragraph (m)(1) required the employer to investigate every incident which results in, or could reasonably have resulted in (near miss), a major accident in the workplace. Several rulemaking participants were opposed to the use of the term "major accident." These commenters contended that if this term is to be used, then OSHA should define "major." Other rulemaking participants suggested that the term "major accident" be replaced with the term "catastrophic release" and then "catastrophic release" should be defined. The Agency has decided to replace the term "major accident" with the term "catastrophic release" since this term is more consistent with the focus of the rule and as discussed has added a definition for "catastrophic release" to paragraph (b). Consequently,

Paragraph (m)(1) has been revised to read as follows:

> "The employer shall investigate each incident which resulted in, or could reasonably have resulted in a catastrophic release of a highly hazardous chemical in the workplace."

Paragraph (m)(2) requires incident investigations to be initiated as promptly as possible, but no later than 48 hours following the incident. It is important that an incident investigation be initiated promptly so that events can be recounted as clearly as possible; to preserve crucial evidence; and so that there is less likelihood that the scene will have been disturbed. The Agency also realizes that circumstances may not facilitate an immediate investigation because of the potential emergency nature of some incidents. This is the reason that this provision requires investigations to be initiated as promptly as possible, "but not

later than 48 hours following the incident." OSHA believes that 48 hours is a reasonable time frame within which to initiate an investigation. It should also be noted that the investigation need only be initiated within this timeframe, not completed, although it is contemplated that there will not be unnecessary delay between initiation and completion of the incident investigation.

Paragraph (m)(3) requires that:

> "An incident investigation team shall be established and consist of at least one person knowledgeable in the process involved, including a contract employee if the incident involved work of the contractor, and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident."

The intent of OSHA is to assure that team members have the ability to properly perform the investigation promptly and that the employer have the flexibility to select team members (in consultation with employees and their representatives as described in paragraph (c)) that possess this ability. Additionally, the Agency believes that in cases where an incident involved a contract employer's work, then a contract employee should be involved in the investigation.

Paragraph (m)(4) requires a report to be prepared at the conclusion of the investigation which included, at a minimum, the date of the incident; date that the investigation began; a description of the incident; the factors that contributed to the incident; and, any recommendations resulting from the investigation.

Paragraph (m)(5) requires that:

> "The employer shall establish a system to promptly address and resolve the report findings and recommendations. Resolutions and corrective actions shall be documented."

There may be situations where it is not necessary or appropriate to implement all of the report recommendations. It is the Agency's position, however, that it is necessary to document the resolution of the report findings and recommendations to assure that they have been adequately considered.

Paragraph (m)(6) requires that the report be reviewed with all operating, maintenance, and other personnel whose work assignments are within the facility where the incident occurred. The provision should more accurately identify to whom this information should be disseminated. Additionally, the Agency believes that the logical progression of an incident investigation is to address the report recommendations before disseminating the information contained in the report to affected personnel.

Paragraph (m)(7) requires incident investigation reports to be retained for five years in order to determine if an incident pattern develops or exists.

(n) Emergency Planning and Response (p. 6396)

The employer is required to establish and implement an emergency action plan in accordance with the provisions contained in 29 CFR 1910.38(a). For information purposes, the Agency also added a note that 29 CFR 1910.120(a), (p) and (q) may also be applicable.

OSHA believes that the implementation of an emergency action plan is extremely important for plant sites which have processes covered by this standard because of the potential hazards posed by highly hazardous chemicals and the elements of the emergency action plan which must be implemented to preplan for emergencies involving these substances (including training) so that employees will be aware of, and execute, appropriate actions.

The emergency action plan requires at a minimum, the implementation of, and training employees in, the following procedures:

Emergency escape procedures and emergency escape route assignments.

Procedures to be followed by employees who remain to operate critical plant operations before they evacuate.

Procedures to account for all employees after emergency evacuation has been completed;

Rescue and medical duties for those employees who are to perform them;

Preferred means of reporting fires and other emergencies; and

Names or regular job titles of persons or departments who can be contacted for further information or explanation of duties under the plan.

The emergency action plan also requires the establishment of a system to alert employees of an emergency. If the alarm system is to be used for alerting fire brigade members, or for some other purpose, a distinctive signal must be used for each purpose.

With respect to training, employers must review the emergency action plan with each employee initially when the plan is developed, whenever the employee's responsibilities or designated actions under the emergency action plan changes, and whenever the emergency action plan, itself, is changed. OSHA believes that the preplanning and training required by the emergency action plan will assure the readiness of employees to respond appropriately and safely to emergencies involving highly hazardous chemicals.

Additionally, as a part of emergency planning, OSHA is adding a provision that employers develop procedures to address small releases and spills, since it is not always obvious when such an event is, or is not, an emergency situation; and such an event may also warrant initiating an incident investigation.

(o) Compliance Safety Audits (p. 6396)

This paragraph includes provisions pertaining to an evaluation of an employer's process safety management system. OSHA believes that an audit with respect to compliance with the provisions contained in this section is an extremely important function. This is because it serves as a self-evaluation for employers to measure the effectiveness of their process safety management system. The audit can identify problem areas, and assist employers in directing attention to process safety management weaknesses.

Paragraph (o)(1) requires employers to certify that they have evaluated compliance with the provisions of this section, at least every three years.

Paragraph (o)(2) requires that the audit to be performed by at least one person knowledgeable in the process, but it is not necessary that it be performed by a team.

Paragraph (o)(3) requires a report of the findings of the audit to be developed.

Paragraph (o)(4) requires the employer to promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies have been corrected. The purpose of this paragraph is to assure that employers determine an appropriate response to each of the report findings and if employers identify a deficiency that needs to be corrected, that they "document" the correction of the deficiency.

Paragraph (o)(5) requires employers to retain the two most recent compliance audit reports, as well as the documented actions described in paragraph (o)(4) of this section. The purpose of this provision is to focus on any continuing areas of concern that are identified through the compliance audits.

(p) Trade Secrets (p. 6397)

As to concerns that OSHA might itself reveal trade secret information, it should be noted that employers are amply protected under the U.S. Code, the Occupational Safety and Health Act and regulations promulgated under the Act. Federal law makes it a criminal offense for federal employees to disclose trade secret information that is not authorized by law (18 U.S.C. 1905). Section 15 of the Occupational Safety and Health Act (the Act) requires that all information reported to or obtained by a Compliance Safety and Health Officer (CSHO) in connection with any inspection or other activity which contains or which might reveal a trade secret be kept confidential. Such information shall not be disclosed except to other OSHA officials concerned with the enforcement of the Act or, when relevant, in any proceeding under the Act. Other OSHA regulations further assure the protection of trade secrets (29 CFR 1903.7(b) and 1903.9). And the OSHA Field Operations Manual further emphasizes this point by stating "it is essential to the effective enforcement of the Act that the CSHO and all OSHA personnel preserve the confidentiality of all information and investigations which might reveal a trade secret" (III-58). Moreover, trade secret information is specifically excluded from disclosure under the Freedom of Information Act (5 U.S.C. 552(b)(4)).

As a general matter, OSHA believes that there are relatively few bona fide trade secrets among the information that is required to be gathered under this standard. However, the addition of provisions to protect trade secrets will give employers with legitimate trade secret concerns adequate protection, but require that they withhold information only on the basis of sound, legal justification.

OSHA has reviewed the definition of "trade secret" that is used in the Hazard Communication standard (29 CFR 1910.1200) and has decided to incorporate that definition of trade secret into the final standard. The Agency believes that this definition of trade secret is broad enough to offer adequate protection to employers with legitimate trade secrets, it is consistent with that used in the Restatement of Torts, and it has the additional advantage of being uniform with that used in the Hazard Communication standard so that many employers are

already familiar with it. The rule also incorporates Appendix D of the Hazard Communication standard which contains criteria to be used in determining whether material meets the definition of trade secret.

The Agency has decided that the best way is to adopt language that will clearly indicate the accessibility and the procedures for obtaining trade secret information under the final rule. Although the trade secret provisions (§1910.1200(i)) of the Hazard Communication standard alone would take care of access to all trade secret information pertinent to the process safety management rule, some may feel that their application might be limited to chemical identity information. In order to clarify its intent, OSHA has specifically stated in the rule that the employer must make all relevant information available to those individuals involved in carrying out various information using and compiling activities required by the final rule regardless of whether the information in question is considered a trade secret or not. This is vital to the effective operation of the process safety management rule. It is questionable as to how useful a compliance safety audit or a process hazard analysis could be if some of the information necessary to their completion were denied or delayed. The language is written in this way to emphasize the right to access this information. However, the employer may take reasonable steps, such as those described in the Hazard Communication standard, to protect against the unauthorized disclosure of trade secrets to unauthorized third persons. Such steps include the signing of a confidentiality agreement.

OSHA believes that employees and their representatives also may have the need to access such information. The rule assures employees access to the process hazard analysis and other information required to be developed under the standard. Under certain circumstances, however, it might be appropriate to substitute more general information or to require some sort of a balancing of the need to know the information with the need to protect the employer. Therefore, the Agency is incorporating into the rule the access procedures that were developed under the Hazard Communication standard with the exception of §1910.1200(i)(13). Section 1910.1200(i)(13) provides "nothing in this paragraph shall be construed as requiring the disclosure under any circumstances of process or percentage of mixture information which is a trade secret." That section is not

being incorporated into the process safety management trade secret provisions in recognition of the fact that employees are entitled to certain process information under the process safety management standard and this process information may at times contain trade secret information. There is no reason why the Hazard Communication information access provisions will not work well for information contained in the process hazard analysis and other documents that contain trade secrets. Employers bear the burden of demonstrating that their trade secret claim is bona fide. The Agency will evaluate the appropriateness of that substantiation in the event that an employer denies a legitimate request for disclosure of the trade secret and a complaint is subsequently made to OSHA.

Paragraph (p)(1):

> "Employers shall make all information necessary to comply with the section available to those persons responsible for compiling the process safety information (required by paragraph (d)), those assisting in the development of the process hazard analysis (required by paragraph (e)), those responsible for developing the operating procedures (required by paragraph (f)), and those involved in incident investigations (required by paragraph (m)), emergency planning and response (paragraph (n)) and compliance audits (paragraph (o)) without regard to possible trade secret status of such information."

Paragraph (p)(2):

> "Nothing in this paragraph shall preclude the employer from requiring the persons to whom the information is made available under paragraph (p)(1) of this section to enter into confidentiality agreements not to disclose the information as set forth in 29 CFR 1910.1200."

Paragraph (p)(3):

> "Subject to the rules and procedures set forth in 29 CFR 1910.1200(i)(1) through 1910.1200(i)(12), employees and their designated representatives shall have access to trade secret information contained within the process hazard analysis and other documents required to be developed by this standard."

INCLUSION OF TOPICS FROM THE OSHA PROCESS SAFETY MANAGEMENT STANDARD IN THE CHEMCIAL ENGINEERING CURRICULUM

Process Principles
- Block flow diagrams
- Process flow diagrams
- Process chemistry
- Material safety data sheets
- Material & energy balances

Fluid Flow, Thermodynamics & Kinetics
- Piping systems, components
- Relief valve & vent sizing
- Reaction hazards & byproducts
- Effects of impurities
- Runaway reaction potential

Process Control & Materials Science
- Materials selection
- Corrosion
- Pumps, piping systems, valves
- P&IDs
- Monitors, sensors, interlocks, alarms

Unit Operations Lab – 1
- Respiratory protection
- Personal protective equipment
- Safety systems & functions
- Electrical classification
- Chemical properties & hazards
- Control of hazardous chemical inventories
- Process safety information
- Process hazard analysis

Unit Operations Lab – 2

- Operating procedures
- Initial startup, operation, shutdown
- Temporary & emergency operations, emergency shutdown
- Startup following shutdowns
- Safe operating limits: T, P, x_i or y_i
- Operating limits: consequences & prevention of deviations
- Emergency planning & response

Process & Plant Design

- Design codes & standards
- Pressure vessels, storage tanks
- Over-pressure hazards
- Relief & vent systems, devices
- Consequences of deviations
- Management of change
- Incident investigation

Process Safety Management of Highly Hazardous Chemicals

Process Safety Management of Highly Hazardous Chemicals

Catastrophic Events

	Deaths	Injuries
1989 Pasadena, TX	23	130
1990 Houston, TX	17	--
1990 Cincinnati, OH	2	72
1991 Lake Charles, LA	5	--
1991 Sterlington, LA	8	120^{+}
1991 Charleston, SC	6	33
1991 Seadrift, TX	1	32

Catastrophic Events

	Deaths	Injuries
1984 Mexico City	650	--
1984 Bhopal, India	2000	--
1984 Chicago area	17	17
1985 West Virginia	--	135
1988 New Orleans	5	23
1988 Henderson, NV	2	350

Process Safety Management

Bhopal: focused OSHA's attention
Institute WV: disasters can happen here
1988-1990: public → Congressional concern

Anticipated Benefits

OSHA estimated that the integrated approach of the PSM standard would reduce the average annual number of deaths (265) by 200 and reduce the average annual number of serious injuries (900) by 700 in industries involved with highly hazardous chemicals.

Resources

- European Economic Community (EEC)
- World Bank
- International Labor Office (ILO)
- U.S. Environmental Protection Agency
- Superfund Amendments and Reauthorization Act (SARA)
- States, Industry and Labor Organizations

OSHA's Process Safety Management Standard

Process Safety Management (PSM)

is the proactive identification, evaluation and mitigation or prevention of chemical releases that could occur as a result of failures in processes, procedures, or equipment.

Purpose

- Prevent Catastrophic Releases of Highly Hazardous Chemicals
- Minimize Consequences of Such Releases to Employees and the Community

PSM Standard

- Holistic approach
- Integrates technologies
- Comprehensive procedures
- Management practices

PSM Standard

- Process safety information
- Process hazard analysis
- Operating procedures
- Training
- Contractors
- Pre-startup safety review

PSM Standard

Mechanical integrity
Hot-work permits
Management of change
Incident investigations
Emergency planning and response
Compliance safety audits

Anticipated Results

- Safety Integrity
- Improved Process Efficiency
  - quality control
  - minor design changes
  - operating changes

What's NOT Covered

- HC fuels used only for workplace consumption & if not a part of a covered hazardous process
- Flammable liquids stored or transferred below NBP w/o chilling or refrigeration
- Retail facilities
- Oil, gas well drilling, servicing
- Normally unmanned remote facilities

What's Covered

- Listed chemicals (Appendix A)
- > 10,000 pounds of flammable liquids or gases

Acetaldehyde
Chlorine
Ethylamine
HF
H_2S
Ketene
Nitromethane
NO
Perchloric Acid
Phosgene
Tetramethyl Lead

Process Safety Information
Chemicals

- Toxicity
- P E L
- Physical data
- Reactivity and corrosivity
- Thermal and chemical stability
- Effects of mixing chemicals

Process Safety Information Process

- Block flow diagram or Process flow diagram
- Process chemistry
- Runaway reaction potential
- Maximum inventory
- Safe limits: T,P, x_i or y_i
- Consequences of deviations

Process Safety Information Equipment

- Materials
- P and IDs
- Electrical classification
- Relief system design
- Ventilation system design
- Design codes and standards
- Material and energy balances
- Safety systems

Process Hazard Analysis

Organized and systematic effort to identify and analyze the significance of potential hazards associated with the processing or handling of highly hazardous chemicals

Process Hazard Analysis

- causes/consequences of fires and explosions
- releases of toxic or flammable chemicals
- major spills of hazardous chemicals
- methodology depends on the process and its characteristics

PHA focuses on

Equipment
Instrumentation
Utilities
Human actions
External factors

Process Hazard Analysis

- What if?
- Checklist
- What if?/Checklist
- Hazard and Operability Study (HAZOP)
- Failure Mode and Effects Analysis (FMEA)
- Fault Tree Analysis (FTA)

PHA Must Address

1. Hazards of the process
2. Engineering & administrative controls
3. Consequences of failure of controls
4. Facility siting
5. Human factors
6. Evaluate potential effects to on-site personnel from failure of controls
7. Identification of previous incidents

PHA Team

- Expertise in engineering and process operations
- One member to have knowledge of and experience with process being evaluated

PHA Team

- One member knowledgeable in specific PHA methodology used for the evaluating the process

- Other members with specific knowledge:instrumentation, maintenance, chemistry, etc.

Employer PHA Actions

- Establish system for prompt response
- Ensure timely resolution of findings and recommendations
- Document actions taken
- Develop written schedule for completions
- Complete actions ASAP
- Communicate actions to affected employees

Operating Procedures

- Initial startup, operation, shutdown
- Temporary and emergency operations, emergency shutdown
- Startup following shutdowns
- Operating limits
  consequences of deviations
  prevention of deviations

Safety and Health Considerations

- Chemical properties and hazards
- Precautions to prevent exposure
- Control measures if contact or airborne exposure occurs
- Quality controls for raw materials
- Control of hazardous chemical inventories
- Special or unique hazards
- Safety systems and their functions

Employer Responsibilities

- Evaluate contractor's safety performance and programs
- Inform contractor of potential hazards: fire, explosion, toxic release; applicable plant safety
- Develop/Implement safe work practices
- Evaluate contractor performance

Training

- Process overview
- Process hazards
- Operating procedures
- Emergency procedures
- Refresher training at least every 3 years
- Documentation

Contractor Responsibilities

- Advise employer of any unique work hazards of contracted work
- Each employee follow all applicable work practices and safety rules of the facility

Contractor Responsibilities

- Ensure each employee is trained in necessary work practices
- Ensure each employee is instructed in known fire, explosion, or toxic release problems related to his/her job
- Document that understanding of training has been evaluated, verified

Pre-startup Safety Review

When:

- New processes
- Modified process

Pre-startup Safety Review Verifies

- Construction: conforms to design
- Procedures: adequate, in place
- PHA recommendations resolved or implemented
- Management of change requirements met
- All affected workers trained

PSM Mechanical Integrity

- Pressure vessels, storage tanks
- Piping systems, components
- Relief and vent systems, devices
- Emergency shutdown systems
- Controls: monitoring devices, sensors, alarms, interlocks
- Pumps

Mechanical Integrity

- Written procedures
- Training: process hazards, job tasks
- Inspections
- Testing
- Corrective action
- Records

Hot Work Permits

- Welding, cutting, brazing
- Control of ignition sources
- Verify safe conditions
- Authorization

Management of Change

Establish written procedures
Develop management support
Evaluate safety of any changes to
- process chemicals
- technology
- equipment
- facility

Procedures Must Address

- Everything except "replacement in kind"
- Temporary as well as permanent changes
- Technical basis for change
- Safety and health effects

Procedures Must Address

- Modified operating procedures
- Time necessary for change
- Authorization for change
- Ways to inform and train workers before change

Incident Investigation Goals

Identify incident causes and implement steps to prevent recurrence

Incident Investigation

- Every incident
- Prompt investigation
- Knowledgeable team
- Documentation and report
- Recommendations and findings
- Resolutions and corrective actions

Emergency Planning and Response

- Develop Emergency Action Plans
- Pre-plan for catastrophe
- Train and equip workers
- Drills

Compliance Safety Audits

- Certify all elements of standard
- Knowledgeable audit team
- Report and recommendations
- Address all findings and recommendations
- Every three years

Appendices

A. List of chemicals
B. Sample block and flow diagrams
C. Compliance guidelines
D. References