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State of California  
DEPARTMENT OF INDUSTRIAL RELATIONS  
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

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DRAFT PSM Regulatory Text  
*Process Safety Management for Refineries*  
Proposed General Industrial Safety Order 5189.1

September 9, 2014

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## **§ 5189.1. Process Safety Management of Highly Hazardous Materials, Petroleum Refineries.**

### **(a) Scope and Purpose.**

(1) These regulations contain requirements to prevent major incidents, as defined in this section, and to eliminate, to the greatest extent feasible, health and safety risks to which employees may be exposed.

(2) All documents developed by the employer pursuant to this Section shall be provided to the Division on request.

### **(b) Application.**

These regulations shall apply to all processes and appurtenances, operations and substances at petroleum refineries that have the potential to cause serious physical harm or a major incident.

### **(c) Definitions.**

**Change.** Any alteration in process chemicals, technology, procedures, equipment, appurtenances, or facilities.

**Damage Mechanism.** The mechanical, chemical, physical, or other process that results in equipment or material degradation.

**Facility.** The plants, units, buildings, containers, or equipment that contain or include a process.

**Fault-Tree Analysis.** A logic model that graphically portrays the potential combinations of events, such as equipment failures, control system failures, or human errors that can lead to a major incident, as defined in this subsection.

**Feasible.** Capable of being achieved.

**Flammable.** A flammable is a liquid or gas as defined in Title 29 Code of Federal Regulations section 1910.1200 Appendix B.

**Hierarchy of Hazard Controls.** Hazard prevention and control measures, in priority order, to eliminate or minimize a hazard, as described in Appendix A. Hazard prevention and control measures ranked from most preferred to least preferred are: First Order Inherent Safety, Second Order Inherent Safety, and Independent Layers of Protection (see definitions below).

**Highly Hazardous Material.** A substance possessing toxic, reactive, flammable, explosive, or other dangerous properties exposure to which could potentially result in death or serious physical harm.

Hierarchy of Hazard Controls Analysis (HCA). A procedure that applies the Hierarchy of Hazard Controls for the purpose of selecting actions that eliminate or minimize a hazard or reduce the risk presented by a hazard.

Hot Work. Electric or gas welding, cutting, brazing or any similar heat, flame, or spark-producing procedures or operations.

Independent Layers of Protection (ILP). Safeguards that reduce the likelihood or consequences of a major incident through the application of devices, systems, or actions. ILPs are (1) independent of an initiating cause and (2) independent of other ILPs. Independence ensures that an initiating cause does not affect the function of an ILP and that failure in any one layer does not affect the function of any other layer. ILPs, ranked from most preferred to least preferred, are passive safeguards (e.g., doubled-walled pressure vessels and piping, remote siting of hazardous processes, and secondary containment); active safeguards (e.g., pressure relief valves and automatic shut-down systems) and procedural safeguards (e.g., emergency response plans and other operations implemented by employees).

Inherent Safety. An approach to safety that focuses on eliminating or reducing the hazards associated with a set of conditions. A process is inherently safer if it reduces or eliminates the hazards associated with materials or operations used in the process, and this reduction or elimination is permanent and inseparable from the material or operation. A process with reduced hazards is described as inherently safer compared to a process with only passive, active, and procedural safeguards. The process of identifying and implementing inherent safety in a specific context is known as inherently safer design.

First Order Inherent Safety measure. A measure that prevents a major incident by eliminating or reducing the hazard. Changes in the chemistry of a process that eliminate or reduce the hazard(s) of the chemicals used or produced are usually considered First Order Inherent Safety measures; for example, by substituting a flammable chemical with an alternative chemical that can serve the same function but with lower vapor pressure and narrower flammable range.

Second Order Inherent Safety measure. A measure that reduces the severity of a hazard or the likelihood of a release without the use of add-on safety devices. Changes in process variables to minimize, moderate and simplify a process are usually considered Second Order Inherent Safety measures; for example, redesigning a high-pressure, high-volume, and high-temperature system to operate at lower temperatures, volumes, and pressures.

**Initiating Cause.** An operational error, mechanical failure, or other internal or external event that is the first event in an incident sequence and marks the transition from a normal situation to an abnormal situation.

**Isolation.** A procedure whereby equipment is removed from service and completely protected against the inadvertent release or introduction of material or energy by such means as blanking or blinding; misaligning or removing sections of lines, pipes, or ducts; implementing a double block and bleed system; or blocking or disconnecting all mechanical linkages.

**Major Change.** Introduction or alteration of a process, process equipment, substance or process chemistry, or any other alteration that may introduce a hazard which has the potential to result in death or serious physical harm.

**Major Incident.** Any event involving fire, explosion or release of a substance which has the potential to result in death or serious physical harm. Such events include, but are not limited to, (1) a release of a toxic, flammable or otherwise hazardous substance; (2) an event that causes a community evacuation or community shelter-in-place order to be officially declared; (3) unplanned releases of non-toxic or non-flammable materials, including, but not limited to, steam, hot condensate, nitrogen, carbon dioxide or compressed air; (4) an event that triggers a pressure relief device to discharge to the atmosphere and results in one or more of the following: liquid carryover, discharge to a potentially unsafe location, an on-site shelter-in-place action or evacuation order, or activation of public protective measures (e.g., road or facility closures).

**Mechanical Integrity.** State or quality of process equipment, controls, and appurtenances that takes into account fabrication from the proper materials of construction, design and use for the intended purpose, proper installation, inspection, maintenance and replacement.

**Petroleum Refinery.** Petroleum refineries as defined in North American Industry Classification System (NAICS) Code 32411 (formerly Standard Industrial Classification (SIC) Code 2911).

**Process.** Any activity involving a highly hazardous material, including use, storage, manufacturing, handling, or on-site movement. For purposes of this definition, any group of vessels that are interconnected, and separate vessels that are located such that a highly hazardous material could be involved in a potential release, shall be considered a single process. Controls on a process or utilities that, in the event of a malfunction, could result in a release of highly hazardous material from the process, are considered to be part of the process.

**Process Safety Culture.** The core values and behaviors resulting from a collective commitment by leaders and individuals that emphasize safety over competing goals in order to ensure protection of people and the environment.

Process Safety Management. The application of management principles to ensure the safety of chemical process facilities.

Process Safety Performance Indicators. Measurements of the facility's activities and events that are used to evaluate the performance of process safety systems.

Recognized and Generally Accepted Good Engineering Practices (RAGAGEP). Engineering, operation, or maintenance activities based on established codes, standards, published technical reports or recommended practices or similar documents, including, but not limited to published consensus standards, codes and guidelines developed by the American Institute of Chemical Engineers (AIChE), American National Standards Institute (ANSI), American Petroleum Institute (API), American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), American Society of Mechanical Engineers (ASME), American Society of Testing and Materials (ASTM), Center for Chemical Process Safety (CCPS), and National Fire Protection Association (NFPA).

Root Cause. Underlying reasons, such as deficiencies in management systems, which if corrected would prevent or significantly reduce the likelihood of the problem's reoccurrence.

Safeguard. A device, system or action that interrupts the chain of events following an initiating cause, or that mitigates the impacts of an incident.

Passive Safeguards. Minimizing the hazard through process and equipment design features that reduce either the frequency or consequence of the hazard without the active functioning of any device; for example, by providing a diked wall around a storage tank of flammable liquids.

Active Safeguards. Using controls, alarms, safety instrumented systems, and mitigation systems to detect and respond to deviations from normal process operations; for example, by using a pump that is shut off by a high-level switch in the downstream tank when the tank is 90% full.

Procedural Safeguards. Using policies, operating procedures, training, administrative checks, emergency response and other management approaches to prevent incidents or to minimize the effects of an incident. Examples include hot work procedures and permits and emergency response procedures implemented by employees.

Safeguard Protection Analysis. A quantitative or semi-quantitative assessment for a particular process of the overall effectiveness of all measures and safeguards as an integrated unit; for example, by assessing the combined effectiveness of First and Second Order Inherent Safety measures, Passive and Active Safeguards, Procedural Safeguards, and personal protective

equipment (PPE) in protecting employee health and safety and reducing the likelihood of a major incident to the greatest extent feasible.

Safety Instrumented Systems. Systems designed to achieve or maintain safe operation of a process in response to an unsafe process condition.

Serious Physical Harm. Serious physical harm as defined in Section 6432(e).

**(d) Process Safety Information.**

(1) The employer shall develop and maintain a compilation of written safety information before conducting any Process Hazard Analysis, Hierarchy of Hazard Controls Analysis, Safeguard Analysis or Damage Mechanism Review, as required by this Section. The compilation of written process safety information shall be sufficient to enable the employer and employees involved in operating or maintaining a process to identify and understand the hazards posed by the process. As described in this subsection, the process safety information shall include information pertaining to (1) the hazards of substances used in or produced by the process, (2) the technology of the process, (3) equipment, controls, safeguards and appurtenances used in the process, and (4) results of previous Damage Mechanism Reviews. The employer shall provide for employee participation in this process. The process safety information shall be made available to, and shall be communicated to, all employees who perform any duties in or near the process.

(2) Information pertaining to hazards of substances used in, present in or produced by the process shall include at least the following:

(A) Toxicity information, including acute and chronic health hazards;

(B) California Permissible Exposure Limits (PELs), as listed in Section 5155; National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Levels (RELs); American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs); and the California Office of Environmental Health Hazard Assessment (OEHHA) acute and eight-hour Reference Exposure Levels (RELs);

(C) Physical data;

(D) Corrosivity data;

(E) Thermal and chemical stability data;

(F) Reactivity data; and,

(G) Hazardous effects of incompatible mixtures that could foreseeably occur.



NOTE: Safety Data Sheets meeting the requirements of Section 5194(g) may be used to comply with this requirement to the extent that they meet the information provisions.

(3) Information pertaining to the technology of the process shall include at least the following:

- (A) A block flow diagram or simplified process flow diagram;
- (B) Process chemistry;
- (C) Maximum intended inventory;
- (D) Safe upper and lower limits for process variables, such as temperatures, pressures, flows, levels and/or compositions; and,
- (E) The consequences of deviations, including chemical mixing and/or reactions that may affect the safety and health of employees.

NOTE: For processes for which data are unavailable, information concerning the technology of the process may be developed from a Process Hazard Analysis, conducted in accordance with subsection (e).

(4) Information pertaining to equipment, controls, safeguards and appurtenances used in the process shall include at least the following:

- (A) Materials of construction;
- (B) Piping and instrument diagrams (P&IDs);
- (C) Electrical classification;
- (D) Relief system design and design basis;
- (E) Ventilation system design;
- (F) Design codes and standards employed, including design conditions and operating limits;
- (G) Material and energy balances for processes built after September 1, 1992;
- (H) Safety systems, such as interlocks and detection and suppression systems; and,
- (I) Electrical supply and distribution systems.

(5) The employer shall document that equipment, controls, safeguards and appurtenances comply with recognized and generally accepted good engineering practices.

(6) If existing equipment was 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 and document a process hazard analysis (PHA) appropriate to the complexity of the process in order to identify, evaluate, and control hazards involved in all processes. All modes of operations shall be covered by the PHA. The purpose of the PHA is to reduce the risks associated with a process to the greatest extent feasible. The employer shall determine and document the priority order for conducting process hazard analyses based on the extent of process hazards, the number of potentially affected employees, the age of the process and the process operating history. The employer shall use at least one of the following methodologies:

(A) What-If;

(B) Checklist;

(C) What-If/Checklist;

(D) Hazard and Operability Study (HAZOP);

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

(F) Fault-Tree Analysis;

(G) Other PHA methods recognized by engineering organizations or governmental agencies; or

(H) In the absence of (A) - (G), the employer may utilize a hazard analysis method developed and certified by a registered professional engineer for use by the process hazards analysis team.

(2) The PHA shall address:

(A) The hazards of the process;

(B) The recommendations of Damage Mechanism Reviews (DMRs), pursuant to subsection (k);

(C) Safeguards applicable to the hazards and their relationships;

(D) Potential consequences of failures of equipment, controls, safeguards and appurtenances;

(E) Whether the placement of processes, equipment, buildings, employee occupancies and work stations effectively protects employees from hazards, including but not limited to, explosions, fires and toxic substances;

(F) Human Factors as required under subsection(s) herein;

(G) A qualitative evaluation of the range and probability of the potential safety and health effects of the failure of equipment, controls, safeguards and appurtenances on employees and contractor employees;

(H) The potential effects of external events, including seismic events, if applicable. PHAs completed for other programs where external events were not considered shall be updated to include external events; and,

(I) The findings of incident investigations relevant to the process.

(3)(A) The PHA shall be performed by a team with expertise in engineering, damage mechanisms, and process operations. The team shall include at least one operating employee with expertise in the process being evaluated and one member with expertise in the PHA methodology being used.

(B) The PHA report for each process shall be available in the respective work area for review by any person working in that area.

(C) The employer shall consult with affected employees and their representatives on the development and conduct of PHAs. Affected employees and their representatives shall be provided access to the records required by this section.

(4) The employer shall document the PHA team's findings and recommended actions in a PHA report.

(5) The employer shall perform a Hierarchy of Hazard Controls Analysis (HCA) for all PHA recommendations, pursuant to subsection (I).

(6) The report shall include: (i) the findings of the Hierarchy of Hazard Controls analysis; (ii) actions taken to implement the team's recommendations; and (iii) an implementation schedule for all recommended actions. The employer shall make the report available to operating, maintenance and other persons whose work assignments are in the facility and who may be affected by the recommendations or actions.

(7) The employer shall establish a system to promptly implement all recommended actions. Each recommended action not requiring a process shutdown shall be completed within two years after the completion of the PHA unless the employer can demonstrate it is not feasible to do so. Where a recommended action cannot be implemented within two years, the employer shall document the decision and rationale for the delay and implement the corrective action as soon as possible. Recommended actions addressing hazards that present the potential for death or serious physical harm shall be corrected immediately, either through permanent corrections or interim safeguards sufficient to ensure employee safety.

(8) All recommended actions requiring a process shutdown shall be completed during the first regularly scheduled turnaround of the applicable process, subsequent to completion of the PHA, unless the employer can demonstrate in writing it is not feasible to do so.

(9) Justification for all PHA recommendations delayed shall be documented and reported in accordance with this subsection.

(10) At least every five (5) years, the written PHA shall be updated and revalidated by a team meeting the requirements of this subsection to ensure that the PHA is consistent with the current process.

(11) The employer shall retain for the life of the process all PHAs and PHA updates and revalidations for each process covered by this section. This information shall contain the documented resolution of recommended actions described in this subsection.

(12) The employer shall provide the PHA documentation to the Division and to employees and employee representatives upon request.

**(f) Operating Procedures.**

(1) The employer shall follow best practices in developing and implementing written operating procedures. The procedures shall provide clear instructions for safely conducting activities involved in each process. The procedures shall be consistent with the process safety information and shall address at least the following:

(A) Steps for each operating phase or mode of operation:

1. Start-up;
2. Normal operation;
3. Temporary operations as the need arises;
4. Emergency shutdown, including the conditions under which emergency shutdown is required, and the assignment of responsibilities to qualified operators in order to ensure that emergency shutdown is executed in a safe and timely manner;
5. Emergency operations, including but not limited to, any response to the over-pressurizing or overheating of equipment or piping, and the handling of leaks, spills, releases and discharges. These procedures shall provide that only qualified operators may initiate these operations, and that prior to allowing employees in the vicinity of a leak, release or discharge, the employer shall, at a minimum, do one of the following:
  - a. Shutdown and depressurize all process operations where a leak, release or discharge is occurring;
  - b. Isolate any vessel, piping, and equipment where a leak, spill or discharge is occurring;

c. The employer may implement alternative procedures for handling leaks, spills, or discharges if the employer can demonstrate that the alternative procedures provide a level of protection equivalent to isolating or shutting down the process.

6. Normal shutdown; and,

7. Start-up following a turnaround, or after an emergency shutdown.

(B) Operating limits:

1. Consequences of deviation(s); and,

2. Steps required to correct and/or avoid deviation(s).

(C) Safety and health considerations:

1. Properties of, and hazards presented by, the chemicals used in the process;

2. Precautions necessary to prevent exposure, including first and second order inherent safety measures; passive, active and procedural safeguards; and personal protective equipment;

3. Protective measures to be taken if physical contact or inhalation exposure occurs;

4. Safety procedures for opening process equipment, such as pipeline breaking;

5. Verification of raw materials and control of hazardous chemical inventory levels; and,

6. Any special or unique hazards.

(D) Safety Systems and their functions.

(2) A copy of the operating procedures shall be readily accessible to employees who work in or near the process area and to any other person who works in or near the process area or who maintains a process.

(3) The operating procedures shall be reviewed as often as necessary to ensure that they reflect current, safe operating practices. The operating procedures shall include any changes that result from alterations in process chemicals, technology, personnel, equipment, appurtenances or other changes to the facility. All changes to operating procedures shall be inserted into the working operating procedures documents as soon as possible. The employer shall certify annually that operating procedures are current and accurate.

(4) The employer shall develop, implement and maintain safe work practices to prevent or control hazards during specific operations, such as: opening process equipment or piping; tasks requiring lock-out/tag-out procedures; confined space entry; handling, controlling, and stopping leaks, spills, releases and discharges; and control over entry into hazardous work areas

by maintenance, contractor, laboratory or other support personnel. Safe work practices shall apply to employees and contractor employees.

**(g) Training.**

(1) Initial training. Each employee involved in operating or maintaining a process, and each employee prior to working in a newly assigned process, shall be trained in an overview of the process and in the operating procedures, as specified in subsection (f). The training shall include material on the specific safety and health hazards, procedures, and safe practices applicable to the employee's job tasks.

(2) Refresher and supplemental training. At least every three years, and more often if necessary, refresher and supplemental training shall be provided to each operating or maintenance employee and other employees in order to ensure safe operation of the facility. The employer, in consultation with employees involved in operation or maintenance of a process, shall determine the appropriate frequency and content of refresher training.

(3) Training certification. The employer shall ensure that each employee involved in the operation or maintenance of a process has received, understood and successfully completed training as specified by this subsection. The employer, after the initial or refresher training, shall prepare a certification record containing the identity of the employee, the date(s) of training, the means used to verify that the employee understood the training, and the signature(s) of the person administering the training.

(4) The employer shall establish and implement employee testing procedures to ensure competency in job skill levels and work practices that protect employee safety and health.

**(h) Contractors.**

(1) Employer responsibilities.

(A) When selecting a contractor, an employer shall obtain and evaluate information regarding the contractor's safety performance, including mechanisms used to prevent employee injuries and illnesses.

(B) The employer shall inform the contractor of the potential hazards associated with the contractor's work and the process, including but not limited to, fires, explosions, loss of containment, hazardous materials exposures and high temperatures and pressures.

(C) The employer shall explain to the contractor the applicable provisions of this Section, including the provisions of the emergency action plan required in subsection (p).

(D) The employer shall develop written procedures in order to ensure the safe entry, presence, and exit of the contractor and contractor's employees in process areas.

(E) The employer shall periodically evaluate the performance of contractors in fulfilling their obligations, as specified in this subsection.

(F) The employer shall obtain and make available to the Division upon request a copy of the contractor's injury and illness log related to the contractor's work in the process areas.

(2) Contractor responsibilities.

(A) The contractor shall ensure that all of its employees are trained in the work practices necessary to safely perform their jobs, including in applicable provisions of the emergency action plan.

(B) The contractor shall ensure that all of its employees are instructed in the potential hazards related to their jobs and the process, including but not limited to, fires, explosions, loss of containment, hazardous materials exposures and high temperatures and pressures.

(C) The contractor shall document that each of its employees has successfully completed the training required by this subsection by maintaining a record identifying: (i) each employee who has received training; (ii) the date(s) and subject(s) of training each employee has received; and (iii) the means used to verify that the employee understood the training received.

(D) The contractor shall ensure that each of its employees understands and follows the safety and health procedures of the employer and the contractor.

(E) The contractor shall advise the employer of any unique hazards presented by the contractor's work, as well as any hazards identified by the contractor while performing work for the employer.

**(i) Pre-Start Up Safety Review.**

(1) The employer shall perform a Pre-Start Up Safety Review for new facilities and for modified facilities if the modification necessitates a change in the Process Safety Information.

(2) The Pre-Start Up Safety Review shall confirm that prior to introduction of hazardous, flammable or explosive materials to a process:

(A) Construction, maintenance and repair work has been performed in accordance with design specifications;

(B) Equipment, controls, safeguards and appurtenances have been maintained and are operable in accordance with design specifications;

- (C) Effective safety, operating, maintenance, and emergency procedures are in place;
- (D) For new facilities, a Process Hazard Analysis, Hierarchy of Hazard Controls Analysis, and Safeguard Analysis have each been performed and recommendations have been implemented or resolved before start-up. For modified facilities, all changes have been implemented in accordance with the requirements contained in the Management of Change subsection (n); and,
- (E) Training of each operating employee and maintenance employee has been completed.
- (3) The Pre-Start Up Safety Review shall involve employees with expertise in process operations and engineering. These employees shall be selected by employees and their representatives on the basis of their level of experience with and knowledge of the process systems being evaluated.

**(j) Process Integrity.**

(1) Written procedures.

(A) The employer shall develop, implement and maintain effective written procedures to ensure the ongoing integrity of process equipment, controls, safeguards and appurtenances. These procedures shall:

1. Include a method for employees to anonymously identify and report potentially faulty or unsafe equipment, controls, safeguards and appurtenances;
2. Include a method for employees to record and report their observations and recommendations to the employer in writing; and
3. Require the employer to respond in writing within 60 calendar days to observations and recommendations recorded and reported in writing by employees pursuant to this subsection.

(B) The employer shall develop and implement effective written maintenance procedures, which shall provide clear instructions for safely conducting maintenance activities on process equipment, controls, safeguards and appurtenances, consistent with the Process Safety Information.

(C) The employer shall provide employees and their representatives access to the procedures developed and the inspection documents generated pursuant to this subsection.

(2) Inspection and testing.



(A) Inspections and tests shall be performed on process equipment, controls, safeguards and appurtenances, using procedures that adhere to recognized and generally accepted good engineering practices (RAGAGEP).

(B) The frequency of inspections and tests shall be consistent with the applicable manufacturer's recommendations as well as RAGAGEP. Inspections and tests shall be conducted more frequently if necessary, based on the operating experience with the process equipment, controls, safeguards and appurtenances.

(D) The employer shall retain a certification record to document that each inspection and test has been performed in accordance with this subsection. The certification record shall identify: the date of the inspection; the name of the person who performed the inspection or test; a description of the inspection or test performed; the results of the inspection or test; and the serial number or other identifier of the equipment, control, safeguard or appurtenance.

(3) Equipment deficiencies. The employer shall correct deficiencies in equipment, controls, safeguards and appurtenances, consistent with RAGAGEP.

(4) Quality assurance.

(A) The employer shall ensure that existing equipment, controls, safeguards and appurtenances comply with this subsection in accordance with RAGAGEP. The employer shall ensure that all equipment, controls, safeguards and appurtenances are: (i) suitable for the process application for which they are or will be used; (ii) designed, installed, operated and maintained to reduce the risk of failure to the greatest extent feasible; and (iii) meet the manufacturer's and any other design specifications and all applicable codes and standards.

(B) The employer shall conduct regularly scheduled checks and inspections as necessary to ensure that the requirements of paragraph (A) are met.

**(k) Damage Mechanism Review.**

(1) The employer shall complete an initial Damage Mechanism Review (DMR) for each process no later than three years after the effective date of this Section, or prior to the employer's next scheduled turnaround or Process Hazard Analysis (PHA) revalidation, whichever occurs earlier.

(2) A DMR shall be revalidated thereafter at least once every five years.

(3) A DMR shall also be conducted prior to initial approval of a major change, as defined in this Section.

- (4) As part of a major incident investigation that involves a damage mechanism, the employer shall review the most recent DMR(s) that are relevant to the investigation or perform a new DMR as part of a root cause analysis.
- (5) Recommended actions that result from DMRs shall be implemented to the greatest extent feasible. The results of the DMR for a process unit shall be available to the team performing a Process Hazard Analysis (PHA) for that process unit and to the Division during an audit or inspection or upon request.
- (6) The employer shall implement recommended actions based on the results of a Hierarchy of Hazard Controls Analysis, in accordance with subsection (l).
- (7) A DMR team shall be established that includes, but not be limited to, engineers and operators familiar with the process(es), individuals with expertise in equipment and pipe inspection, and individuals with expertise in damage and failure mechanisms.
- (8) Employees and their representatives shall be included on the DMR team.
- (9) DMRs for all processes shall include an assessment of process flow diagrams, materials of construction, process conditions, and chemical substances contained in piping or equipment in order to determine potential damage/failure mechanisms. These mechanisms include, but are not limited to:
- (A) Mechanical loading failures, such as ductile fracture, brittle fracture, mechanical fatigue and buckling;
  - (B) Wear, such as abrasive wear, adhesive wear and fretting;
  - (C) Corrosion, such as uniform corrosion, localized corrosion and pitting;
  - (D) Thermal-related failures, such as creep, metallurgical transformation and thermal fatigue;
  - (E) Cracking, such as stress-corrosion cracking; and,
  - (F) Embrittlement, such as high-temperature hydrogen attack.
- (10) A DMR shall include an assessment of previous experience with the process, including the inspection history and all damage mechanism data; a review of industry-wide experience with the process; and applicable standards, codes and practices.
- (11) At the conclusion of the analysis, the employer shall prepare a written DMR report that includes, at a minimum:
- (A) The process unit(s) and damage mechanisms analyzed;
  - (B) Results of all analyses;

- (C) Recommended temporary mitigation actions;
- (D) Recommended prevention actions, based on a Hierarchy of Hazard Controls Analysis, in accordance with subsection (I);
- (E) An implementation schedule for all recommended actions; and
- (F) Resolution of all recommended actions.

(12) The report shall be provided to and reviewed with all operating, maintenance and other personnel whose work assignments are within the scope of the DMR. The report shall be provided to employee representatives on request.

(13) The employer shall establish a system to promptly implement all recommended actions. Each recommended action not requiring a process shutdown shall be completed within two years after the completion of the DMR unless the employer can demonstrate it is not feasible to do so. Where a recommended action cannot be implemented within two years, the employer shall document the decision and rationale for the delay and implement the corrective action as soon as possible. Recommended actions addressing hazards that present the potential for death or serious physical harm shall be corrected immediately, either through permanent corrections or interim safeguards sufficient to ensure employee safety.

(14) All recommended actions requiring a process shutdown shall be completed during the first regularly scheduled turnaround of the applicable process, subsequent to completion of the DMR, unless the employer can demonstrate in writing it is not feasible to do so.

(15) DMR reports shall be retained for the life of the process unit and shall be provided to the Division upon request.

#### **(I) Hierarchy of Hazard Controls Analysis.**

(1) An HCA shall be performed, updated and revalidated by a team that consists of individuals with expertise that includes, but is not limited to, process engineering, process chemistry, occupational health and safety, damage mechanisms, process operations, and control systems,

(2) The HCA team shall include:

(A) At least one operating employee with expertise in the process being evaluated;

(B) At least one individual who is knowledgeable in the application of inherent safety measures and layers of protection for the process being evaluated; and

(C) At least one employee representative.

(3) The employer shall conduct an HCA for existing processes in conjunction with the analysis and implementation of corrective actions that result from a Process Hazard Analysis (PHA), and pursuant to an established PHA schedule that provides for revalidations occurring every five years after the completion of an initial HCA for each process.

(4) The employer shall also conduct an HCA in the following instances:

(A) When a major change is proposed by the employer as part of a Management of Change review, pursuant to subsection (n) of this regulation,

(B) When an incident occurs that results in an incident investigation, pursuant to subsection (o) of this regulation;

(C) When ensuring the quality of new or modified equipment, controls, safeguards and appurtenances;

(D) During the design and review of new equipment, processes, process units, and facilities; and,

(E) At the request of the Division.

(5) In the course of conducting an HCA, the employer shall:

(A) Produce or collect all necessary risk-relevant data for each process;

(B) Identify, characterize and prioritize each process safety risk against the objective of preventing major incidents, as defined in this Section, and eliminating to the greatest extent feasible, health and safety risks to which employees may be exposed.

(C) In accordance with Appendix A to this Section, identify and evaluate relevant inherent safety measures and safeguards (or where appropriate, combinations of measures and safeguards) in an iterative manner to reduce each risk to the greatest extent feasible. The employer shall select and implement first and second order inherent safety measures unless the employer can demonstrate in writing it is not feasible to do so. Where the employer does not implement a first or second order inherent safety measure, the employer shall document and justify in writing: (a) why that measure is not feasible; and (b) why the measures it has implemented are the most protective alternative measures feasible. If the inherent safety measure meets any of the following criteria, it shall be presumed feasible:

(i) RAGAGEP, as described in guidelines, standards and codes;

(ii) All control techniques or management systems that have been achieved in practice for the petroleum refining and related industrial sectors, and, where applicable, emerging technologies in the refining industry and other industrial sectors; and

(iii) Control techniques or management systems that have been required or recommended for the petroleum refining and, where applicable, related industrial sectors in a regulation or report by a federal, state or local agency.

(6) The employer shall complete an HCA report, which shall include:

(A) A description of the composition and expertise of the members of the team that performed the HCA;

(B) The description, characterization and prioritization of all process safety risks;

(C) A summary identifying and evaluating all measures and safeguards considered by the HCA team;

(D) The HCA team's recommended measures and safeguards to address each process safety risk, in accordance with the iterative process described in Appendix A;

(E) The employer's proposed actions and schedule to implement the HCA team's recommended measures and safeguards for each process safety risk; and

(F) The employer's plan for communicating the findings, recommendations and implementation schedule to all affected employees.

(7) The facility manager shall sign all HCA reports.

(8) Within ten days of completing an HCA report, the employer shall provide notice of availability of the report to the Division. Upon the request of the Division, the employer shall promptly submit the HCA Report to the Division.

(9) Where the Division identifies deficiencies in an HCA report, the Division may require the employer to do any or all of the following:

(A) Submit further information or documentation;

(B) Perform a reanalysis and submit a revised HCA report;

(C) Modify the HCA report to incorporate changes to the proposed measures or safeguards, in accordance with this Section.

(10) The employer shall implement all recommended protective measures and safeguards in the HCA report, or the revised HCA report, as follows:

(A) The employer shall establish a system to promptly implement all recommended actions. All recommended actions not requiring a process shutdown shall be completed within two years after the completion of the HCA, except that recommended actions addressing hazards that present the potential for death or serious physical harm shall be corrected immediately, either through permanent corrections or interim safeguards sufficient to ensure employee safety.

(B) All recommended actions requiring a process shutdown shall be completed during the first regularly scheduled turnaround of the process, unless infeasible.

(11) The employer shall retain all documents pertaining to a Hierarchy of Hazard Controls Analysis (HCA) for the life of each covered process.

**(m) Hot Work Permit.**

(1) The employer shall develop, implement and maintain a written procedure for the issuance of hot work permits.

(2) The permit shall (a) certify that the applicable portions of the fire prevention and protection requirements contained in Sections 4848 and 6777 have been implemented prior to the initiation of hot work operations; (b) indicate the date(s) and times during which hot work is to be performed; (c) identify the equipment or process on which hot work is to be performed; and, (d) identify the name and contact information of the party performing the hot work.

(3) All hot work permits shall be kept on file for the life of the unit.

**(n) Management of Change.**

(1) The employer shall develop, implement and maintain written Management of Change (MOC) procedures to manage changes (except for replacements that satisfy design specifications) in process chemicals, technology, procedures, equipment, appurtenances or facilities.

(2) The MOC procedures shall be implemented as part of a Damage Mechanism Review, Hierarchy of Hazard Controls Analysis, and/or Safeguard Protection Analysis, as appropriate.

(3) The MOC procedures shall assure that the following items are addressed and documented prior to any change:

(A) The technical basis for the proposed change;

(B) Potential impacts of the change on safety and health;

(C) Modifications to operating procedures;

(D) The time period required for the change; and,

(E) Authorization requirements for the proposed change.

(4) Employees involved in the process, as well as maintenance workers and employees of contractors whose job tasks will be affected by a change, shall be informed of, and be trained in the change in the process as early as practicable prior to its start-up.

(5) If a change covered by this subsection results in a change to the Process Safety Information, such information shall be amended and updated as soon as possible, in accordance with subsection (d).

(6) If a change covered by this subsection results in a change to the Operating Procedures, the procedures shall be amended and updated, in accordance with subsection (f).

**(o) Incident Investigation – Root Cause Analysis.**

(1) The employer shall develop, implement and maintain written procedures for promptly investigating and reporting any incident that results in, or could reasonably have resulted in, a major incident.

(2) The written procedures shall include an effective method for conducting a thorough root cause analysis. The root cause analysis method shall provide information sufficient for the employer to reduce the risk of a recurrence or similar incidents to the greatest extent feasible.

(3) The employer shall investigate all incidents that resulted in, or could reasonably have resulted in, a major incident. The employer shall initiate the incident investigation as promptly as possible, but no later than 48 hours following an incident.

(4) An incident investigation team shall be established and shall, at a minimum, consist of a person with expertise in the process involved; a person with expertise in the employer's root cause analysis method; and a person with expertise in overseeing the investigation and analysis. The incident investigation team shall also include employee and employee representatives. If the incident involved the work of a contractor, an employee of that contractor shall also be included on the investigation team.

(5) The incident investigation team shall implement the employer's root cause analysis method and shall determine the underlying management system causes of the incident, including but not limited to organizational and safety culture causes.

(6) A written report shall be prepared at the conclusion of the investigation, which shall include, at a minimum:

(A) Date and time of the incident;

(B) Date and time the investigation began;

- (C) A detailed description of the incident;
  - (D) The factors that caused or contributed to the incident, including direct causes, indirect causes and root causes, determined through the root cause analysis.
  - (E) The results of a Hierarchy of Hazard Controls Analysis of any recommended actions, in accordance with subsection (l);
  - (F) The results of any prior DMR and any DMRs performed as part of the investigation of this incident, in accordance with subsection (k);
  - (G) Recommended corrective actions implemented by the employer to reduce the risk of a recurrence or similar incident to the greatest extent feasible;
  - (H) Recommended corrective actions scheduled for implementation; and,
  - (I) Recommended corrective actions not implemented or scheduled, with justification.
- (7) The report shall be provided to and reviewed with all operating, maintenance, and other personnel, including employees of contractors where applicable, whose work assignments are within the facility where the incident occurred and whose job tasks are relevant to the incident findings. The report shall also be provided to employee representatives.
- (8) The employer shall establish a system to promptly implement all recommended actions. Each recommended action not requiring a process shutdown shall be completed within two years after the completion of the incident investigation unless the employer can demonstrate it is not feasible to do so. Where a recommended action cannot be implemented within two years, the employer shall document the decision and rationale for the delay and implement the corrective action as soon as possible. Recommended actions addressing hazards that present the potential for death or serious physical harm shall be corrected immediately, either through permanent corrections or interim safeguards sufficient to ensure employee safety.
- (9) All recommended actions requiring a process shutdown shall be completed during the first regularly scheduled turnaround of the applicable process, subsequent to completion of the incident investigation, unless the employer can demonstrate in writing it is not feasible to do so.
- (10) Incident investigation reports shall be retained for the life of the process unit and shall be provided to the Division upon request.



**(p) Emergency Planning and Response.**

The employer shall develop, implement and maintain an Emergency Action Plan in accordance with the provisions of Section 3220.

**(q) Employee Participation.**

(1) The employer shall develop, implement and maintain a written plan to ensure employee participation in Process Safety Management, as required by this Section. The plan shall include provisions that provide for the following:

(A) Consultation by the employer with employees and their representatives on the development, implementation and maintenance of all elements of Process Safety Management required by this Section;

(B) Access by employees and their representatives to all information developed by the employer pursuant to this Section, including information that might be subject to protection as a trade secret.

(2) All employees who serve on any committee or in an advisory capacity pursuant to this Section shall be selected by employees or employee representatives.

(3) The employer shall develop, implement and maintain an effective Stop Work Authority and Hazard Reporting Program that ensures at a minimum:

(A) The right of all employees, including employees of contractors, to refuse work based on safety or health concerns and anonymously report hazards;

(B) The right of all employees, including employees of contractors, to recommend to the operator in charge of a unit that an operation or process be stopped or shut down based on safety or health concerns; and

(C) The authority of the operator in charge of a unit to stop or shut down an operation or process based on safety or health concerns.

NOTE: Nothing in this subsection shall preclude the employer from requiring an employee, contract employee or employee representative to whom information is made available under subsection (q)(1)(B) to enter into a confidentiality agreement prohibiting him or her from disclosing such information, as set forth in Section 5194.

**(r) Process Safety Culture Assessment.**

(1) The employer shall conduct an effective Process Safety Culture Assessment and produce a written report and action plan within twelve months following the effective date of this Section and once every three years thereafter. The purpose of the PSCA shall be to evaluate safety culture practices with regard to the following:

(A) Encouragement for reporting of safety concerns;

(B) Ensuring that reward or incentive programs do not deter reporting of safety concerns, near misses, injuries and incidents;

(C) Ensuring that safety is not comprised by production pressures;

(D) Promoting effective process safety leadership at all levels of the organization

(2) The written report and action plan shall include:

(A) The method(s) used to assess the process safety culture;

(B) The conclusions of the process safety culture assessment

(C) The rationale for the conclusions;

(D) The recommended actions to address the findings from the process safety culture assessment; and

(E) The action plan to address the recommended actions from the assessment, including a timeline when the recommended actions will be implemented.

(3) The facility manager shall serve as signatory to all process safety culture assessments, reports and action plans.

(4) Employees and/or their representatives shall effectively participate in the development of the Process Safety Culture Assessment, report and action plan.

(5) The Process Safety Culture Assessment report and action plan shall be communicated and made available to employees, their representatives and participating contractors within sixty days of the completion of the report.

(6) The Process Safety Culture Assessment report and action plan shall be made available to the Division upon request.

**(s) Human Factors.**

(1) The employer shall develop, implement and maintain an effective written Human Factors program.

(2) At a minimum, the Human Factors program shall take into account the complexity of tasks, the level of training and expertise of employees, the human-machine and human-system interface, the physical challenges of the work environment in which the task is performed, employee fatigue, and other effects of shiftwork and overtime.

(3) The employer shall include an assessment of human factors under all subsections of this Section. Where human factors are not relevant to an analysis, the employer shall so indicate in the analysis.

(4) Employees and their representatives shall participate in the development, implementation and maintenance of the written Human Factors program.

(5) The employer shall provide a copy of the written Human Factors program to employees and their representatives, to affected contractors and their employees, and to the Division on request.

**(t) Management of Organizational Change.**

(1) The employer shall develop, implement and maintain written procedures to manage organizational changes prior to reducing staffing levels or making other changes that could affect the occupational safety and health. The areas to which these procedures shall apply include, but are not be limited to, operations, engineering, maintenance, health and safety, and emergency response. This requirement shall also apply to employers using contractors in permanent positions.

(2) The procedures shall include a Management of Organizational Change assessment, which addresses the following:

(A) The experience levels of employees involved in the process before and after the proposed change, in order to ensure that the change will not compromise employee health and safety; the safety of operations and maintenance; and the effectiveness of emergency operations and response.

(B) A description of the change being proposed; the makeup of the team responsible for assessing the proposed change; the factors to be evaluated by the team; the rationale for the team's decision to implement or not implement the change; and the actions required to make the change.

(3) The facility manager shall certify that the assessment is accurate and that the proposed organizational change(s) will reduce the likelihood of a major incident to the greatest extent feasible.

(4) Prior to conducting the assessment, the employer shall ensure that the job function descriptions are current and accurate for all positions potentially affected by the change.

(5) Employees and their representatives shall meaningfully participate in the assessment.

(6) Prior to implementing a change, the employers shall inform all employees potentially affected by the change.

**(u) Safeguard Protection Analysis.**

(1) For each process, the employer shall conduct a Safeguard Protection Analysis (SPA) to assess:

(A) The combined effectiveness of existing inherent safety measures and passive, active and procedural safeguards;

(B) The combined effectiveness of measures and safeguards recommended in a Process Hazard Analysis (PHA) and Hierarchy of Hazard Controls Analysis (HCA); and

(C) Whether additional or alternative inherent safety measures or independent layers of protection may be needed to reduce to the greatest extent feasible the risk of a major incident.

(2) The SPA for each process shall be completed on the same schedule as the PHA for that process.

(3) The SPA shall be performed by a team with expertise in engineering and process operations, including at least one employee with expertise specific to the process, one employee with expertise in the safeguards under evaluation, and one employee with expertise in the specific semi-quantitative or quantitative SPA method used. Employee representatives shall be invited to participate in all SPAs.

(4) The employer shall generate a written SPA report for each process, using a semi-quantitative or quantitative method acceptable to the Division. The report shall document that the employer has applied best practices in assessing initiating causes, the propagation of initiating events, and their respective measures safeguards. The report may be a stand-alone document or may be incorporated into the PHA or HCA.

(5) The SPA report shall include a compilation of the nature and frequency of initiating causes, including external events, equipment failures, process deviations and human errors that have the potential to lead to hazardous conditions.

(6) For each device, system or human factor, the employer shall document in the report that best practice failure rate data have been used to determine the initiating cause frequency rate.

(7) The SPA report shall include a compilation of inherent safety measures and independent layers of protection which in combination will prevent events from initiating and propagating. All layers of protection shall be independent of each other and of initiating causes. The risk reduction obtainable by inherent safety measures and each layer of protection shall be quantified and documented.

(8) The SPA report shall include an evaluation of safeguards identified in the PHA to determine the effectiveness of each safeguard and identify additional or alternative independent safeguards that may be needed to reduce the likelihood of a major incident. The employer shall implement each safeguard that may reduce the risk of a major incident unless the employer can demonstrate in writing it is not feasible to do so.

(9) The SPA report shall include a compilation of all additional or alternative inherent safety solutions or independent layers of protection that may be needed to reduce the risk of a major incident to the greatest extent feasible. The report shall include actions to be taken to implement the SPA recommendations; a schedule of when these actions are to be completed; and the means that will be used to communicate the actions to operating, maintenance and other employees who may be affected by the recommended actions.

(10) The employer shall establish a system to promptly implement all recommended actions. All recommended actions that do not require a process shutdown shall be completed within two years after the completion of the SPA, except that recommended actions addressing hazards that present the potential for death or serious physical harm shall be immediately corrected either through permanent corrections or interim safeguards sufficient to ensure employee safety while permanent corrections are completed.

(11) All recommended actions that require a process shutdown shall be completed during the first regularly scheduled turnaround of the applicable process after completion of SPA, unless the employer can demonstrate in writing it is not feasible to do so.

(12) The employer shall complete the SPA report within sixty days after the completion of the SPA. The SPA report for each process shall be available to employees and employee representatives, and to the Division upon request.

**(v) PSM Management System.**

(1) The employer shall develop and implement a written Process Safety Management (PSM) Management System, administered by a PSM Management Coordinator working with a PSM Management Team. The PSM Management Coordinator shall be responsible for compliance

with all portions of this Section, including the development of annual goals to achieve continuous improvement in all subsections.

(2) The PSM Management Team shall develop and maintain:

(A) Written policies and procedures;

(B) Job descriptions of employer and employee roles and responsibilities under each subsection of this Section;

(C) An organizational chart of employer and employee representatives with responsibilities for each subsection;

(D) Written procedures for ensuring the effective exchange and tracking of safety, operations, and maintenance information among and across process and maintenance personnel, contractors, support personnel, supervisors and senior management;

(E) Policies and procedures to ensure that employees are able to effectively and anonymously communicate hazards related to any subsection in this Section or with any process, organizational structure, equipment or other aspect of the facility;

(F) Policies and procedures to ensure that the findings, recommendations and action items of all subsections in this Section and the PSM Management System are communicated effectively to employees and employee representatives;

(G) Policies and procedures to ensure effective employee participation in all applicable subsections in this Section.

(3) Compliance Audits

(A) Every three years, the PSM Management Team shall conduct a compliance audit and certify that the facility is in compliance with all provisions of this Section.

(B) The PSM Management Coordinator shall prepare a written audit report of the findings of the compliance audit, including documentation of all deficiencies, recommendations and actions taken to correct deficiencies. The PSM Management Coordinator shall make the report available to employees and employee representatives.

(C) The employer shall promptly implement corrective actions to all deficiencies identified in the compliance audit.

(D) The employer shall retain compliance audit reports for the life of the facility and shall make the reports available to the Division on request.

(E) The compliance audit report shall serve to meet the inspection requirements of the Injury and Illness Prevention Program as required by Section 3203.

(4) An employee and/or employee representative shall serve on the PSM Management Team. The PSM Management Team shall consult with operators with expertise in each process reviewed.

(5) As part of the compliance audit, the PSM Management Coordinator shall at a minimum document the following process safety performance indicators:

(A) Past due inspections for process piping and components;

(B) Past due inspections for pressure vessels;

(C) Past due recommendations resulting from any action required by this Section; and,

(D) The number of major incidents that have occurred each calendar year.

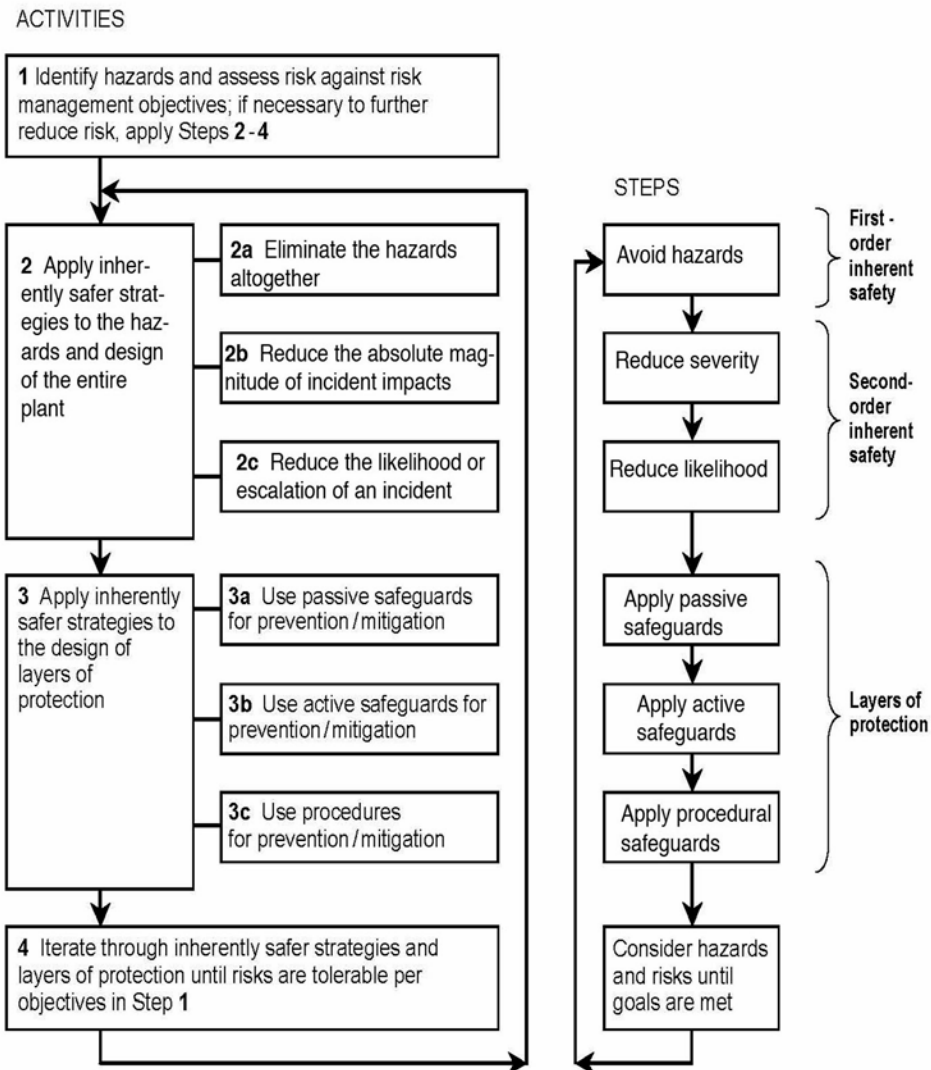
(6) A process safety performance indicator shall be reported as past due if it is not completed by the end of the month when it is scheduled to be completed.

(7) The documentation of any process safety performance indicator shall be provided to the Division upon request.

Note: Authority cited: Section 142.3 and 7856, Labor Code. Reference: Sections 142.3 and 7855-7868, Labor Code.

## Appendix A

### Hierarchy of Hazard Control Analysis



Source: Inherently Safer Chemical Processes: A Life Cycle Approach (2009). American Institute of Chemical Engineers, Center for Chemical Process Safety.