

29 CFR 1910.119 - Process safety management of highly hazardous chemicals.

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§ 1910.119 Process safety management of highly hazardous chemicals.

Purpose. This section contains requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. These releases may result in toxic, fire or explosion hazards.

(a) Application.

(1) This section applies to the following:

(i) A process which involves a chemical at or above the specified threshold quantities listed in appendix A to this section;

(ii) A process which involves a Category 1 flammable gas (as defined in 1910.1200(c)) or a flammable liquid with a flashpoint below 100 °F (37.8 °C) on site in one location, in a quantity of 10,000 pounds (4535.9 kg) or more except for:

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

(B) Flammable liquids with a flashpoint below 100 °F (37.8 °C) stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration.

(2) This section does not apply to:

(i) Retail facilities;

(ii) Oil or gas well drilling or servicing operations; or,

(iii) Normally unoccupied remote facilities.

(b) **Definitions. Atmospheric tank** means a storage tank which has been designed to operate at pressures from atmospheric through 0.5 psig. (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 (psig.) (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**, which is incorporated by reference as specified in **§ 1910.6**, 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. See Appendix E to **§ 1910.1200** - Definition of a **Trade Secret** (which sets out the criteria to be **used** in evaluating trade secrets).

(c)Employee participation.

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

(2) Employers shall consult with employees and their representatives on the conduct and development of process hazards analyses and on the development of the other elements of process safety management in this standard.

(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. In accordance with the schedule set forth in paragraph (e)(1) of this section, the employer shall complete a compilation of written process safety information before conducting any process hazard analysis required by the standard. The compilation of written process safety information is to enable the employer and the employees involved in operating the process to identify and understand the hazards posed by those processes involving highly hazardous chemicals. This process safety information shall include information pertaining to the hazards of the highly hazardous chemicals used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process.

(1) Information pertaining to the hazards of the highly hazardous chemicals in the process. This information shall consist of at least the following:

- (i) Toxicity information;
- (ii) Permissible exposure limits;
- (iii) Physical data;
- (iv) Reactivity data;
- (v) Corrosivity data;
- (vi) Thermal and chemical stability data; and
- (vii) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur.

NOTE:

Safety data sheets meeting the requirements of 29 CFR 1910.1200(g) may be used to comply with this requirement to the extent they contain the information required by this subparagraph.

(2) Information pertaining to the technology of the process.

(i) Information concerning the technology of the **process** shall include at least the following:

(A) A block flow diagram or simplified **process** flow diagram (see appendix B to this section);

(B) **Process** chemistry;

(C) Maximum intended inventory;

(D) Safe upper and lower limits for such items as temperatures, pressures, flows or compositions; and,

(E) An evaluation of the consequences of deviations, including those affecting the safety and health of employees.

(ii) Where the original technical information no longer exists, such information may be developed in conjunction with the **process** hazard analysis in sufficient detail to support the analysis.

(3) Information pertaining to the equipment in the process.

(i) Information pertaining to the equipment in the **process** shall include:

(A) Materials of construction;

(B) Piping and instrument diagrams (P&ID's);

(C) **Electrical classification**;

(D) Relief system design and design basis;

(E) Ventilation system design;

(F) Design codes and **standards** employed;

(G) Material and energy balances for **processes** built after May 26, 1992; and,

(H) Safety systems (e.g. interlocks, detection or suppression systems).

(ii) The **employer** shall document that equipment complies with recognized and generally accepted good engineering practices.

(iii) For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general **use**, the **employer** shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

(e) Process hazard analysis.

(1) The employer shall perform an initial process hazard analysis (hazard evaluation) on processes covered by this standard. The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. Employers shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process. The process hazard analysis shall be conducted as soon as possible, but not later than the following schedule:

(i) No less than 25 percent of the initial process hazards analyses shall be completed by May 26, 1994;

(ii) No less than 50 percent of the initial process hazards analyses shall be completed by May 26, 1995;

(iii) No less than 75 percent of the initial process hazards analyses shall be completed by May 26, 1996;

(iv) All initial process hazards analyses shall be completed by May 26, 1997.

(v) Process hazards analyses completed after May 26, 1987 which meet the requirements of this paragraph are acceptable as initial process hazards analyses. These process hazard analyses shall be updated and revalidated, based on their completion date, in accordance with paragraph (e)(6) of this section.

(2) The employer shall use one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed.

(i) What-If;

(ii) Checklist;

(iii) What-If/Checklist;

(iv) Hazard and Operability Study (HAZOP);

(v) Failure Mode and Effects Analysis (FMEA);

(vi) Fault Tree Analysis; or

(vii) An appropriate equivalent methodology.

(3) The process hazard analysis shall address:

(i) The hazards of the process;

- (ii) The identification of any previous incident which had a likely potential for catastrophic consequences in the [workplace](#);
- (iii) Engineering and administrative [controls](#) applicable to the hazards and their interrelationships such as 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.);
- (iv) Consequences of failure of engineering and administrative controls;
- (v) [Facility](#) siting;
- (vi) Human factors; and
- (vii) A qualitative evaluation of a range of the possible safety and health effects of failure of [controls](#) on [employees](#) in the [workplace](#).

(4) The [process](#) hazard analysis shall be performed by a team with expertise in engineering and [process](#) operations, and the team shall include at least one [employee](#) who has experience and knowledge specific to the [process](#) being evaluated. Also, one member of the team must be knowledgeable in the specific [process](#) hazard analysis methodology being used.

(5) The [employer](#) shall establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other [employees](#) whose work assignments are in the [process](#) and who may be affected by the recommendations or actions.

(6) At least every five (5) years after the completion of the initial [process](#) hazard analysis, the [process](#) hazard analysis shall be updated and revalidated by a team meeting the requirements in [paragraph \(e\)\(4\) of this section](#), to assure that the [process](#) hazard analysis is consistent with the current [process](#).

(7) [Employers](#) shall retain [process](#) hazards analyses and updates or revalidations for each [process](#) covered by [this section](#), as well as the documented resolution of recommendations described in [paragraph \(e\)\(5\) of this section](#) for the life of the [process](#).

(f) Operating procedures (1) The [employer](#) shall develop and implement written operating [procedures](#) that provide clear instructions for safely conducting activities involved in each covered [process](#) consistent with

the **process** safety information and shall address at least the following elements.

(i)Steps for each operating phase:

- (A) Initial startup;
- (B) Normal operations;
- (C) Temporary operations;
- (D) **Emergency** shutdown including the conditions under which **emergency** shutdown is required, and the assignment of shutdown responsibility to qualified operators to ensure that **emergency** shutdown is executed in a safe and timely manner.
- (E) **Emergency** Operations;
- (F) Normal shutdown; and,
- (G) Startup following a turnaround, or after an **emergency** shutdown.

(ii)Operating limits:

- (A) Consequences of deviation; and
- (B) Steps required to correct or avoid deviation.

(iii)Safety and health considerations:

- (A) Properties of, and hazards presented by, the **chemicals used** in the **process**;
- (B) Precautions necessary to prevent exposure, including **engineering controls**, administrative controls, and personal protective equipment;
- (C) **Control** measures to be taken if physical contact or airborne exposure occurs;
- (D) Quality **control** for raw materials and **control** of **hazardous chemical** inventory levels; and,
- (E) Any special or unique hazards.

(iv)Safety systems and their functions.

(2) Operating **procedures** shall be readily accessible to **employees** who work in or maintain a **process**.

(3) The operating **procedures** shall be reviewed as often as necessary to assure that they reflect current operating practice, including changes that result from changes in **process** chemicals, technology, and equipment, and changes to facilities. The **employer** shall certify annually that these operating **procedures** are current and accurate.

(4) The employer shall develop and implement safe work practices to provide for the control of hazards during operations such as lockout/tag out; confined space entry; opening process equipment or piping; and control over entrance into a facility by maintenance, contractor, laboratory, or other support personnel. These safe work practices shall apply to employees and contractor employees.

(g) Training -

(1) Initial training.

(i) 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.

(ii) 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.

(2) Refresher training. 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 of the process. The employer, in consultation with the employees involved in operating the process, shall determine the appropriate frequency of refresher training.

(3) Training documentation. The employer shall ascertain that each employee involved in operating a process has received and understood the training required by this paragraph. The employer shall prepare a record which contains the identity of the employee, the date of training, and the means used to verify that the employee understood the training.

(h) Contractors -

(1) Application. This paragraph applies to contractors performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process. 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.

(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 contractor's 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 covered **process** areas.
- (v)** The **employer** shall periodically evaluate the performance of contract **employers** in fulfilling their obligations as specified in **paragraph (h)(3)** of **this section**.
- (vi)** The **employer** shall maintain a contract **employee** injury and illness log related to the contractor's work in **process** areas.

(3)Contract employer responsibilities.

- (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 the 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 by the contract **employer's** work.

(i) Pre-startup safety review.

(1) 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.

(2) The pre-startup safety review shall confirm that prior to the introduction of **highly hazardous chemicals** to a process:

(i) Construction and equipment is in accordance with design specifications;

(ii) Safety, operating, maintenance, and **emergency procedures** are in place and are adequate;

(iii) For new facilities, a **process** hazard analysis has been performed and recommendations have been resolved or implemented before startup; and modified facilities meet the requirements contained in management of change, paragraph (I).

(iv) Training of each **employee** involved in operating a **process** has been completed.

(j) Mechanical integrity -

(1) Application. Paragraphs (j)(2) through (j)(6) of **this section** apply to the following **process** equipment:

(i) Pressure vessels and storage tanks;

(ii) Piping systems (including piping components such as valves);

(iii) Relief and vent systems and devices;

(iv) **Emergency** shutdown systems;

(v) **Controls** (including monitoring devices and sensors, alarms, and interlocks) and,

(vi) Pumps.

(2) Written procedures. The **employer** shall establish and implement written **procedures** to maintain the on-going integrity of **process** equipment.

(3) Training for process maintenance activities. The **employer** shall train each **employee** involved in maintaining the on-going integrity of **process** equipment in 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.

(4) Inspection and testing.

(i) Inspections and tests shall be performed on **process** equipment.

(ii) Inspection and **testing procedures** shall follow recognized and generally accepted good engineering practices.

(iii) 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.

(iv) 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 on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

(5)Equipment deficiencies. The **employer** shall correct deficiencies in equipment that are outside **acceptable** limits (defined by the **process** safety information in **paragraph (d)** of this section) before further **use** or in a safe and timely manner when necessary means are taken to assure safe operation.

(6)Quality assurance.

(i) 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 they will be used.

(ii) Appropriate checks and inspections shall be performed to assure that equipment is installed properly and consistent with design specifications and the manufacturer's instructions.

(iii) The **employer** shall assure that maintenance materials, spare parts and equipment are suitable for the **process application** for which they will be used.

(k)Hot work permit.

(1) The **employer** shall issue a **hot work permit** for **hot work** operations conducted on or near a covered **process**.

(2) The **permit** shall document that the fire prevention and protection requirements in **29 CFR 1910.252(a)** have been implemented prior to beginning the **hot work** operations; it shall indicate the date(s) authorized for **hot work**; and identify the object on which **hot work** is to be performed. The **permit** shall be kept on file until completion of the **hot work** operations.

(l) Management of change.

(1) The employer shall establish and implement written procedures to manage changes (except for “replacements in kind”) to process chemicals, technology, equipment, and procedures; and, changes to facilities that affect a covered process.

(2) The procedures shall assure that the following considerations are 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.

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

(4) If a change covered by this paragraph results in a change in the process safety information required by paragraph (d) of this section, such information shall be updated accordingly.

(5) If a change covered by this paragraph results in a change in the operating procedures or practices required by paragraph (f) of this section, such procedures or practices shall be updated accordingly.

(m) Incident investigation.

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

(2) An incident investigation shall be initiated as promptly as possible, but not later than 48 hours following the incident.

(3) 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.

(4) A report shall be prepared at the conclusion of the investigation which includes at a minimum:

- (i) Date of incident;

- (ii) Date investigation began;
- (iii) A description of the incident;
- (iv) The factors that contributed to the incident; and,
- (v) Any recommendations resulting from the investigation.

(5) The **employer** shall establish a system to promptly address and resolve the incident report findings and recommendations. Resolutions and corrective actions shall be documented.

(6) The report shall be reviewed with all affected personnel whose job tasks are relevant to the incident findings including contract **employees** where applicable.

(7) Incident investigation reports shall be retained for five years.

(n)Emergency planning and response. The **employer** shall establish and implement an **emergency** action plan for the entire plant in accordance with the provisions of 29 CFR 1910.38. In addition, the **emergency** action plan shall include **procedures** for handling small releases. **Employers** covered under **this standard** may also be subject to the **hazardous waste** and **emergency** response provisions contained in 29 CFR 1910.120 (a), (p) and (q).

(o)Compliance Audits.

(1) **Employers** shall certify that they have evaluated compliance with the provisions of **this section** at least every three years to verify that the **procedures** and practices developed under the **standard** are adequate and are being followed.

(2) The compliance audit shall be conducted by at least one person knowledgeable in the **process**.

(3) A report of the findings of the audit shall be developed.

(4) The **employer** shall promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies have been corrected.

(5) **Employers** shall retain the two (2) most recent compliance audit reports.

(p)Trade secrets.

(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)** of this section), those assisting in the development of the **process** hazard analysis

(required by [paragraph \(e\)](#) of this section), those responsible for developing the operating [procedures](#) (required by [paragraph \(f\)](#) of this section), and those involved in incident investigations (required by [paragraph \(m\)](#) of this section), [emergency](#) planning and response ([paragraph \(n\)](#) of this section) and compliance audits ([paragraph \(o\)](#) of this section) without regard to possible [trade secret](#) status of such information.

(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](#).

(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](#).

APPENDIX A TO § 1910.119 - LIST OF HIGHLY HAZARDOUS CHEMICALS, TOXICS AND REACTIVES (MANDATORY)

This appendix contains a listing of toxic and reactive [highly hazardous chemicals](#) which present a potential for a catastrophic event at or above the threshold quantity.

CHEMICAL name

Acetaldehyde

Acrolein (2-Propenal)

Acrylyl Chloride

Allyl Chloride

Allylamine

Alkylaluminums

Ammonia, Anhydrous

Ammonia solutions (>44% ammonia by weight)

Ammonium Perchlorate

Ammonium Permanganate

Arsine (also called Arsenic Hydride)

Bis(Chloromethyl) Ether

Boron Trichloride

Boron Trifluoride

Bromine

Bromine Chloride

Bromine Pentafluoride

Bromine Trifluoride

3-Bromopropyne (also called Propargyl Bromide)

Butyl Hydroperoxide (Tertiary)

Butyl Perbenzoate (Tertiary)

Carbonyl Chloride (see Phosgene)

Carbonyl Fluoride

Cellulose Nitrate (concentration >12.6% nitrogen)

Chlorine

Chlorine Dioxide

Chlorine Pentafluoride

Chlorine Trifluoride

Chlorodiethylaluminum (also called Diethylaluminum Chloride)

1-Chloro-2,4-Dinitrobenzene

Chloromethyl Methyl Ether

Chloropicrin

Chloropicrin and Methyl Bromide mixture

Chloropicrin and Methyl Chloride mixture

Cumene Hydroperoxide

Cyanogen

Cyanogen Chloride

Cyanuric Fluoride

Diacetyl Peroxide (Concentration >70%)

Diazomethane

Dibenzoyl Peroxide

Diborane

Dibutyl Peroxide (Tertiary)

Dichloro Acetylene

Dichlorosilane

Diethylzinc

Diisopropyl Peroxydicarbonate

Dilaluroyl Peroxide

Dimethyldichlorosilane

Dimethylhydrazine, 1,1-

Dimethylamine, Anhydrous

2,4-Dinitroaniline

Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration >60%)

Ethyl Nitrite

Ethylamine

Ethylene Fluorohydrin

Ethylene Oxide

Ethyleneimine

Fluorine

Formaldehyde (Formalin)

Furan

Hexafluoroacetone

Hydrochloric Acid, Anhydrous

Hydrofluoric Acid, Anhydrous

Hydrogen Bromide

Hydrogen Chloride

Hydrogen Cyanide, Anhydrous

Hydrogen Fluoride

Hydrogen Peroxide (52% by weight or greater)

Hydrogen Selenide

Hydrogen Sulfide

Hydroxylamine

Iron, Pentacarbonyl

Isopropylamine

Ketene

Methacrylaldehyde

Methacryloyl Chloride

Methacryloyloxyethyl Isocyanate

Methyl Acrylonitrile

Methylamine, Anhydrous

Methyl Bromide

Methyl Chloride

Methyl Chloroformate

Methyl Ethyl Ketone Peroxide (concentration >60%)

Methyl Fluoroacetate

Methyl Fluorosulfate

Methyl Hydrazine

Methyl Iodide

Methyl Isocyanate

Methyl Mercaptan

Methyl Vinyl Ketone

Methyltrichlorosilane

Nickel Carbonyl (Nickel Tetracarbonyl)

Nitric Acid (94.5% by weight or greater)

Nitric Oxide

Nitroaniline (para Nitroaniline)

Nitromethane

Nitrogen Dioxide

Nitrogen Oxides (NO; NO₂; N₂O₄; N₂O₃)

Nitrogen Tetroxide (also called Nitrogen Peroxide)

Nitrogen Trifluoride

Nitrogen Trioxide

Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)

Osmium Tetroxide

Oxygen Difluoride (Fluorine Monoxide)

Ozone

Pentaborane

Peracetic Acid (concentration >60% Acetic Acid; also called Peroxyacetic Acid)

Perchloric Acid (concentration >60% by weight)

Perchloromethyl Mercaptan

Perchloryl Fluoride

Peroxyacetic Acid (concentration >60% Acetic Acid; also called Peracetic Acid)

Phosgene (also called Carbonyl Chloride)

Phosphine (Hydrogen Phosphide)

Phosphorus Oxychloride (also called Phosphoryl Chloride)

Phosphorus Trichloride

Phosphoryl Chloride (also called Phosphorus Oxychloride)

Propargyl Bromide

Propyl Nitrate

Sarin

Selenium Hexafluoride

Stibine (Antimony Hydride)

Sulfur Dioxide (liquid)

Sulfur Pentafluoride

Sulfur Tetrafluoride

Sulfur Trioxide (also called Sulfuric Anhydride)

Sulfuric Anhydride (also called Sulfur Trioxide)

Tellurium Hexafluoride

Tetrafluoroethylene

Tetrafluorohydrazine

Tetramethyl Lead

Thionyl Chloride

Trichloro (chloromethyl) Silane

Trichloro (dichlorophenyl) Silane

Trichlorosilane

Trifluorochloroethylene

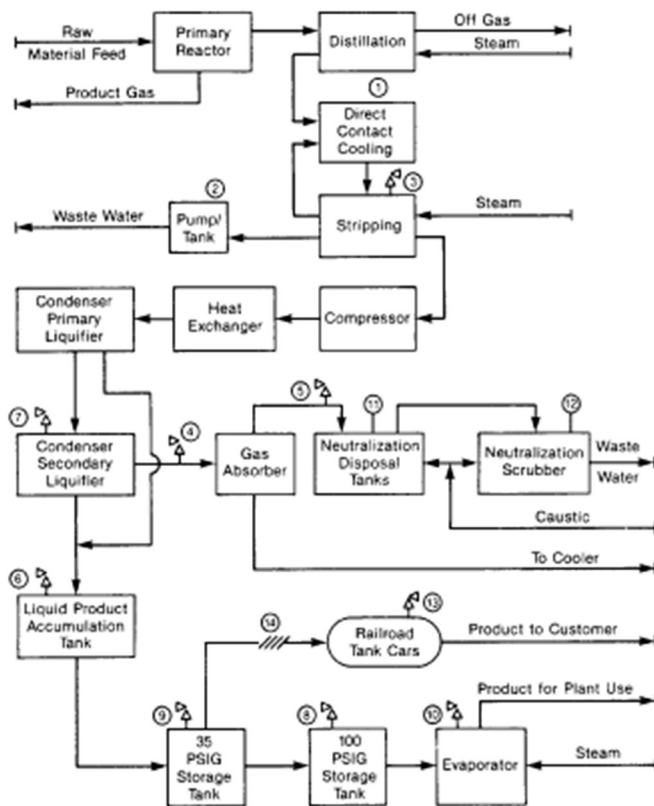
Trimethoxysilane

*Chemical Abstract Service Number.

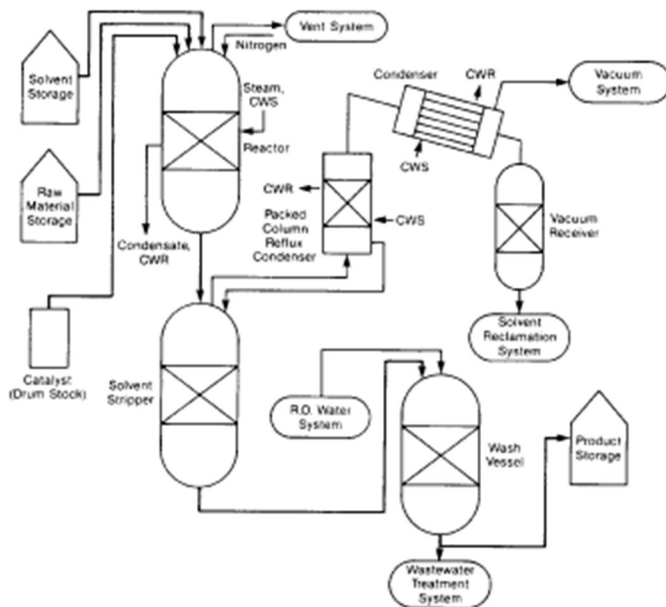
**Threshold Quantity in Pounds (Amount necessary to be covered by this standard).

Appendix B to [§ 1910.119](#) - Block Flow Diagram and Simplified Process Flow Diagram (Nonmandatory)

Example of a Block Flow Diagram



Example of a Process Flow Diagram



APPENDIX C TO § 1910.119 - COMPLIANCE GUIDELINES AND RECOMMENDATIONS FOR PROCESS SAFETY MANAGEMENT (NONMANDATORY)

This appendix serves as a nonmandatory guideline to assist employers and employees in complying with the requirements of this

section, as well as provides other helpful recommendations and information. Examples presented in this appendix are not the only means of achieving the performance goals in the standard. This appendix neither adds nor detracts from the requirements of the standard.

1. *Introduction to Process Safety Management.* The major objective of process safety management of highly hazardous chemicals is to prevent unwanted releases of hazardous chemicals especially into locations which could expose employees and others to serious hazards. An effective process safety management program requires a systematic approach to evaluating the whole process. Using this approach the process design, process technology, operational and maintenance activities and procedures, non-routine activities and procedures, emergency preparedness plans and procedures, training programs, and other elements which impact the process are all considered in the evaluation. The various lines of defense that have been incorporated into the design and operation of the process to prevent or mitigate the release of hazardous chemicals need to be evaluated and strengthened to assure their effectiveness at each level. Process safety management is the proactive identification, evaluation and mitigation or prevention of chemical releases that could occur as a result of failures in process, procedures or equipment.

The process safety management standard targets highly hazardous chemicals that have the potential to cause a catastrophic incident. This standard as a whole is to aid employers in their efforts to prevent or mitigate episodic chemical releases that could lead to a catastrophe in the workplace and possibly to the surrounding community. To control these types of hazards, employers need to develop the necessary expertise, experiences, judgement and proactive initiative within their workforce to properly implement and maintain an effective process safety management program as envisioned in the OSHA standard. This OSHA standard is required by the Clean Air Act Amendments as is the Environmental Protection Agency's Risk Management Plan. Employers, who merge the two sets of requirements into their process safety management program, will better assure full compliance with each as well as enhancing their relationship with the local community.

While OSHA believes process safety management will have a positive effect on the safety of employees in workplaces and also offers other potential benefits to employers (increased productivity), smaller businesses which may have limited resources available to them at this time, might consider alternative avenues of decreasing the risks associated with highly hazardous chemicals at their workplaces. One method which might be considered is the reduction in the inventory of the highly hazardous chemical. This reduction in inventory will result in a reduction of the risk or potential for a catastrophic incident. Also, employers including small employers may be able to establish more efficient inventory control by reducing the quantities of highly hazardous chemicals on site below the established threshold quantities. This reduction can be accomplished by ordering smaller shipments and maintaining the minimum

inventory necessary for efficient and safe operation. When reduced inventory is not feasible, then the **employer** might consider dispersing inventory to several locations on site. Dispersing storage into locations where a release in one location will not cause a release in another location is a practical method to also reduce the risk or potential for catastrophic incidents.

2. *Employee Involvement in Process Safety Management.* Section 304 of the Clean Air Act Amendments states that **employers** are to consult with their **employees** and their representatives regarding the **employers** efforts in the development and **implementation** of the **process** safety management program elements and hazard assessments. Section 304 also requires **employers** to train and educate their **employees** and to inform affected **employees** of the findings from incident investigations required by the **process** safety management program. Many employers, under their safety and health programs, have already established means and methods to keep **employees** and their representatives informed about relevant safety and health issues and **employers** may be able to adapt these practices and **procedures** to meet their obligations under **this standard**. **Employers** who have not implemented an occupational safety and health program may wish to form a safety and health committee of **employees** and management representatives to help the **employer** meet the obligations specified by **this standard**. These committees can become a significant ally in helping the **employer** to implement and maintain an effective **process** safety management program for all employees.

3. *Process Safety Information.* Complete and accurate written information concerning **process** chemicals, **process** technology, and **process** equipment is essential to an effective **process** safety management program and to a **process** hazards analysis. The compiled information will be a necessary resource to a variety of users including the team that will perform the **process** hazards analysis as required under paragraph (e); those developing the training programs and the operating procedures; contractors whose **employees** will be working with the **process**; those conducting the pre-startup reviews; local **emergency** preparedness planners; and insurance and enforcement officials.

The information to be compiled about the chemicals, including **process** intermediates, needs to be comprehensive enough for an accurate assessment of the fire and explosion characteristics, reactivity hazards, the safety and **health hazards** to workers, and the corrosion and erosion effects on the **process** equipment and monitoring tools. Current **safety data sheet (SDS)** information can be **used** to help meet this requirement which must be supplemented with **process** chemistry information including runaway reaction and over pressure hazards if applicable.

Process technology information will be a part of the **process** safety information package and it is expected that it will include diagrams of the type shown in appendix B of **this section** as well as **employer** established criteria for maximum inventory levels for **process** chemicals; limits beyond which would be considered

upset conditions; and a qualitative estimate of the consequences or results of deviation that could occur if operating beyond the established **process** limits. **Employers** are encouraged to **use** diagrams which will help users understand the **process**.

A block flow diagram is **used** to show the major **process** equipment and interconnecting **process** flow lines and show flow rates, stream composition, temperatures, and pressures when necessary for clarity. The block flow diagram is a simplified diagram.

Process flow diagrams are more complex and will show all main flow streams including valves to enhance the understanding of the **process**, as well as pressures and temperatures on all feed and product lines within all major vessels, in and out of headers and heat exchangers, and points of pressure and temperature **control**. Also, materials of construction information, pump capacities and pressure heads, compressor horsepower and vessel design pressures and temperatures are shown when necessary for clarity. In addition, major components of **control** loops are usually shown along with key utilities on **process** flow diagrams.

Piping and instrument diagrams (P&IDs) may be the more appropriate type of diagrams to show some of the above details and to display the information for the piping designer and engineering staff. The P&IDs are to be **used** to describe the relationships between equipment and instrumentation as well as other relevant information that will enhance clarity. Computer software programs which do P&IDs or other diagrams useful to the information package, may be used to help meet this requirement.

The information pertaining to **process** equipment design must be documented. In other words, what were the codes and **standards** relied on to establish good engineering practice. These codes and **standards** are published by such organizations as the American Society of Mechanical Engineers, American Petroleum Institute, American National **Standards** Institute, National Fire Protection Association, American Society for **Testing** and Materials, National Board of Boiler and Pressure Vessel Inspectors, National Association of Corrosion Engineers, American Society of Exchange Manufacturers Association, and model building code groups.

In addition, various engineering societies issue technical reports which impact **process** design. For example, the American Institute of **Chemical** Engineers has published technical reports on topics such as two phase flow for venting devices. This type of technically recognized report would constitute good engineering practice.

For existing equipment designed and constructed many years ago in accordance with the codes and **standards** available at that time and no longer in general **use** today, the **employer** must document which codes and **standards** were **used** and that the design and construction along with the **testing**, inspection and operation are still suitable for the intended **use**.

Where the **process** technology requires a design which departs from the applicable codes and standards, the **employer** must document that the design and construction is suitable for the intended purpose.

4. *Process Hazard Analysis.* A **process** hazard analysis (PHA), sometimes called a **process** hazard evaluation, is one of the most important elements of the **process** safety management program. A PHA is an organized and systematic effort to identify and analyze the significance of potential hazards associated with the processing or handling of highly hazardous chemicals. A PHA provides information which will assist **employers** and **employees** in making decisions for improving safety and reducing the consequences of unwanted or unplanned releases of hazardous chemicals. A PHA is directed toward analyzing **potential causes** and consequences of fires, explosions, releases of toxic or flammable **chemicals** and major spills of hazardous **chemicals**. The PHA focuses on equipment, instrumentation, utilities, human actions (routine and non-routine), and external factors that might impact the **process**. These considerations assist in determining the hazards and potential failure points or failure modes in a **process**.

The selection of a PHA methodology or technique will be influenced by many factors including the amount of existing knowledge about the **process**. Is it a **process** that has been operated for a long period of time with little or no innovation and extensive experience has been generated with its use? Or, is it a new **process** or one which has been changed frequently by the inclusion of innovative features? Also, the size and complexity of the **process** will influence the decision as to the appropriate PHA methodology to **use**. All PHA methodologies are subject to certain limitations. For example, the checklist methodology works well when the **process** is very stable and no changes are made, but it is not as effective when the **process** has undergone extensive change. The checklist may miss the most recent changes and consequently the changes would not be evaluated. Another limitation to be considered concerns the assumptions made by the team or analyst. The PHA is dependent on good judgement and the assumptions made during the study need to be documented and understood by the team and reviewer and kept for a future PHA.

The team conducting the PHA need to understand the methodology that is going to be **used**. A PHA team can vary in size from two people to a number of people with varied operational and technical backgrounds. Some team members may only be a part of the team for a limited time. The team leader needs to be fully knowledgeable in the proper **implementation** of the PHA methodology that is to be **used** and should be impartial in the evaluation. The other full or part time team members need to provide the team with expertise in areas such as **process** technology, **process** design, operating **procedures** and practices, including how the work is actually performed, alarms, **emergency** procedures, instrumentation, maintenance procedures, both routine and non-routine tasks, including how the tasks are authorized, procurement of parts and supplies,

safety and health, and any other relevant subject as the need dictates. At least one team member must be familiar with the [process](#).

The ideal team will have an intimate knowledge of the standards, codes, specifications and regulations applicable to the [process](#) being studied. The selected team members need to be compatible and the team leader needs to be able to manage the team, and the PHA study. The team needs to be able to work together while benefiting from the expertise of others on the team or outside the team, to resolve issues, and to forge a consensus on the findings of the study and recommendations.

The [application](#) of a PHA to a [process](#) may involve the [use](#) of different methodologies for various parts of the [process](#). For example, a [process](#) involving a series of unit operation of varying sizes, complexities, and ages may [use](#) different methodologies and team members for each operation. Then the conclusions can be integrated into one final study and evaluation. A more specific example is the [use](#) of a checklist PHA for a [standard](#) boiler or heat exchanger and the [use](#) of a Hazard and Operability PHA for the overall [process](#). Also, for batch type [processes](#) like custom batch operations, a generic PHA of a representative batch may be [used](#) where there are only small changes of monomer or other ingredient ratios and the chemistry is documented for the full range and ratio of batch ingredients. Another [process](#) that might consider using a generic type of PHA is a gas plant. Often these plants are simply moved from site to site and therefore, a generic PHA may be [used](#) for these movable plants. Also, when an [employer](#) has several similar size gas plants and no sour gas is being [processed](#) at the site, then a generic PHA is feasible as long as the variations of the individual sites are accounted for in the PHA. Finally, when an [employer](#) has a large continuous [process](#) which has several [control](#) rooms for different portions of the [process](#) such as for a distillation tower and a blending operation, the [employer](#) may wish to do each segment separately and then integrate the final results.

Additionally, small businesses which are covered by this rule, will often have [processes](#) that have less storage volume, less capacity, and less complicated than [processes](#) at a large [facility](#). Therefore, OSHA would anticipate that the less complex methodologies would be [used](#) to meet the [process](#) hazard analysis criteria in the [standard](#). These [process](#) hazard analyses can be done in less time and with a few people being involved. A less complex [process](#) generally means that less data, P&IDs, and [process](#) information is needed to perform a [process](#) hazard analysis.

Many small businesses have [processes](#) that are not unique, such as cold storage lockers or water treatment facilities. Where [employer](#) associations have a number of members with such facilities, a generic PHA, evolved from a checklist or what-if questions, could be developed and [used](#) by each [employer](#) effectively to reflect his/her particular [process](#); this would simplify compliance for them.

When the **employer** has a number of **processes** which require a PHA, the **employer** must set up a priority system of which PHAs to conduct first. A preliminary or gross hazard analysis may be useful in prioritizing the **processes** that the **employer** has determined are subject to coverage by the **process** safety management **standard**. Consideration should first be given to those **processes** with the potential of adversely affecting the largest **number of employees**. This prioritizing should consider the potential severity of a **chemical** release, the number of potentially affected employees, the operating history of the **process** such as the frequency of **chemical** releases, the age of the **process** and any other relevant factors. These factors would suggest a ranking order and would suggest either using a weighing factor system or a systematic ranking method. The **use** of a preliminary hazard analysis would assist an **employer** in determining which **process** should be of the highest priority and thereby the **employer** would obtain the greatest improvement in safety at the **facility**.

Detailed guidance on the content and **application** of **process** hazard analysis methodologies is available from the American Institute of **Chemical** Engineers' Center for **Chemical Process** Safety (see appendix D).

5. *Operating Procedures and Practices.* Operating **procedures** describe tasks to be performed, data to be recorded, operating conditions to be maintained, samples to be collected, and safety and health precautions to be taken. The **procedures** need to be technically accurate, understandable to employees, and revised periodically to ensure that they reflect current operations. The **process** safety information package is to be **used** as a resource to better assure that the operating **procedures** and practices are consistent with the known hazards of the **chemicals** in the **process** and that the operating parameters are accurate. Operating **procedures** should be reviewed by engineering staff and operating personnel to ensure that they are accurate and provide practical instructions on how to actually carry out job duties safely.

Operating **procedures** will include specific instructions or details on what steps are to be taken or followed in carrying out the stated **procedures**. These operating instructions for each **procedure** should include the applicable safety precautions and should contain appropriate information on safety implications. For example, the operating **procedures** addressing operating parameters will contain operating instructions about pressure limits, temperature ranges, flow rates, what to do when an upset condition occurs, what alarms and instruments are pertinent if an upset condition occurs, and other subjects. Another example of using operating instructions to properly implement operating **procedures** is in starting up or shutting down the **process**. In these cases, different parameters will be required from those of normal operation. These operating instructions need to clearly indicate the distinctions between startup and normal operations such as the appropriate allowances for heating up a unit to reach the normal operating parameters. Also the operating instructions need to describe the

proper method for increasing the temperature of the unit until the normal operating temperature parameters are achieved.

Computerized **process control systems** add complexity to operating instructions. These operating instructions need to describe the logic of the software as well as the relationship between the equipment and the **control system**; otherwise, it may not be apparent to the operator.

Operating **procedures** and instructions are important for training operating personnel. The operating **procedures** are often viewed as the **standard** operating practices (SOPs) for operations. **Control** room personnel and operating staff, in general, need to have a full understanding of operating **procedures**. If workers are not fluent in English then **procedures** and instructions need to be prepared in a second language understood by the workers. In addition, operating **procedures** need to be changed when there is a change in the **process** as a result of the management of change **procedures**. The consequences of operating **procedure** changes need to be fully evaluated and the information conveyed to the personnel. For example, mechanical changes to the **process** made by the maintenance department (like changing a valve from steel to brass or other subtle changes) need to be evaluated to determine if operating **procedures** and practices also need to be changed. All management of change actions must be coordinated and integrated with current operating **procedures** and operating personnel must be oriented to the changes in **procedures** before the change is made. When the **process** is shut down in order to make a change, then the operating **procedures** must be updated before startup of the **process**.

Training in how to **handle** upset conditions must be accomplished as well as what operating personnel are to do in emergencies such as when a pump seal fails or a pipeline ruptures. Communication between operating personnel and workers performing work within the **process** area, such as non-routine tasks, also must be maintained. The hazards of the tasks are to be conveyed to operating personnel in accordance with established **procedures** and to those performing the actual tasks. When the work is completed, operating personnel should be informed to provide closure on the job.

6. *Employee Training.* All employees, including maintenance and contractor employees, involved with **highly hazardous chemicals** need to fully understand the safety and **health hazards** of the **chemicals** and **processes** they work with for the protection of themselves, their fellow **employees** and the citizens of nearby communities. Training conducted in compliance with § 1910.1200, the **Hazard Communication standard**, will help **employees** to be more knowledgeable about the **chemicals** they work with as well as familiarize them with reading and understanding SDSs. However, additional training in subjects such as operating **procedures** and safety work practices, **emergency** evacuation and response, safety procedures, routine and non-routine work authorization activities, and other areas pertinent to **process** safety and health will need to be covered by an **employer's** training program.

In establishing their training programs, **employers** must clearly define the **employees** to be trained and what subjects are to be covered in their training. **Employers** in setting up their training program will need to clearly establish the goals and objectives they wish to achieve with the training that they provide to their **employees**. The learning goals or objectives should be written in clear measurable terms before the training begins. These goals and objectives need to be tailored to each of the specific training modules or segments. **Employers** should describe the important actions and conditions under which the **employee** will demonstrate competence or knowledge as well as what is **acceptable** performance.

Hands-on-training where **employees** are able to **use** their senses beyond listening, will enhance learning. For example, operating personnel, who will work in a **control** room or at **control** panels, would benefit by being trained at a simulated **control** panel or panels. Upset conditions of various types could be displayed on the simulator, and then the **employee** could go through the proper operating **procedures** to bring the simulator panel back to the normal operating parameters. A training environment could be created to help the trainee feel the full reality of the situation but, of course, under **controlled** conditions. This realistic type of training can be very effective in teaching **employees** correct **procedures** while allowing them to also see the consequences of what might happen if they do not follow established operating **procedures**. Other training techniques using videos or on-the-job training can also be very effective for teaching other job tasks, duties, or other important information. An effective training program will allow the **employee** to fully participate in the training **process** and to practice their skill or knowledge.

Employers need to periodically evaluate their training programs to see if the necessary skills, knowledge, and routines are being properly understood and implemented by their trained **employees**. The means or methods for evaluating the training should be developed along with the training program goals and objectives. Training program evaluation will help **employers** to determine the amount of training their **employees** understood, and whether the desired results were obtained. If, after the evaluation, it appears that the trained **employees** are not at the level of knowledge and skill that was expected, the **employer** will need to revise the training program, provide retraining, or provide more frequent refresher training sessions until the deficiency is resolved. Those who conducted the training and those who received the training should also be consulted as to how best to improve the training **process**. If there is a language barrier, the language known to the trainees should be **used** to reinforce the training messages and information.

Careful consideration must be given to assure that **employees** including maintenance and contract **employees** receive current and updated training. For example, if changes are made to a **process**, impacted **employees** must be trained in the changes and understand the effects of the changes on their job tasks (e.g., any new operating **procedures** pertinent to their tasks). Additionally,

as already discussed the evaluation of the **employee's** absorption of training will certainly influence the need for training.

7. *Contractors.* **Employers** who **use** contractors to perform work in and around **processes** that involve highly hazardous chemicals, will need to establish a screening **process** so that they hire and **use** contractors who accomplish the desired job tasks without compromising the safety and health of **employees** at a **facility**. For contractors, whose safety performance on the job is not known to the hiring **employer**, the **employer** will need to obtain information on injury and illness rates and experience and should obtain contractor references. Additionally, the **employer** must assure that the contractor has the appropriate job skills, knowledge and **certifications** (such as for pressure vessel welders). Contractor work methods and experiences should be evaluated. For example, does the contractor conducting demolition work swing **loads** over operating **processes** or does the contractor avoid such hazards?

Maintaining a site injury and illness log for contractors is another method **employers** must **use** to track and maintain current knowledge of work activities involving contract **employees** working on or adjacent to covered processes. Injury and illness logs of both the **employer's employees** and contract **employees** allow an **employer** to have full knowledge of **process** injury and illness experience. This log will also contain information which will be of **use** to those auditing **process** safety management compliance and those involved in incident investigations.

Contract **employees** must perform their work safely. Considering that contractors often perform very specialized and potentially hazardous tasks such as **confined space entry** activities and non-routine repair activities it is quite important that their activities be **controlled** while they are working on or near a covered **process**. A **permit system** or work authorization system for these activities would also be helpful to all affected **employers**. The **use** of a work authorization system keeps an **employer** informed of contract **employee** activities, and as a benefit the **employer** will have better coordination and more management **control** over the work being performed in the **process** area. A well run and well maintained **process** where **employee** safety is fully recognized will benefit all of those who work in the **facility** whether they be contract **employees** or **employees** of the owner.

8. *Pre-Startup Safety.* For new **processes**, the **employer** will find a PHA helpful in improving the design and construction of the **process** from a reliability and quality point of view. The safe operation of the new **process** will be enhanced by making **use** of the PHA recommendations before final **installations** are completed. P&IDs are to be completed along with having the operating **procedures** in place and the operating staff trained to run the **process** before startup. The initial startup **procedures** and normal operating **procedures** need to be fully evaluated as part of the pre-startup review to assure a safe transfer into the normal operating mode for meeting the **process** parameters.

For existing **processes** that have been shutdown for turnaround, or modification, etc., the **employer** must assure that any changes other than “replacement in kind” made to the **process** during shutdown go through the management of change **procedures**. P&IDs will need to be updated as necessary, as well as operating **procedures** and instructions. If the changes made to the **process** during shutdown are significant and impact the training program, then operating personnel as well as **employees** engaged in routine and non-routine work in the **process** area may need some refresher or additional training in light of the changes. Any incident investigation recommendations, compliance audits or PHA recommendations need to be reviewed as well to see what impacts they may have on the **process** before beginning the startup.

9. *Mechanical Integrity.* **Employers** will need to review their maintenance programs and schedules to see if there are areas where “breakdown” maintenance is **used** rather than an on-going mechanical integrity program. Equipment **used** to **process**, store, or **handle highly hazardous chemicals** needs to be designed, constructed, installed and maintained to minimize the risk of releases of such chemicals. This requires that a mechanical integrity program be in place to assure the continued integrity of **process** equipment. Elements of a mechanical integrity program include the identification and categorization of equipment and instrumentation, inspections and tests, **testing** and inspection frequencies, development of maintenance procedures, training of maintenance personnel, the **establishment** of criteria for **acceptable** test results, documentation of test and inspection results, and documentation of manufacturer recommendations as to meantime to failure for equipment and instrumentation.

The first line of defense an **employer** has available is to operate and maintain the **process** as designed, and to keep the **chemicals** contained. This line of defense is backed up by the next line of defense which is the **controlled** release of **chemicals** through venting to scrubbers or flares, or to surge or overflow tanks which are designed to receive such **chemicals**, etc. These lines of defense are the primary lines of defense or means to prevent unwanted releases. The secondary lines of defense would include fixed fire protection systems like sprinklers, water spray, or deluge systems, monitor guns, etc., dikes, designed drainage systems, and other systems which would **control** or mitigate **hazardous chemicals** once an unwanted release occurs. These primary and secondary lines of defense are what the mechanical integrity program needs to protect and strengthen these primary and secondary lines of defenses where appropriate.

The first step of an effective mechanical integrity program is to compile and categorize a list of **process** equipment and instrumentation for inclusion in the program. This list would include pressure vessels, storage tanks, **process** piping, relief and vent systems, fire protection system components, **emergency** shutdown systems and alarms and **interlocks** and pumps. For the categorization of instrumentation and the listed equipment the **employer** would prioritize which pieces of equipment require closer scrutiny

than others. Meantime to failure of various instrumentation and equipment parts would be known from the manufacturers data or the **employer's** experience with the parts, which would then influence the inspection and **testing** frequency and associated procedures. Also, applicable codes and **standards** such as the National Board Inspection Code, or those from the American Society for **Testing** and Material, American Petroleum Institute, National Fire Protection Association, American National **Standards** Institute, American Society of Mechanical Engineers, and other groups, provide information to help establish an effective **testing** and inspection frequency, as well as appropriate methodologies.

The applicable codes and **standards** provide criteria for external inspections for such items as foundation and supports, anchor bolts, concrete or steel supports, guy wires, nozzles and sprinklers, pipe hangers, grounding connections, protective **coatings** and insulation, and external metal surfaces of piping and vessels, etc. These codes and **standards** also provide information on methodologies for internal inspection, and a frequency formula based on the corrosion rate of the materials of construction. Also, erosion both internal and external needs to be considered along with corrosion effects for piping and valves. Where the corrosion rate is not known, a maximum inspection frequency is recommended, and methods of developing the corrosion rate are available in the codes. Internal inspections need to cover items such as vessel shell, bottom and head; metallic linings; nonmetallic linings; thickness measurements for vessels and piping; inspection for erosion, corrosion, cracking and bulges; internal equipment like trays, baffles, sensors and screens for erosion, corrosion or cracking and other deficiencies. Some of these inspections may be performed by state or local government inspectors under state and local statutes. However, each **employer** needs to develop **procedures** to ensure that tests and inspections are conducted properly and that consistency is maintained even where different **employees** may be involved. Appropriate training is to be provided to maintenance personnel to ensure that they understand the preventive maintenance program procedures, safe practices, and the proper **use** and **application** of special equipment or unique tools that may be required. This training is part of the overall training program called for in the **standard**.

A quality assurance system is needed to help ensure that the proper materials of construction are used, that fabrication and inspection **procedures** are proper, and that **installation procedures** recognize field **installation** concerns. The quality assurance program is an essential part of the mechanical integrity program and will help to maintain the primary and secondary lines of defense that have been designed into the **process** to prevent unwanted **chemical** releases or those which **control** or mitigate a release. "As built" drawings, together with **certifications** of coded vessels and other equipment, and materials of construction need to be **verified** and retained in the quality assurance documentation. Equipment **installation** jobs need to be properly inspected in the field for **use** of proper materials and **procedures** and to assure that qualified

craftsmen are **used** to do the job. The **use** of appropriate gaskets, packing, bolts, valves, lubricants and welding rods need to be **verified** in the field. Also **procedures** for **installation** of safety devices need to be **verified**, such as the torque on the bolts on ruptured disc installations, uniform torque on flange bolts, proper **installation** of pump seals, etc. If the quality of parts is a problem, it may be appropriate to conduct audits of the equipment supplier's facilities to better assure proper purchases of required equipment which is suitable for its intended service. Any changes in equipment that may become necessary will need to go through the management of change procedures.

10. *Non-routine Work Authorizations.* Non-routine work which is conducted in **process** areas needs to be **controlled** by the **employer** in a consistent manner. The hazards identified involving the work that is to be accomplished must be communicated to those doing the work, but also to those operating personnel whose work could affect the safety of the **process**. A work authorization notice or **permit** must have a **procedure** that describes the steps the maintenance supervisor, contractor representative or other person needs to follow to obtain the necessary clearance to get the job started. The work authorization **procedures** need to reference and coordinate, as applicable, lockout/tag out **procedures**, **line breaking** procedures, **confined space entry procedures** and **hot work** authorizations. This **procedure** also needs to provide clear steps to follow once the job is completed in order to provide closure for those that need to know the job is now completed and equipment can be returned to normal.

11. *Managing Change.* To properly manage changes to **process** chemicals, technology, equipment and facilities, one must define what is meant by change. In this **process** safety management **standard**, change includes all modifications to equipment, procedures, raw materials and processing conditions other than "replacement in kind". These changes need to be properly managed by identifying and reviewing them prior to **implementation** of the change. For example, the operating **procedures** contain the operating parameters (pressure limits, temperature ranges, flow rates, etc.) and the importance of operating within these limits. While the operator must have the flexibility to maintain safe operation within the established parameters, any operation outside of these parameters requires review and approval by a written management of change **procedure**.

Management of change covers such as changes in **process** technology and changes to equipment and instrumentation. Changes in **process** technology can result from changes in production rates, raw materials, experimentation, equipment unavailability, new equipment, new product development, change in catalyst and changes in operating conditions to improve yield or quality. Equipment changes include among others change in materials of construction, equipment specifications, piping pre-arrangements, experimental equipment, computer program revisions and changes in alarms and

interlocks. **Employers** need to establish means and methods to detect both technical changes and mechanical changes.

Temporary changes have caused a number of catastrophes over the years, and **employers** need to establish ways to detect temporary changes as well as those that are permanent. It is important that a time limit for temporary changes be established and monitored since, without **control**, these changes may tend to become permanent. Temporary changes are subject to the management of change provisions. In addition, the management of change **procedures** are **used** to insure that the equipment and **procedures** are returned to their original or designed conditions at the end of the temporary change. Proper documentation and review of these changes is invaluable in assuring that the safety and health considerations are being incorporated into the operating **procedures** and the **process**.

Employers may wish to develop a form or clearance sheet to facilitate the processing of changes through the management of change procedures. A typical change form may include a description and the purpose of the change, the technical basis for the change, safety and health considerations, documentation of changes for the operating procedures, maintenance procedures, inspection and **testing**, P&IDs, **electrical classification**, training and communications, pre-startup inspection, duration if a temporary change, approvals and authorization. Where the impact of the change is minor and well understood, a check list reviewed by an **authorized person** with proper communication to others who are affected may be sufficient. However, for a more complex or significant design change, a hazard evaluation **procedure** with approvals by operations, maintenance, and safety departments may be appropriate. Changes in documents such as P&IDs, raw materials, operating procedures, mechanical integrity programs, **electrical** classifications, etc., need to be noted so that these revisions can be made permanent when the drawings and **procedure** manuals are updated. Copies of **process** changes need to be kept in an accessible location to ensure that design changes are available to operating personnel as well as to PHA team members when a PHA is being done or one is being updated.

12. *Investigation of Incidents.* Incident investigation is the **process** of identifying the underlying causes of incidents and implementing steps to prevent similar events from occurring. The intent of an incident investigation is for **employers** to learn from past experiences and thus avoid repeating past mistakes. The incidents for which OSHA expects **employers** to become aware and to investigate are the types of events which result in or could reasonably have resulted in a **catastrophic release**. Some of the events are sometimes referred to as "near misses," meaning that a serious consequence did not occur, but could have.

Employers need to develop in-house capability to investigate incidents that occur in their facilities. A team needs to be assembled by the **employer** and trained in the techniques of investigation including how to conduct interviews of

witnesses, needed documentation and report writing. A multi-disciplinary team is better able to gather the facts of the event and to analyze them and develop plausible scenarios as to what happened, and why. Team members should be selected on the basis of their training, knowledge and ability to contribute to a team effort to fully investigate the incident. **Employees** in the **process** area where the incident occurred should be consulted, interviewed or made a member of the team. Their knowledge of the events form a significant set of facts about the incident which occurred. The report, its findings and recommendations are to be shared with those who can benefit from the information. The cooperation of **employees** is essential to an effective incident investigation. The focus of the investigation should be to obtain facts, and not to place blame. The team and the investigation **process** should clearly deal with all involved individuals in a fair, open and consistent manner.

13. *Emergency Preparedness.* Each **employer** must address what actions **employees** are to take when there is an unwanted release of highly hazardous chemicals. **Emergency** preparedness or the **employer's** tertiary (third) lines of defense are those that will be relied on along with the secondary lines of defense when the primary lines of defense which are **used** to prevent an unwanted release fail to stop the release. **Employers** will need to decide if they want **employees** to **handle** and stop small or minor incidental releases. Whether they wish to mobilize the available resources at the plant and have them brought to bear on a more significant release. Or whether **employers** want their **employees** to evacuate the danger area and promptly escape to a preplanned safe zone area, and allow the local community **emergency** response organizations to **handle** the release. Or whether the **employer** wants to **use** some combination of these actions. **Employers** will need to select how many different **emergency** preparedness or tertiary lines of defense they plan to have and then develop the necessary plans and procedures, and appropriately train **employees** in their **emergency** duties and responsibilities and then implement these lines of defense.

Employers at a minimum must have an **emergency** action plan which will facilitate the prompt evacuation of **employees** due to an unwanted release of a **highly hazardous chemical**. This means that the **employer** will have a plan that will be activated by an alarm system to alert **employees** when to evacuate and, that **employees** who are physically impaired, will have the necessary support and assistance to get them to the safe zone as well. The intent of these requirements is to alert and move **employees** to a safe zone quickly. Delaying alarms or confusing alarms are to be avoided.

The **use** of **process control** centers or similar **process** buildings in the **process** area as safe areas is discouraged. Recent catastrophes have shown that a large life loss has occurred in these structures because of where they have been sited and because they are not necessarily designed to withstand over-pressures from shockwaves resulting from explosions in the **process** area.

Unwanted incidental releases of highly hazardous chemicals in the process area must be addressed by the employer as to what actions employees are to take. If the employer wants employees to evacuate the area, then the emergency action plan will be activated. For outdoor processes where wind direction is important for selecting the safe route to a refuge area, the employer should place a wind direction indicator such as a wind sock or pennant at the highest point that can be seen throughout the process area. Employees can move in the direction of cross wind to upwind to gain safe access to the refuge area by knowing the wind direction.

If the employer wants specific employees in the release area to control or stop the minor emergency or incidental release, these actions must be planned for in advance and procedures developed and implemented. Preplanning for handling incidental releases for minor emergencies in the process area needs to be done, appropriate equipment for the hazards must be provided, and training conducted for those employees who will perform the emergency work before they respond to handle an actual release. The employer's training program, including the Hazard Communication standard training is to address the training needs for employees who are expected to handle incidental or minor releases.

Preplanning for releases that are more serious than incidental releases is another important line of defense to be used by the employer. When a serious release of a highly hazardous chemical occurs, the employer through preplanning will have determined in advance what actions employees are to take. The evacuation of the immediate release area and other areas as necessary would be accomplished under the emergency action plan. If the employer wishes to use plant personnel such as a fire brigade, spill control team, a hazardous materials team, or use employees to render aid to those in the immediate release area and control or mitigate the incident, these actions are covered by § 1910.120, the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard. If outside assistance is necessary, such as through mutual aid agreements between employers or local government emergency response organizations, these emergency responders are also covered by HAZWOPER. The safety and health protections required for emergency responders are the responsibility of their employers and of the on-scene incident commander.

Responders may be working under very hazardous conditions and therefore the objective is to have them competently led by an on-scene incident commander and the commander's staff, properly equipped to do their assigned work safely, and fully trained to carry out their duties safely before they respond to an emergency. Drills, training exercises, or simulations with the local community emergency response planners and responder organizations is one means to obtain better preparedness. This close cooperation and coordination between plant and local community emergency preparedness managers will also aid the employer in complying with the Environmental Protection Agency's Risk Management Plan criteria.

One effective way for medium to large facilities to enhance coordination and communication during emergencies for on plant operations and with local community organizations is for **employers** to establish and equip an **emergency control** center. The **emergency control** center would be sited in a safe zone area so that it could be occupied throughout the duration of an **emergency**. The center would serve as the major communication **link** between the on-scene incident commander and plant or corporate management as well as with the local community officials. The communication equipment in the **emergency control** center should include a network to receive and transmit information by telephone, radio or other means. It is important to have a backup communication network in case of power failure or one communication means fails. The center should also be equipped with the plant layout and community maps, utility drawings including fire water, **emergency** lighting, appropriate reference materials such as a government agency notification list, company personnel phone list, SARA Title III reports and safety data sheets, **emergency** plans and **procedures** manual, a listing with the location of **emergency** response equipment, mutual aid information, and access to meteorological or weather condition data and any dispersion modeling data.

14. *Compliance Audits.* **Employers** need to select a trained individual or assemble a trained team of people to audit the **process** safety management system and program. A small **process** or plant may need only one knowledgeable person to conduct an audit. The audit is to include an evaluation of the design and effectiveness of the **process** safety management system and a field inspection of the safety and health conditions and practices to verify that the **employer's** systems are effectively implemented. The audit should be conducted or **lead** by a person knowledgeable in audit techniques and who is impartial towards the **facility** or area being audited. The essential elements of an audit program include planning, staffing, conducting the audit, evaluation and corrective action, follow-up and documentation.

Planning in advance is essential to the success of the auditing **process**. Each **employer** needs to establish the format, staffing, scheduling and verification methods prior to conducting the audit. The format should be designed to provide the **lead** auditor with a **procedure** or checklist which details the requirements of each section of the **standard**. The names of the audit team members should be listed as part of the format as well. The checklist, if properly designed, could serve as the verification sheet which provides the auditor with the necessary information to expedite the review and assure that no requirements of the **standard** are omitted. This verification sheet format could also identify those elements that will require evaluation or a response to correct deficiencies. This sheet could also be **used** for developing the follow-up and documentation requirements.

The selection of effective audit team members is critical to the success of the program. Team members should be chosen for their experience, knowledge,

and training and should be familiar with the **processes** and with auditing techniques, practices and procedures. The size of the team will vary depending on the size and complexity of the **process** under consideration. For a large, complex, highly instrumented plant, it may be desirable to have team members with expertise in **process** engineering and design, **process** chemistry, instrumentation and computer controls, **electrical** hazards and classifications, safety and health disciplines, maintenance, **emergency** preparedness, warehousing or shipping, and **process** safety auditing. The team may **use** part-time members to provide for the depth of expertise required as well as for what is actually done or followed, compared to what is written.

An effective audit includes a review of the relevant documentation and **process** safety information, inspection of the physical facilities, and interviews with all levels of plant personnel. Utilizing the audit **procedure** and checklist developed in the preplanning stage, the audit team can systematically analyze compliance with the provisions of the **standard** and any other corporate policies that are relevant. For example, the audit team will review all aspects of the training program as part of the overall audit. The team will review the written training program for adequacy of content, frequency of training, effectiveness of training in terms of its goals and objectives as well as to how it fits into meeting the **standard's** requirements, documentation, etc. Through interviews, the team can determine the **employee's** knowledge and awareness of the safety procedures, duties, rules, **emergency** response assignments, etc. During the inspection, the team can observe actual practices such as safety and health policies, procedures, and work authorization practices. This approach enables the team to identify deficiencies and determine where corrective actions or improvements are necessary.

An audit is a technique **used** to gather sufficient facts and information, including statistical information, to verify compliance with standards. Auditors should select as part of their preplanning a sample size sufficient to give a degree of confidence that the audit reflects the level of compliance with the **standard**. The audit team, through this systematic analysis, should document areas which require corrective action as well as those areas where the **process** safety management system is effective and working in an effective manner. This provides a record of the audit **procedures** and findings, and serves as a baseline of operation data for future audits. It will assist future auditors in determining changes or trends from previous audits.

Corrective action is one of the most important parts of the audit. It includes not only addressing the identified deficiencies, but also planning, follow up, and documentation. The corrective action **process** normally begins with a management review of the audit findings. The purpose of this review is to determine what actions are appropriate, and to establish priorities, timetables, resource allocations and requirements and responsibilities. In some cases, corrective action may involve a simple change in **procedure** or minor maintenance effort to remedy the concern. Management of

change [procedures](#) need to be used, as appropriate, even for what may seem to be a minor change. Many of the deficiencies can be acted on promptly, while some may require engineering studies or in depth review of actual [procedures](#) and practices. There may be instances where no action is necessary and this is a valid response to an audit finding. All actions taken, including an explanation where no action is taken on a finding, needs to be documented as to what was done and why.

It is important to assure that each deficiency identified is addressed, the corrective action to be taken noted, and the audit person or team responsible be properly documented by the [employer](#). To [control](#) the corrective action [process](#), the [employer](#) should consider the [use](#) of a tracking system. This tracking system might include periodic status reports shared with affected levels of management, specific reports such as completion of an engineering study, and a final [implementation](#) report to provide closure for audit findings that have been through management of change, if appropriate, and then shared with affected [employees](#) and management. This type of tracking system provides the [employer](#) with the status of the corrective action. It also provides the documentation required to verify that appropriate corrective actions were taken on deficiencies identified in the audit.

**APPENDIX D TO § 1910.119 - SOURCES OF FURTHER INFORMATION
(NONMANDATORY)**

1. Center for [Chemical Process Safety](#), American Institute of [Chemical Engineers](#), 345 East 47th Street, New York, NY 10017, (212) 705-7319.
2. "Guidelines for Hazard Evaluation Procedures," American Institute of [Chemical Engineers](#); 345 East 47th Street, New York, NY 10017.
3. "Guidelines for Technical Management of [Chemical Process Safety](#)," Center for [Chemical Process Safety](#) of the American Institute of [Chemical Engineers](#); 345 East 47th Street, New York, NY 10017.
4. "Evaluating [Process Safety](#) in the [Chemical Industry](#)," [Chemical Manufacturers Association](#); 2501 M Street NW, Washington, DC 20037.
5. "Safe Warehousing of Chemicals," [Chemical Manufacturers Association](#); 2501 M Street NW, Washington, DC 20037.
6. "Management of [Process Hazards](#)," American Petroleum Institute (API Recommended Practice 750); 1220 L Street, N.W., Washington, D.C. 20005.
7. "Improving Owner and Contractor Safety Performance," American Petroleum Institute (API Recommended Practice 2220); API, 1220 L Street N.W., Washington, D.C. 20005.
8. [Chemical Manufacturers Association](#) (CMA's Manager Guide), First Edition, September 1991; CMA, 2501 M Street, N.W., Washington, D.C. 20037.

9. "Improving Construction Safety Performance," Report A-3, The Business Roundtable; The Business Roundtable, 200 Park Avenue, New York, NY 10166. (Report includes criteria to evaluate contractor safety performance and criteria to enhance contractor safety performance).
 10. "Recommended Guidelines for Contractor Safety and Health," Texas [Chemical](#) Council; Texas [Chemical](#) Council, 1402 Nueces Street, Austin, TX 78701-1534.
 11. "Loss Prevention in the [Process](#) Industries," Volumes I and II; Frank P. Lees, Butterworth; London 1983.
 12. "Safety and Health Program Management Guidelines," 1989; U.S. Department of Labor, Occupational Safety and Health Administration.
 13. "Safety and Health Guide for the [Chemical](#) Industry," 1986, (OSHA 3091); U.S. Department of Labor, Occupational Safety and Health Administration; 200 Constitution Avenue, N.W., Washington, D.C. 20210.
 14. "Review of [Emergency](#) Systems," June 1988; U.S. Environmental Protection Agency (EPA), Office of Solid Waste and [Emergency](#) Response, Washington, DC 20460.
 15. "Technical Guidance for Hazards Analysis, [Emergency](#) Planning for Extremely Hazardous Substances," December 1987; U.S. Environmental Protection Agency (EPA), Federal [Emergency](#) Management Administration (FEMA) and U.S. Department of Transportation (DOT), Washington, DC 20460.
 16. "Accident Investigation * * * A New Approach," 1983, National Safety Council; 444 North Michigan Avenue, Chicago, IL 60611-3991.
 17. "Fire & Explosion Index Hazard [Classification](#) Guide," 6th Edition, May 1987, Dow [Chemical](#) Company; Midland, Michigan 48674.
 18. "Chemical Exposure Index," May 1988, Dow [Chemical](#) Company; Midland, Michigan 48674.
- [[57 FR 6403](#), Feb. 24, 1992; [57 FR 7847](#), Mar. 4, 1992, as amended at [61 FR 9238](#), Mar. 7, 1996; [67 FR 67964](#), Nov. 7, 2002; [76 FR 80738](#), Dec. 27, 2011; [77 FR 17776](#), Mar. 26, 2012; [78 FR 9313](#), Feb. 8, 2013]