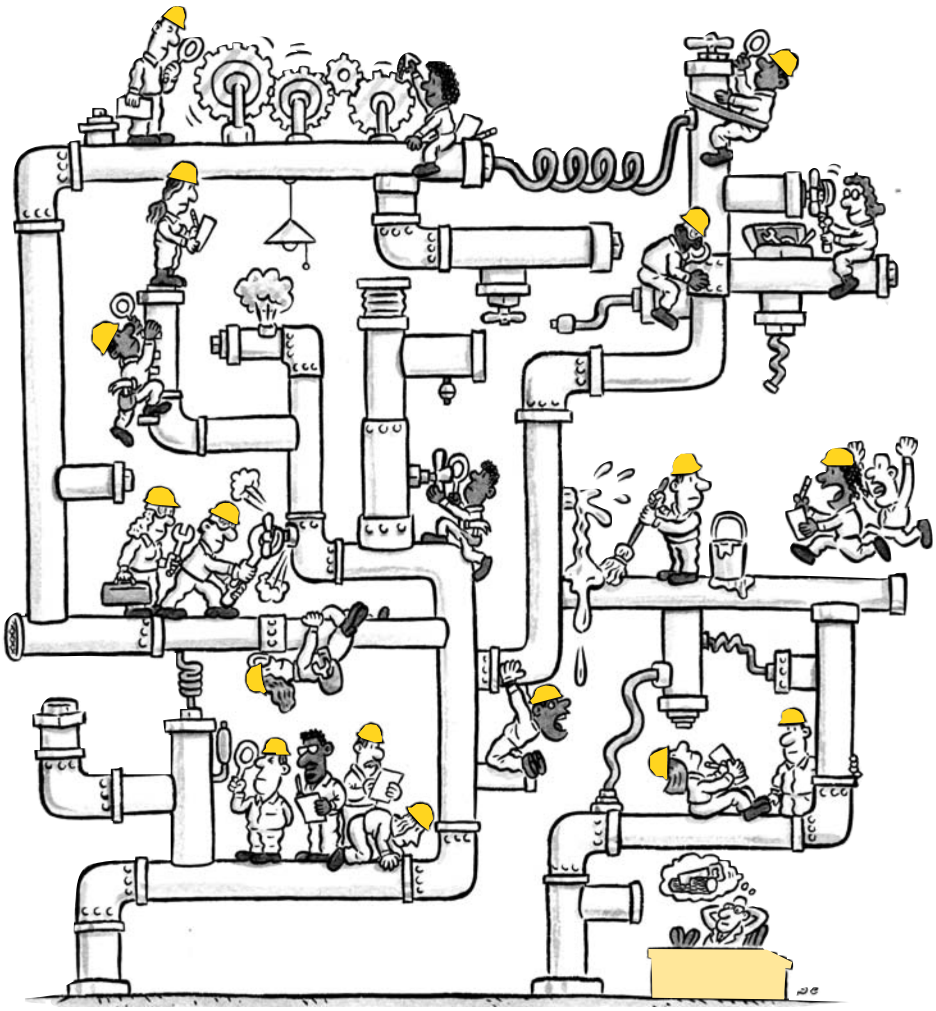
Process Safety Management Training



Edition 2
March 2009

TONY MAZZOCCHI CENTER
FOR HEALTH, SAFETY AND ENVIRONMENTAL EDUCATION
A PROJECT OF THE UNITED STEELWORKERS AND THE LABOR INSTITUTE

Process Safety Management Training

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This material was developed by the United Steelworkers Tony Mazzocchi Center for Safety, Health and Environmental Education and produced by the Steelworkers Charitable and Educational Organization, funded in whole or in part with federal funds from the Occupational Safety and Health Administration, U.S. Department of Labor, under grant number SH-16632-07-60-F-42. These materials do not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

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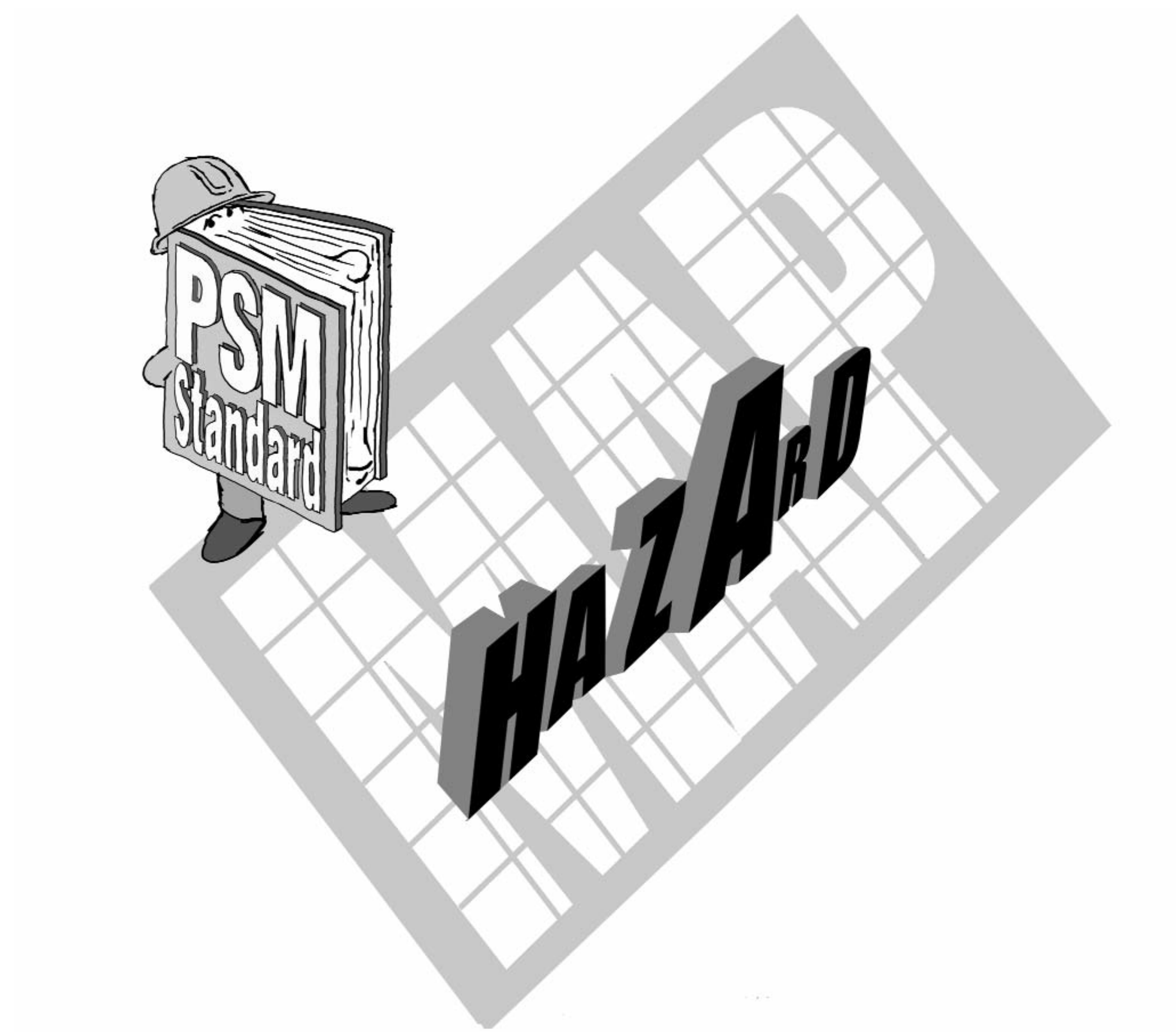
Activity 1: An Introduction to the Process Safety Management Standard (PSM)

Purpose

To begin to apply the lessons of Texas City to our own facilities.

To become acquainted with the basic elements and the reason for the development of the Process Safety Management (PSM) Standard.

This Activity has four tasks.



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Task 1

Purpose Restated: To begin to apply the lessons of Texas City to our own facilities.

Scenario: A Deadly Explosion

On March 23, 2005, an explosion at the BP refinery in Texas City, Texas, killed 15 workers and injured 180. It was the worst industrial disaster in the U. S. outside of mining in a quarter century. Financial losses exceeded $1.5 billion. OSHA issued the largest citation and penalty in its history. Lawsuits and criminal charges are still pending more than three years later.

A two year investigation by the U.S. Chemical Safety and Hazard Investigation Board, a federal agency, found that the accident resulted from "organizational and safety deficiencies at all levels of the BP Corporation." The specific technical causes included poorly designed and maintained alarms and instrumentation, the use of outmoded blowdown drums and atmospheric stacks to vent flammable liquids and vapors, the unsafe siting of temporary trailers leading to the presence of nonessential personnel in dangerous areas during critical operations, poor internal communications, inadequate training, fatigue from excess overtime and outdated and ineffective procedures for critical operations like unit startups.

A recent study by the USW found that similar conditions exist in a majority of U.S. refineries. There is no reason to believe that they don't exist in petrochemical plants as well.

Source: U.S. Chemical Safety and Hazard Investigation Board (CSB), *Investigation Report: Refinery Explosion and Fire (15 Killed, 180 Injured), BP, Texas City, Texas, March 23, 2005,* Washington, DC, 2007.

Task:

Appoint one person as a spokesperson for the group who can report back your response, along with an explanation.

Please put a check mark next to the conditions that exist at your facility.

- ☐ Poorly designed and maintained instrumentation and alarms;
- ☐ Atmospheric venting of flammable liquids and vapors, without flaring;
- ☐ Trailers and other temporary structures sited too close to process units;
- ☐ Nonessential personnel in potentially dangerous areas during critical operations like startups;
- ☐ Poor internal communications;
- ☐ Inadequate training;
- ☐ Fatigue from excess overtime;
- ☐ Outmoded and ineffective procedures for critical operations;
- ☐ The failure to properly analyze and respond to the potential for an accident in every aspect of the process.

Give any examples of those things you checked on the lines below:

____

____

____

____

After looking at these conditions, is it possible an accident like the one at BP in Texas City could ever happen in your facility?

Task 2

Factsheet Reading Method for Task 2.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a new scribe for this Task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

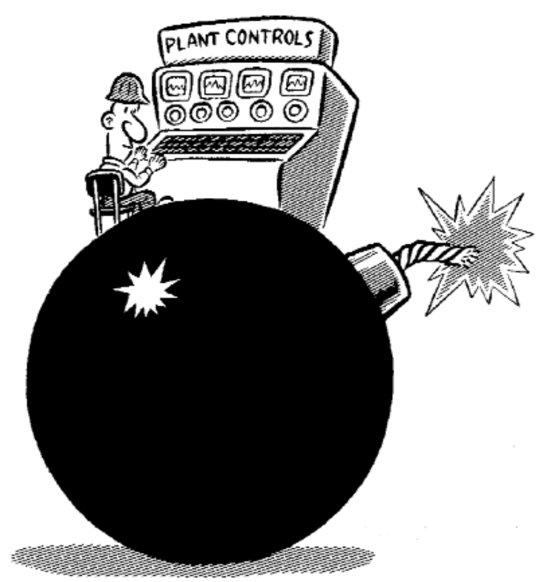
Starting with the scribe and moving to the left, count out loud from 1 to 8. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5; the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 8 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (1 through 8), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet #1
New Technology Can Give Rise to New Hazards

Some experts believe that petrochemical plants are increasingly likely to have catastrophic accidents because:

- Petrochemical plants are tied together and have many complex interactive components.
- The plants are getting bigger, more complex and closer to communities.
- New chemicals are being created and used as throughput.
- The computerization of processes has resulted in many point-of-production problems being controlled by microprocessors in the field, with only high-level functions being fed back to the central control room. This centralization of control room functions makes it more difficult for operators to understand the process as a whole system and may make it harder to intervene when unexpected things happen.



Source: Perrow, *Normal Accidents: Living with High Risk Technologies*, New York: Basic Books, 1984, pp. 101-102 and 121-122.

Factsheet #2
Explosions and Fires in Oil Refineries and Petrochemical Plants Impacting USW Members

Explosions and Fires Impacting USW* Members, 1984-1991		
July 23, 1984 17 Dead 30 Injured	**Union Oil Co.**	**Oil refinery. Propane escaped from a crack in an amine absorber and formed a gas cloud which ignited. This led to an explosion and fire in the alkylation unit and a fire in the Unifiring area. Damaged 59 homes. OSHA cited and fined Union Oil $21,000 for willful and serious violations including inadequate preventive maintenance and lack of personal protective equipment. It was later determined that the crack in the process tower was due to improper contractor welding procedures.**
August 21, 1984 3 Dead	Ashland Oil, Inc. Freedom, Pa. PACE Local 8-621	Oil refinery. Explosion and fire in tank farm.
Sept. 14, 1985 1 Dead	Koch Refining Co. Pine Bend, MN PACE Local 6-662	Oil refinery. Furnace explosion and fire.
Dec. 5, 1986 5 Dead 44 Injured	Arco Petroleum Co. Carson, CA PACE Local 1-128	Oil refinery. Failure of eight-inch line spewing hydrogen naphtha mix caused vapor cloud which ignited and exploded. OSHA cited Arco for inadequate preventive maintenance on the pipe.
Dec. 15, 1986 1 Dead	Sohio Oil Co. Lima, OH PACE Local 7-624	Oil refinery. Fire caused by ruptured natural gas line.
Dec. 15, 1987 1 Dead	Koch Refining Co.	Oil refinery. Truck exploded due to fire during the transfer of light hydrocarbons from the truck to underground storage.
April 21, 1988 2 Dead	Derby Refining Co. Wichita, KS PACE Local 5-446 Oil refinery.	Truck exploded due to fire during the transfer of light hydrocarbons from the truck to underground storage.

Explosions and Fires Impacting USW* Members, 1984-1991		
May 4, 1988 2 Dead 350 workers and residents injured; 17,000 evacuated.	Henderson, NV USWA Local 4856	Rocket oxidizer plant. Runaway fire reached a large open area where drums of oxidizer were stored causing a massive explosion.
May 5, 1988 7 Dead 42 Injured, including 23 in community	Norco LA PACE Local 4-750	Oil refinery. Explosion and fire in catalytic cracking unit causing structural damage to homes up to a mile away, caused by a failed eight-inch elbow in pipe. Shell was sited by OSHA for inadequate preventive maintenance.
May 24, 1988 1 Dead 1 Injured	Amoco Oil Co. Yorktown, VA PACE Local 3-1	Oil refinery. Fire resulted when product overflowed and was sparked by compressor. Three months prior, the victim had authorized memo to company with details on necessary redesign of process that later killed him.
Oct. 30, 1988 3 Dead 1 Injured	**Amoco Oil Co. Whiting, IN PACE Local 7-1**	**Oil refinery. Explosion and fire in oxidizer unit coated workers with 500-degree asphalt. The oxidizer, a 70-foot-high, 32-foot diameter vessel went up like a rocket 40 to 50 feet when it blew. OSHA cited and fined Amoco more than $300,000 for a wide variety of violations. Unit began to malfunction several days earlier but company kept it running in order to maintain production. (This explosion followed two others earlier in 1988 that injured 18.)**
Dec 14, 1988 1 Dead	Cenex, Inc. Laurel, MT PACE Local 2-443	Oil refinery. Explosion and flash fire in a compressor.
March 25, 1989 1 Dead 1 Injured	Tosco Oil Corp. Avon, CA PACE Local 1-5	Oil refinery. Explosion and flash fire in a compressor.
Aug 24, 1989 2 Dead 3 Injured	Phillips Chemical Co. Pasadena, TX PACE Local 4-227	Petrochemical Plant. Flash fire resulted when contract workers mistakenly opened a live line. The gas traveled into an adjoining area, igniting and burning a PACE member to death. OSHA fined Phillips $750; Phillips contested.

continued

Factsheet #2
Explosions and Fires in Oil Refineries and Petrochemical Plants Impacting USW Members
(continued)

Explosions and Fires Impacting USW* Members, 1984-1991

Oct. 23, 1989 23 Dead 232 Injured	Phillips Chemical Co. Pasadena, TX. PACE Local 4-227	Petrochemical Plant. Explosion and fire in polyethylene reactor threw debris six miles into community. Subsequent explosions resulted; fires burned for several days. Some loss estimates exceed $1 billion. Evidence suggests contractor crew removed blocking device from valve and actuated valve by hooking up actuating hoses in reverse order. 220,000 pounds of hydrocarbons were released.
Dec. 23, 1989 1 Dead 1 Injured	Amoco Oil Co. Casper, WY.	Oil refinery. Explosion and fire after butane gas escaped past an improperly maintained block valve.
June 18, 1990 1 Dead	Petrolite Corp. Barnsdall, OK. PACE Local 5-391	Lubricants refinery. Loose particulate rust matter caused ignition of flammable at high velocity in reactor vent line, flashback to reactor, blown gaskets, directional release and secondary flash fire and explosion. Inadequate preventive maintenance cited.
Jan. 19, 1991 1 Dead 6 Injured	**BP Corp. Ferndale, WA PACE Local 1-590**	**Oil refinery. Difficulty getting crude unit up after turnaround and seals were leaking. Unit was brought part-way down and quickly fired in order to get put back up as soon as possible. Blinded line near heater not purged. Flashback killed one contractor, injured three others and injured three BP employees. Inadequate maintenance practices were blamed.**

*On January 4, 1999, the Oil, Chemical and Atomic Workers International Union (OCAW) merged with the United Paperworkers International Union (UPIU) to become the Paper, Allied-Industrial, Chemical and Energy Workers International Union (PACE). In April of 2005, PACE formally merged with the United Steelworkers of America (USWA) to form the USW-United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union.

Source: Robert E. Wages, Testimony on OSHA's Proposed Safety Standard for Highly Hazardous Chemicals, Houston, Texas, 1991, *New Solutions*, Fall 1991, pp. 98-100; and "Chemical Safety Board to Issue Report, Hold Public Hearing on Reactive Chemical Incidents, "*The PACEsetter*, March/April 2002.

Factsheet #3
Disasters on the Rise

A report published in 2003 by an industry consulting firm gives us an idea of the magnitude of the largest petroleum industry accidents and their causes. The 100 largest on-shore losses, in terms of damage to property, over the period 1972–2001, total $10.8 billion. The first table below gives a five-year snapshot (1987-1991) of the number of accidents which resulted in losses over $10 million. The second chart shows the total dollar amount of damages, adjusted for inflation, for accidents over $10 million for the period 1987 through 1991.

Large Property Losses in the Petroleum Industry 1987–1992	
Refinery	
U.S.	98
Non-U.S.	141
Petrochemical Plants	
U.S.	58
Non-U.S.	140
Terminals/Distribution	
U.S.	83
Non-U.S.	182

continued

Factsheet #3
Disasters on the Rise
(continued)

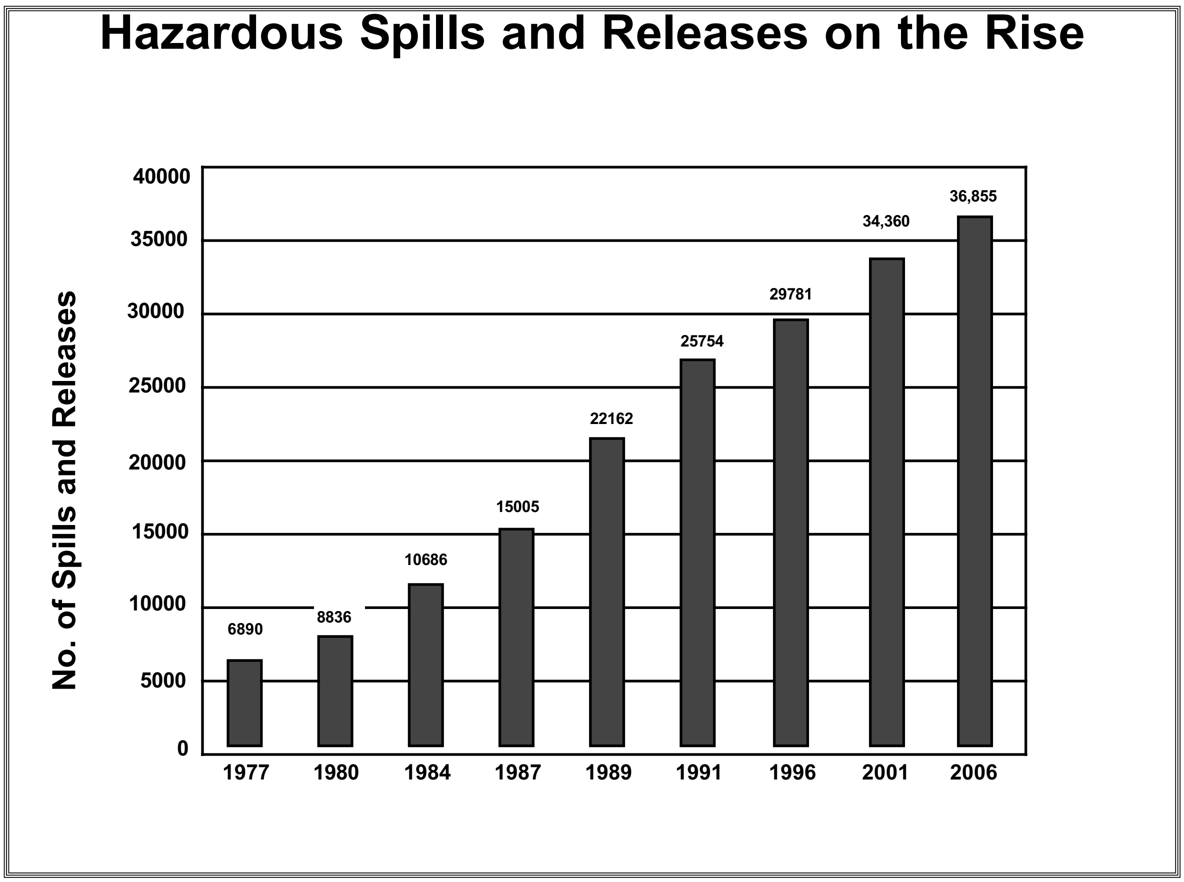
Property Value Losses from 1987–1991 (Adjusted for Inflation January 2002 $)	
Refineries	$775,000,000
Petrochemical Plants	$1,417,000,000
Terminals/Distributions	$40,000,000
Off-shore Incidents	$512,000,000

Sources: U.S. PIRG, "Irresponsible Care: The Failure of the Chemical Industry to Protect the Public from Chemical Accidents," Washington, D .C.: U.S. PIRG, April 2004, available at http://uspirg.org/usprig.asp?id2=12860&id3=USPIRG; and James C. Coco, Editor, *The 100 Largest Losses 1972-2001: Large property damage losses in the hydrocarbon-chemical industries*, Twentieth Edition, Marsh's Risk Consulting Practice, February 2003.

Factsheet #4
Toxic Chemical Incidents Were on the Rise

Both workers and community residents do have reason to worry about accidents at USW-represented facilities, including oil refineries.

The following chart shows the number of accidents that were reported to the National Response Center. The actual number of incidents is estimated to be two-and-a-half to three times higher.



In 2002, the number of reported spills was 32,185. Since then, there has been an increase in each year. By 2006, 36,855 incidents had been reported.

Source: Data derived from the Emergency Response Notification System (ERNS), a national computer database, from reports filed with the National Response Center, a federal authority, http://www.nrc.uscg.mil/.

Factsheet #5
The Body Count Was on the Rise

In the past, some industry experts have downplayed the seriousness of catastrophic accidents in oil refineries and petrochemical facilities. But the tragic October 1989 fire and explosion at Phillips Chemical, followed as it was by a string of similar catastrophes at Amoco (Wyoming), Amoco (Indiana), Exxon, ARCO, BASF, BP and elsewhere, proves that such calamities are not isolated events or simple coincidences.

USW (formerly OCAW and PACE) has been outspoken on this problem since 1984 when an explosion and fire at Union Oil in Illinois killed 17. That accident, as well as 16 subsequent fatal explosions and fires at USW-represented petroleum industry facilities, are listed on pages 6 through 8.

These accidents are linked as much by cause as they are by effect.

Factsheet #6
A History of the OSHA Process Safety Standard

Despite a growing number of major accidents, OSHA delayed work on a process safety standard. Unions and environmental organizations successfully lobbied Congress to require action by both OSHA and EPA, as part of the 1990 Clean Air Act Amendments. The legislation also established the U.S. Chemical Safety and Hazard Identification Board.

1984	Toxic chemical release in Bhopal, India, kills over 4,000 people. • The AFL-CIO and USWA joined in an international team of experts investigating this accident. They note that, had the release occurred in the U.S., none of the root causes would have violated any OSHA or EPA regulation. • U.S. unions begin to lobby for a Process Safety Standard.
1985	Release from a chemical plant in Institute, West Virginia, injures 135. American Institute of Chemical Engineers forms the Center for Chemical Process Safety and publishes Guidelines for Hazard Evaluation Procedures.
1989	Phillips Chemical Plant explosion kills 23, injures 232.
1990	American Petroleum Institute (API) publishes Management of Process Hazards voluntary guidelines. Arco Chemical plant disaster kills 17 workers. OSHA releases a Proposed Safety Standard based on the API Guidelines and Recommendations. Congress passes the Clean Air Act Amendments, which mandate that OSHA enact process safety rules covering 14 specific areas.
1991	OSHA releases study of the effects of using contract workers in the U.S. petrochemical industry.
1992	The final OSHA PSM Standard is issued. One year later, EPA released its Risk Management Program Regulation.
1997	May 26, 1997, was the deadline for 100 percent completion of all Process Hazard Analysis.

Source: "Learning from Hamlet: The Case for a National Safety and Health Board," *New Solutions*, Vol. 3, No. 2, Winter 1993.

Factsheet #7
The Expected Results of the PSM Standard

After extensive hearings and much resistance from some companies, the PSM Standard became effective in 1992, with OSHA making these remarks:

> OSHA anticipates that full compliance with the PSM Standard will lead to fewer catastrophic fires, explosions, releases of hazardous substances and other types of serious accidents. It is expected that many minor incidents will be prevented as well.
>
> In addition to the health and safety benefits from preventing catastrophic incidents, reductions in injuries and illnesses related to minor process disruptions are anticipated, as well as reductions in the long-run risks posed by occasional releases of toxic vapors and gases and by the physical hazards of poor process design.

Source: *OSHA Process Safety Management Standard*, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #8
The PSM Standard Is a Performance-based Standard

Performance-based Standards

The PSM Standard is a performance-based standard. That means it is goal-oriented and what you should judge is a program's effectiveness. The specifications are not spelled out, just the desired results.

The PSM Standard gives each facility flexibility to design its own program to match its needs, as long as the outcome prevents or minimizes spills, fires and explosions.

Specification-based Standards

Some OSHA standards are specification-based standards. That means they give exact rules for compliance such as height of a guard rail, lengths of pipe, exact limits of exposure, etc.

Your work experience is your guide

Another way to understand the accident prevention requirement of a performance standard is to think in terms of our five senses. We can look and listen for hazards; we can feel for vibrations and smell for leaks; and, at times, we may even be alerted by our sense of taste. But the most important sense we bring to the job is our work experience — in other words, our horse sense.

You should ask yourself the following question when reviewing your company's PSM program:

> Will this program, as it is written and applied, help to prevent accidents? If the answer is "no," then the company is not complying with the spirit and intent of the law.
>
> For example, if management develops a preventive maintenance program (PM) but assigns the PM work orders the lowest priority, your work experience tells you that there really is no PM program at all.

Task 2 *(continued)*

Purpose Restated: To become acquainted with the basic elements of the Process Safety Management (PSM) Standard.

Please read the following scenario. Then, within your group, develop a response to the question this worker is asking. Your scribe should keep a master list of the discussion and be prepared to report back to the workshop as a whole.

Statement/Scenario:

I came to work here immediately after being released from the service almost 30 years ago. This was a good job with good pay and benefits. I've seen a lot of change; some for the better, some worse. I just heard a supervisor talking about problems for our industry now from increased OSHA enforcement of the Process Safety Management Standard.

He said there's really no need for more government regulation or enforcement; that this will just hurt our industry. In particular, he was questioning the PSM Standard; asking why it was so important in the first place, and why, years after it was put in place, is OSHA increasing its attention to Process Safety Management in our industry in particular.

I think the PSM Standard was one of the good changes in our industry, but I'd like some facts to back that up.

Task:

1. List reasons for a Process Safety Management Standard.

Task 3

Factsheet Reading Method for Task 3.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a new scribe for this Task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 9 to 18. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 9, 13 and 17; the person to their left will be responsible for Factsheets 10, 14 and 18, etc. The numbers that you have assigned yourself correspond to Factsheets 9 through 18 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (9 through 18), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Note: In addition to the factsheet information, the actual text of the Standard is listed at the end of this Activity.

Factsheet #9
OSHA's PSM Standard — The 14 Required Elements

The OSHA Process Safety Management Standard, 29 CFR 1910.119, enacted in 1992, is composed of 16 sections: Applications, Definitions and the 14 elements (c through p). These elements are listed below and are described in detail on Factsheets 10 through 24.

Section		Factsheet
(a)	Application	10
(b)	Definitions	11
14 Required Elements		
(c)	Employee Participation	12
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(l)	Management of Change	21
(m)	Incident Investigation	22
(n)	Emergency Planning and Response	23
(o)	Compliance Audits	24
(p)	Trade Secrets	24

Factsheet #10
Application — Paragraph (a) of OSHA's PSM Standard

(a) Application

What is covered:

- A process that involves a chemical which is present at or above certain levels (see Appendix A of the Standard); and
- A process that involves flammable liquid or gas in excess of 10,000 pounds.

Except:

1. Hydrocarbons used for comfort heating, if not used elsewhere as part of a process;
2. Flammable liquids stored in atmospheric tanks below their boiling point, which don't need cooling (unless interconnected or involved in a process); and
3. Any flammable liquid or gas, provided it is consumed as a fuel and is not part of a process containing another highly hazardous chemical.

Factsheet #11 Definitions — Paragraph (b) of OSHA's PSM Standard

(b) Definitions:

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

2 **Boiling Point.** The boiling point of a liquid at a pressure of 14.7 pounds per square inch absolute (p.s.i.a.) (7650 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 Sec. 1910.6, may be used as the boiling point of the liquid.

3. **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.

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

5. **Highly Hazardous Chemical** means a substance possessing toxic, reactive, flammable or explosive properties and specified by paragraph (a)(1) of this section.

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

7. **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.

8. **Process** means any activity involving a highly hazardous chemical including any use, storage, manufacturing, handling or the onsite movement of such chemicals or combination of these activities. For purposes of this definition, any group of vessels which are inter-connected 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.

9. **Replacement in Kind** means a replacement which satisfies the design specification.

10. **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.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #12
Employee Participation
Paragraph (c) of OSHA's PSM Standard

(c) Employee Participation

Requirements:

- Develop a **written plan** explaining how employers shall consult with employees and union representatives on the Standard.
- Consult with employees and union representatives on all of the elements of the Standard.
- **Give workers and Union representatives** access to all information required to be developed in this Standard.

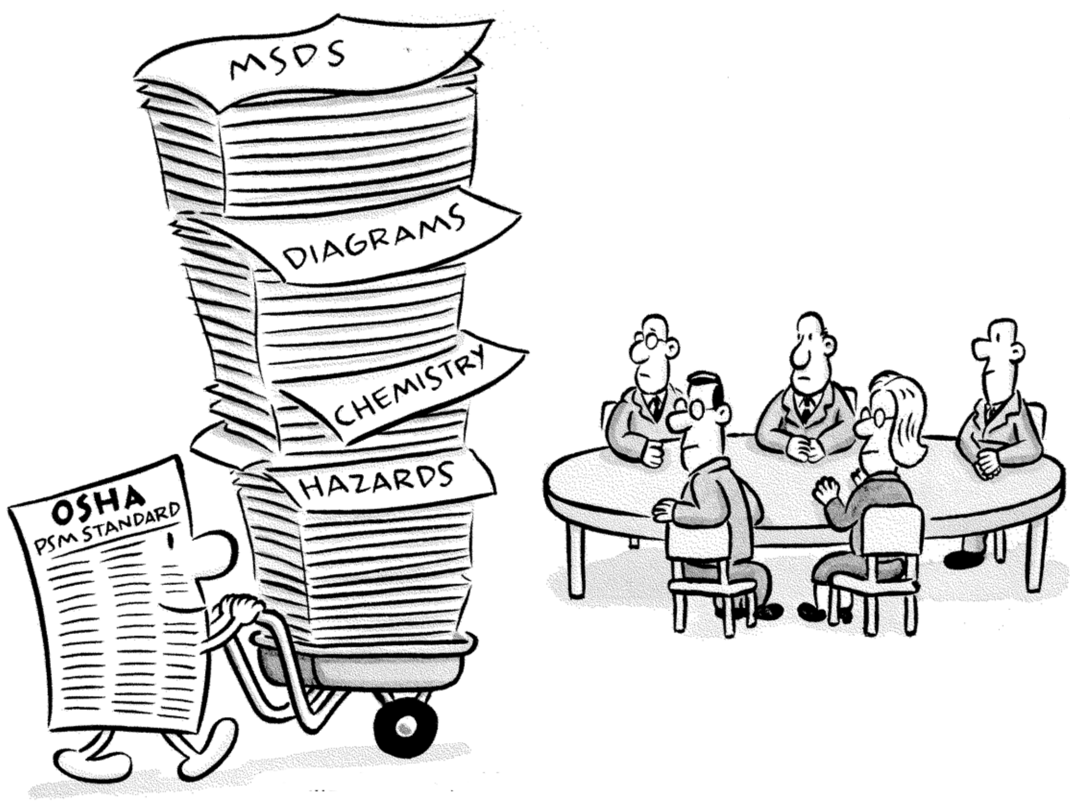
Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #13
Process Safety Information
Paragraph (d) of OSHA's PSM Standard

(d) Process Safety Information

Requirements:

- Compile specific information before starting a process hazard analysis that covers:
    1. The hazards of highly hazardous chemicals in the process (MSDSs are okay if they contain all required information.);
    2. The technology of the process (block flow diagrams, chemistry of process); and
    3. Information pertaining to the equipment in the process.



Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #14
Process Hazard Analysis (PHA)
Paragraph (e) of OSHA's PSM Standard

(e) Process Hazard Analysis (PHA)

Process Hazard Analyses (PHAs), also called process hazard evaluations, use various methods to identify, evaluate and control the hazards involved in a process.

Requirements:

- Develop a priority order for conducting PHAs and do the most important ones first.
- Set a timetable for requirements.
- Use one of the six listed methods or equivalent methodology:
    1. What-if;
    2. Checklist;
    3. What-if/Checklist;
    4. Hazard and Operability Study (HAZOP);
    5. Failure Mode and Effects Analysis (FMEA); or
    6. Fault Tree Analysis.
- Outline what must be covered in a PHA.
- Establish a team to do the PHA.
- Set up a tracking system to assure that the team's findings and recommendations are addressed and resolved in a timely manner.
- Update the PHAs every five years and keep the records throughout the life of the process.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #15
Safe Operating Procedures
Paragraph (f) of OSHA's PSM Standard

(f) Safe Operating Procedures

Requirements:

Develop and implement written procedures covering:

1. Each operating phase:
   - Startup;
   - Normal operations; and
   - Emergency shutdown.

2. Conditions which require emergency shutdown;
3. Operating limits;
4. Safety and health considerations; and
5. Safety systems.

Keep these procedures current, updated once a year.

Develop safe work practices for employees and contractors covering:

1. Lockout/tagout;
2. Confined space entry; and
3. Opening of process equipment or piping.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #16
Training — Paragraph (g) of OSHA's PSM Standard

(g) Training

The Process Safety Standard has different training requirements for operators, maintenance workers and contractors. This element addresses operators.

Requirements:

- Initial training:
    1. Process overview;
    2. Safe operating procedures;
    3. Specific process health and safety hazards;
    4. Emergency shutdown operations; and
    5. Safe work practices.

- Refresher training to operating personnel at least every three years; and
- Provide written documentation that employees have been trained and understand the training. (Testing is not required.)

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #17
Contractors — Paragraph (h) of OSHA's PSM Standard

(h) Contractors

Plant Employer Requirements:

- When selecting a contractor, the employer must evaluate its safety performance and programs.
- **Maintain a log** on contractor injuries and illnesses.
- Inform the contract employers of potential fire, explosion or toxic release hazards related to the contractor's work.
- **Develop and implement safe** work practices to control the entrance, presence and exit of contract employees.
- Periodically evaluate the onsite performance of the contractor to ensure compliance with the PSM Standard; and
- Explain the company's emergency action plan to the contractor.

Contract Employer Requirements:

- Train its employees to perform work safely.
- Inform all of its employees of potential fire, explosion or toxic release hazards and what to do if they occur.
- Document that workers have been trained and understand the training.
- Assure that employees follow plant safety rules.
- Inform plant employer of any hazards introduced by contractor's work or of any hazards discovered by the contractor.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #18
Pre-startup Safety Review — Paragraph (i) of OSHA's PSM Standard

(i) Pre-startup Safety Review

A pre-startup safety review applies to all new facilities and to existing facilities when modification is significant enough to require change in the process equipment.

Requirements:

Before a highly hazardous chemical is introduced into a process it will be confirmed that:

- Construction and equipment meets specifications;
- All procedures are in place, such as:
  1. Safety;
  2. Operating;
  3. Maintenance; and
  4. Emergency.
- In new facilities: process hazard analyses have been performed and recommendations have been resolved or implemented;
- In modified facilities: comply with management of change requirements (see paragraph (l) of the Standard (Factsheet 21); and
- Operating employees have been trained.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Task 3 *(continued)*

Purpose Restated: To become acquainted with the basic elements of the Process Safety Management (PSM) Standard.

Now that you have reviewed seven of the elements of the Process Safety Management Standard, review again the accidents listed below. These accidents occurred before the PSM standard was implemented.

Under each accident description is listed the seven PSM elements you just reviewed. Place an "x" by each element which might have prevented the accident and list your reasons on the lines provided.

1. **July 23, 1984 - Union Oil Co**.
   Oil refinery. Propane escaped from a crack in an amine absorber and formed a gas cloud which ignited. This led to an explosion and fire in the alkylation unit and a fire in the Unifiring area. Damaged 59 homes. OSHA cited and fined Union Oil $21,000 for willful and serious violations including inadequate preventive maintenance and lack of personal protective equipment. It was later determined that the crack in the process tower was due to improper contractor welding procedures.

   ___ (c) Employee Participation

   ___ (d) Process Safety Information

   ___ (e) Process Hazard Analysis (PHA)

   ___ (f) Safe Operating Procedures

   ___ (g) Training

   ___ (h) Contractors

   ___ (i) Pre-startup Safety Review

___

___

___

continued

Task 3 *(continued)*

2. **October 30, 1988 - Amoco Oil Co.**
   Oil refinery. Explosion and fire in oxidizer unit coated workers with 500-degree asphalt. The oxidizer, a 70-foot-high, 32-foot diameter vessel went up like a rocket 40 to 50 feet when it blew. OSHA cited and fined Amoco more than $300,000 for a wide variety of violations. Unit began to malfunction several days earlier but company kept it running in order to maintain production. (This explosion followed two others earlier in 1988 that injured 18.)

   ___ (c) Employee Participation

   ___ (d) Process Safety Information

   ___ (e) Process Hazard Analysis (PHA)

   ___ (f) Safe Operating Procedures

   ___ (g) Training

   ___ (h) Contractors

   ___ (i) Pre-startup Safety Review

3. **January 19, 1991 - British Petroleum (BP) Corp.**
Oil refinery. Difficulty getting crude unit up after turnaround and seals were leaking. Unit was brought part-way down and quickly fired in order to get put back up as soon as possible. Blinded line near heater not purged. Flashback killed one contractor, injured three others and injured three BP employees. Inadequate maintenance practices were blamed.

___ (c) Employee Participation

___ (d) Process Safety Information

___ (e) Process Hazard Analysis (PHA)

___ (f) Safe Operating Procedures

___ (g) Training

___ (h) Contractors

___ (i) Pre-startup Safety Review

Task 4

Factsheet Reading Method for Task 4.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a new scribe for this Task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 19 to 24. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 19 and 23; the person to their left will be responsible for Factsheets 20 and 24, etc. The numbers that you have assigned yourself correspond to Factsheets 19 through 24 on the following pages.

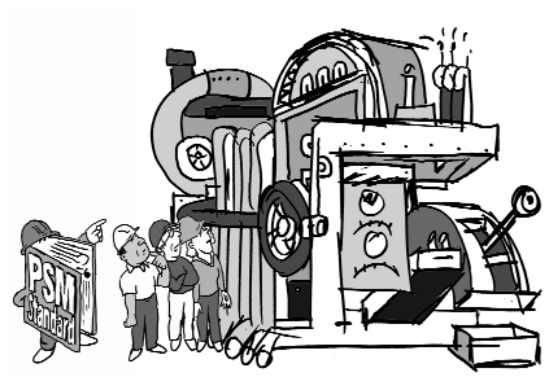
Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (19 through 24), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Note: In addition to the factsheet information, the actual text of the Standard is listed at the end of this Activity.

Factsheet #19
Mechanical Integrity — Paragraph (j) of OSHA's PSM Standard

(j) Mechanical Integrity

These requirements only apply to six types of process equipment where failure is likely to be catastrophic. The process equipment covered includes:



1. Pressure vessels and storage tanks;
2. Piping systems (including valves, other components);
3. Relief and vent systems and devices;
4. Emergency shutdown systems;
5. Controls (monitoring devices and sensors, alarms and interlocks); and
6. Pumps.

Requirements:

- Provide written procedures to maintain integrity of equipment.
- Train employees involved in maintaining integrity of equipment.
- Perform periodic inspection, testing and maintain records.
- Correct deficiencies in equipment.
- Assure that equipment is suitable and properly installed.
- Assure that maintenance materials, spare parts and equipment are suitable and correct for use in the process.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #20
Hot Work Permit — Paragraph (k) of OSHA's PSM Standard

(k) Hot Work Permit

Requirements:

- Hot work permits are required on or near process systems.
- Minimum permit requirements:
  1. Comply with 29 CFR 1910.252(a), OSHA's hot work permit standard;
  2. Date; and
  3. Name of equipment.
- Retain the permit until completion.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #21
Management of Change — Paragraph (l) of OSHA's PSM Standard

(l) Management of Change

Requirements:

- Establish written procedures to manage changes to:
  1. Process chemicals;
  2. Technology;
  3. Equipment;
  4. Procedures; and
  5. Facilities.
- Assess the impact of change on safety and operating procedures.
- Provide updated training to employees and contract workers prior to startup.
- If change is significant, then a pre-startup review is required.
- Update process safety information.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #22
Incident Investigation — Paragraph (m) of OSHA's PSM Standard

(m) Incident Investigation

Requirements:

- **Investigate** all incidents or near-misses which could result in a catastrophic release of a highly **hazardous chemical**.
- **Begin investigation** as soon as possible (within 48 hours).
- Form an **investigation team** which includes at least one person knowledgeable about the process involved and a contract worker if the incident involved work by the contractor.
- Prepare a **report** with dates, description of incident, contributing factors and recommendations.
- Establish a system to promptly **address and resolve findings** and recommendations.
- **Review** report findings with affected employees and contract workers.
- Incident investigation **reports** must be **retained for five years**.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #23
Emergency Planning and Response — Paragraph (n) of OSHA's PSM Standard

(n) Emergency Planning and Response

Requirements:

- Establish and implement an emergency action plan as required by OSHA 29 CFR 1910.389(a). Also, include procedures for handling small chemical releases.
- Establish and implement a more comprehensive emergency response program as required by OSHA 1910.120, the HAZWOPER Standard.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #24
Compliance Audits and Trade Secrets — Paragraphs (o) and (p) of OSHA's PSM Standard

(o) Compliance Audits

Requirements:

- Review the PSM programs every three years for compliance.
- Include on the team at least one person knowledgeable about the process.
- Write a report of the findings of the audit.
- Respond to the audit report findings and document that deficiencies have been corrected.

(p) Trade Secrets

Requirements:

- Make all necessary information available to those people responsible for complying with the different sections of the Standard, including trade secrets.
- Give workers and union representatives access to trade secret information, subject to OSHA 29 CFR 1910.1200 (the Hazard Communication Standard).
- Allows the employer to require a confidentiality agreement that the employees must not disclose this information.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119,57 FR 6356, February 24, 1992.

Task 4 *(continued)*

Purpose Restated: To become acquainted with the basic elements of the Process Safety Management (PSM) Standard.

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   Oil refinery. Propane escaped from a crack in an amine absorber and formed a gas cloud which ignited. This led to an explosion and fire in the alkylation unit and a fire in the Unifiring area. Damaged 59 homes. OSHA cited and fined Union Oil $21,000 for willful and serious violations including inadequate preventive maintenance and lack of personal protective equipment. It was later determined that the crack in the process tower was due to improper contractor welding procedures.

   ___ (j) Mechanical Integrity

   ___ (k) Hot Work Permit

   ___ (l) Management of Change

   ___ (m) Incident Investigation

   ___ (n) Emergency Planning and Response

   ___ (o) Compliance Audits

   ___ (p) Trade Secrets

continued

Task 4 *(continued)*

2. **October 30, 1988 - Amoco Oil Co.**
   Oil refinery. Explosion and fire in oxidizer unit coated workers with 500-degree asphalt. The oxidizer, a 70-foot-high, 32-foot diameter vessel went up like a rocket 40 to 50 feet when it blew. OSHA cited and fined Amoco more than $300,000 for a wide variety of violations. Unit began to malfunction several days earlier but company kept it running in order to maintain production. (This explosion followed two others earlier in 1988 that injured 18.)

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3. **January 19, 1991 - British Petroleum (BP) Corp.**
Oil refinery. Difficulty getting crude unit up after turnaround and seals were leaking. Unit was brought part-way down and quickly fired in order to get put back up as soon as possible. Blinded line near heater not purged. Flashback killed one contractor, injured three others and injured three BP employees. Inadequate maintenance practices were blamed.

___ (j) Mechanical Integrity

___ (k) Hot Work Permit

___ (l) Management of Change

___ (m) Incident Investigation

___ (n) Emergency Planning and Response

___ (o) Compliance Audits

___ (p) Trade Secrets

Summary: An Introduction to the Process Safety Management Standard

1. Leading up to the implementation of OSHA's PSM standard, we increasingly saw disasters which led to immeasurable misery in both injuries and loss of life and the loss of billions of dollars in property damage.
2. This loss of life and damage is unacceptable and also preventable.
3. OSHA issued the Process Safety Management Standard in an attempt to prevent the ever-increasing number of disasters from occurring.
4. The PSM Standard, when properly implemented in the workplace, gives workers more control over workplace safety by increasing their participation, their skills and abilities in bringing about needed safeguards to prevent catastrophes.
5. The PSM Standard is a valued tool to make our workplaces safer, but only when properly implemented in our workplaces.

Full Text of OSHA Regulations (Standards - 29 CFR)

Process Safety Management of Highly Hazardous Chemicals 1910.119

OSHA Regulations (Standards - 29 CFR)
Process safety management of highly hazardous chemicals 1910.119

Standard Number: 1910.119
Standard Title: Process Safety Management of Highly Hazardous Chemicals.
SubPart Number: H
SubPart Title: Hazardous Materials

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.

(a)(1)
This section applies to the following:

(a)(1)(i)
A process which involves a chemical at or above the specified threshold quantities listed in Appendix A to this section;

(a)(1)(ii)
A process which involves a flammable liquid or gas (as defined in 1910.1200(c) of this part) on site in one location, in a quantity of 10,000 pounds (4535.9 kg) or more except for:

(a)(1)(ii)(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;

(a)(1)(ii)(B)
Flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration.

(a)(2)
This section does not apply to:

(a)(2)(i)
Retail facilities;
..1910.119(a)(2)(ii)
(a)(2)(ii)
Oil or gas well drilling or servicing operations; or,
(a)(2)(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 p.s.i.g. (pounds per square inch gauge, 3.45 Kpa).
Boiling point means the boiling point of a liquid at a pressure of 14.7 pounds per square inch absolute (p.s.i.a.) (760 mm.). For the purposes of this section, where an accurate boiling point is unavailable for the material in question, or for mixtures which do not have a constant boiling point, the 10 percent point of a distillation performed in accordance with the Standard Method of Test for Distillation of Petroleum Products, ASTM D-86-62, which is incorporated by reference as specified in Sec. 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.

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

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

(c) Employee participation.

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

(c)(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.

(c)(3)
Employers shall provide to employees and their representatives access to process hazard analyses and to all other information required to be developed under this standard.
..1910.119(d)

(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.

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

(d)(1)(i)
Toxicity information;

(d)(1)(ii)
Permissible exposure limits;

(d)(1)(iii)
Physical data;

(d)(1)(iv)
Reactivity data:

(d)(1)(v)
Corrosivity data;

(d)(1)(vi)
Thermal and chemical stability data; and

(d)(1)(vii)
Hazardous effects of inadvertent mixing of different materials that could foreseeably occur. Note: Material 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.

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

(d)(2)(i)
Information concerning the technology of the process shall include at least the following: ..1910.119(d)(2)(i)(A)

(d)(2)(i)(A)
A block flow diagram or simplified process flow diagram (see Appendix B to this section);

(d)(2)(i)(B)
Process chemistry;

(d)(2)(i)(C)
Maximum intended inventory;

(d)(2)(i)(D)
Safe upper and lower limits for such items as temperatures, pressures, flows or compositions; and

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(d)(2)(i)(E)
An evaluation of the consequences of deviations, including those affecting the safety and health of employees.

(d)(2)(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.

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

(d)(3)(i)
Information pertaining to the equipment in the process shall include:

(d)(3)(i)(A)
Materials of construction;

(d)(3)(i)(B)
Piping and instrument diagrams (P&ID's);
..1910.119(d)(3)(i)(C)

(d)(3)(i)(C)
Electrical classification;

(d)(3)(i)(D)
Relief system design and design basis;

(d)(3)(i)(E)
Ventilation system design;

(d)(3)(i)(F)
Design codes and standards employed;

(d)(3)(i)(G)
Material and energy balances for processes built after May 26, 1992; and,

(d)(3)(i)(H)
Safety systems (e.g. interlocks, detection or suppression systems).

(d)(3)(ii)
The employer shall document that equipment complies with recognized and generally accepted good engineering practices.

(d)(3)(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.
..1910.119(e)

(e) Process hazard analysis.

(e)(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:

(e)(1)(i)
No less than 25 percent of the initial process hazards analyses shall be completed by May 26, 1994;

(e)(1)(ii)
No less than 50 percent of the initial process hazards analyses shall be completed by May 26, 1995;

(e)(1)(iii)
No less than 75 percent of the initial process hazards analyses shall be completed by May 26, 1996;

(e)(1)(iv)
All initial process hazards analyses shall be completed by May 26, 1997.

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(e)(1)(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 standard.

(e)(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.

(e)(2)(i)
What-If;
..1910.119(e)(2)(ii)
(e)(2)(ii)
Checklist;

(e)(2)(iii)
What-If/Checklist;

(e)(2)(iv)
Hazard and Operability Study (HAZOP);

(e)(2)(v)
Failure Mode and Effects Analysis (FMEA);

(e)(2)(vi)
Fault Tree Analysis; or

(e)(2)(vii)
An appropriate equivalent methodology.

(e)(3)
The process hazard analysis shall address:

(e)(3)(i)
The hazards of the process;

(e)(3)(ii)
The identification of any previous incident which had a likely potential for catastrophic consequences in the workplace;

(e)(3)(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.);
..1910.119(e)(3)(iv)

(e)(3)(iv)
Consequences of failure of engineering and administrative controls;

(e)(3)(v)
Facility siting;

(e)(3)(vi)
Human factors; and

(e)(3)(vii)
A qualitative evaluation of a range of the possible safety and health effects of failure of controls on employees in the workplace.

(e)(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.

(e)(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.
..1910.119(e)(6)

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(e)(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.

(e)(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.

(f)(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.

(f)(1)(i)
Steps for each operating phase:

(f)(1)(i)(A)
Initial startup;

(f)(1)(i)(B)
Normal operations;

(f)(1)(i)(C)
Temporary operations;
..1910.119(f)(1)(i)(D)

(f)(1)(i)(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.

(f)(1)(i)(E)
Emergency Operations;

(f)(1)(i)(F)
Normal shutdown; and,

(f)(1)(i)(G)
Startup following a turnaround, or after an emergency shutdown.

(f)(1)(ii)
Operating limits:

(f)(1)(ii)(A)
Consequences of deviation; and

(f)(1)(ii)(B)
Steps required to correct or avoid deviation.

(f)(1)(iii)
Safety and health considerations:

(f)(1)(iii)(A)
Properties of, and hazards presented by, the chemicals used in the process;

(f)(1)(iii)(B)
Precautions necessary to prevent exposure, including engineering controls, administrative controls and personal protective equipment;
..1910.119(f)(1)(iii)(C)

(f)(1)(iii)(C)
Control measures to be taken if physical contact or airborne exposure occurs;

(f)(1)(iii)(D)
Quality control for raw materials and control of hazardous chemical inventory levels; and

(f)(1)(iii)(E)
Any special or unique hazards.

(f)(1)(iv)
Safety systems and their functions.

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

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(f)(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.
..1910.119(f)(4)

(f)(4)
The employer shall develop and implement safe work practices to provide for the control of hazards during operations such as lockout/tagout; 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. (g)(1)
Initial training.

(g)(1)(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.

(g)(1)(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.

(g)(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.
..1910.119(g)(3)

(g)(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.

(h)(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.

(h)(2)
Employer responsibilities.

(h)(2)(i)
The employer, when selecting a contractor, shall obtain and evaluate information regarding the contract employer's safety performance and programs.

(h)(2)(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.

h)(2)(iii)
The employer shall explain to contract employers the applicable provisions of the emergency action plan required by paragraph (n) of this section.
..1910.119(h)(2)(iv)

(h)(2)(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.

(h)(2)(v)
The employer shall periodically evaluate the performance of contract employers in fulfilling their obligations as specified in paragraph (h)(3) of this section.

((h)(2)(vi)
The employer shall maintain a contract employee injury and illness log related to the contractor's work in process areas.

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(h)(3)
Contract employer responsibilities.

(h)(3)(i)
The contract employer shall assure that each contract employee is trained in the work practices necessary to safely perform his/her job.

(h)(3)(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.

(h)(3)(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.
..1910.119(h)(3)(iv)

(h)(3)(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.

(h)(3)(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.

(i)(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.

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

(i)(2)(i)
Construction and equipment is in accordance with design specifications;

(i)(2)(ii)
Safety, operating, maintenance and emergency procedures are in place and are adequate;

(i)(2)(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 (l).
..1910.119(i)(2)(iv)

(i)(2)(iv)
Training of each employee involved in operating a process has been completed.

(j) Mechanical integrity.

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

(j)(1)(i)
Pressure vessels and storage tanks;

(j)(1)(ii)
Piping systems (including piping components such as valves);

(j)(1)(iii)
Relief and vent systems and devices;

(j)(1)(iv)
Emergency shutdown systems;

(j)(1)(v)
Controls (including monitoring devices and sensors, alarms and interlocks); and,

(j)(1)(vi)
Pumps.

(j)(2)
Written procedures. The employer shall establish and implement written procedures to maintain the on-going integrity of process equipment.
..1910.119(j)(3)

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(j)(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.

(j)(4)
Inspection and testing.

(j)(4)(i)
Inspections and tests shall be performed on process equipment.

(j)(4)(ii)
Inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

(j)(4)(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.

(j)(4)(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.
..1910.119(j)(5)

(j)(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.

(j)(6)
Quality assurance.

(j)(6)(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.

(j)(6)(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.

(j)(6)(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.

(k)(1)
The employer shall issue a hot work permit for hot work operations conducted on or near a covered process.
..1910.119(k)(2)

(k)(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.

(l)(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. The procedures shall assure that the following considerations are addressed prior to any change:

(l)(2)(i)
The technical basis for the proposed change;

(l)(2)(ii)
Impact of change on safety and health;

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(l)(2)(iii)
(l)(2)
Modifications to operating procedures;

(l)(2)(iv)
Necessary time period for the change; and,

(l)(2)(v)
Authorization requirements for the proposed change.

(l)(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 startup of the process or affected part of the process.
..1910.119(l)(4)

(l)(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.

(l)(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.

(m)(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.

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

(m)(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.

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

(m)(4)(i)
Date of incident;
..1910.119(m)(4)(ii)

(m)(4)(ii)
Date investigation began;

(m)(4)(iii)
A description of the incident;

(m)(4)(iv)
The factors that contributed to the incident; and,

(m)(4)(v)
Any recommendations resulting from the investigation.

(m)(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.

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

(m)(7)
Incident investigation reports shall be retained for five years.
..1910.119(n)

continued

OSHA Regulations (Standards - 29 CFR) *(continued)*

(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(a). 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.

(o)(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.

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

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

(o)(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.

(o)(5)
Employers shall retain the two (2) most recent compliance audit reports.
..1910.119(p)

(p) Trade secrets.

(p)(1)
Employers shall make all information necessary to comply with the section available to those persons responsible for compiling the process safety information (required by paragraph (d) 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.

(p)(2)
Nothing in this paragraph shall preclude the employer from requiring the persons to whom the information is made available under paragraph (p)(1) of this section to enter into confidentiality agreements not to disclose the information as set forth in 29 CFR 1910.1200.

(p)(3)
Subject to the rules and procedures set forth in 29 CFR 1910.1200(i)(1) through 1910.1200(i)(12), employees and their designated representatives shall have access to trade secret information contained within the process hazard analysis and other documents required to be developed by this standard.
[57 FR 23060, June 1, 1992; 61 FR 9227, March 7, 1996]

List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory) - 1910.119 App A

- Standard Number: 1910.119 App A
- Standard Title: List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory).
- SubPart Number: H
- SubPart Title: Hazardous Materials

Bottom of Form 1

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	CAS*	TQ**
Acetaldehyde	75-07-0	2500
Acrolein (2-Popenal)	107-02-8	150
Acrylyl Chlorde	814-68-6	250
Allyl Chlorid	107-05-1	1000
Allylamine	107-11-9	1000
Alkylaluminum	Varies	5000
Ammonia, Anhydrous	7664-41-7	10000
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7	15000
Ammonium Perchlorate	7790-98-9	7500
Ammonium Permanganate	7787-36-2	7500
Arsine (also called Arsenic Hydride)	7784-42-1	100
Bis(Chloromethyl) Ether	542-88-1	100
Boron Trichloride	10294-34-5	2500
Boron Trifluoride	7637-07-2	250
Bromine	7726-95-6	1500
Bromine Chloride	13863-41-7	1500
Bromine Pentafluoride	7789-30-2	2500
Bromine Trifluoride	7787-71-5	15000
3-Bromopropyne (also called Propargyl Bromide)	106-96-7	100
Butyl Hydroperoxide (Tertiary)	75-91-2	5000
Butyl Perbenzoate (Tertiary)	614-45-9	7500
Carbonyl Chloride (see Phosgene)	75-44-5	100
Carbonyl Fluoride	353-50-4	2500

CHEMICAL NAME	CAS*	TQ**
Cellulose Nitrate (concentration greater than 12.6% nitrogen	9004-70-0	2500
Chlorine	7782-50-5	1500
Chlorine Dioxide	10049-04-4	1000
Chlorine Pentrafluoride	13637-63-3	1000
Chlorine Trifluoride	7790-91-2	1000
Chlorodiethylaluminum (also called Diethylaluminum Chloride)	96-10-6	5000
1-Chloro-2,4-Dinitrobenzene	97-00-7	5000
Chloromethyl Methyl Ether	107-30-2	500
Chloropicrin	76-06-2	500
Chloropicrin and Methyl Bromide mixture	None	1500
Chloropicrin and Methyl Chloride mixture	None	1500
Cumene Hydroperoxide	80-15-9	5000
Cyanogen	460-19-5	2500
Cyanogen Chloride	506-77-4	500
Cyanuric Fluoride	675-14-9	100
Diacetyl Peroxide (concentration greater than 70%)	110-22-5	5000
Diazomethane	334-88-3	500
Dibenzoyl Peroxide	94-36-0	7500
Diborane	19287-45-7	100
Dibutyl Peroxide (Tertiary)	110-05-4	5000
Dichloro Acetylene	7572-29-4	250
Dichlorosilane	4109-96-0	2500
Diethylzinc	557-20-0	10000
Diisopropyl Peroxydicarbonate	105-64-6	7500
Dilauroyl Peroxide	105-74-8	7500
Dimethyldichlorosilane	75-78-5	1000
Dimethylhydrazine, 1,1-	57-14-7	1000
Dimethylamine, Anhydrous	124-40-3	2500
2,4-Dinitroaniline	97-02-9	5000
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration greater than 60%)	1338-23-4	5000
Ethyl Nitrite	109-95-5	5000
Ethylamine	75-04-7	7500
Ethylene Fluorohydrin	371-62-0	100
Ethylene Oxide	75-21-8	5000
Ethyleneimine	151-56-4	1000
Fluorine	7782-41-4	1000
Formaldehyde (Formalin)	50-00-0	1000
Furan	110-00-9	500
Hexafluoroacetone	684-16-2	5000
Hydrochloric Acid, Anhydrous	7647-01-0	5000
Hydrofluoric Acid, Anhydrous	7664-39-3	1000
Hydrogen Bromide	10035-10-6	5000
Hydrogen Chloride	7647-01-0	5000

continued

List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory). - 1910.119 App A *(continued)*

CHEMICAL NAME	CAS*	TQ**
Hydrogen Cyanide, Anhydrous	74-90-8	1000
Hydrogen Fluoride	7664-39-3	1000
Hydrogen Peroxide (52% by weight or greater)	7722-84-1	7500
Hydrogen Selenide	7783-07-5	150
Hydrogen Sulfide	7783-06-4	1500
Hydroxylamine	7803-49-8	2500
Iron, Pentacarbonyl	13463-40-6	250
Isopropylamine	75-31-0	5000
Ketene	463-51-4	100
Methacrylaldehyde	78-85-3	1000
Methacryloyl Chloride	920-46-7	150
Methacryloyloxyethyl Isocyanate	30674-80-7	100
Methyl Acrylonitrile	126-98-7	250
Methylamine, Anhydrous	74-89-5	1000
Methyl Bromide	74-83-9	2500
Methyl Chloride	74-87-3	15000
Methyl Chloroformate	79-22-1	500
Methyl Ethyl Ketone Peroxide (concentration greater than 60%)	1338-23-4	5000
Methyl Fluoroacetate	453-18-9	100
Methyl Fluorosulfate	421-20-5	100
Methyl Hydrazine	60-34-4	100
Methyl Iodide	74-88-4	7500
Methyl Isocyanate	624-83-9	250
Methyl Mercaptan	74-93-1	5000
Methyl Vinyl Ketone	79-84-4	100
Methyltrichlorosilane	75-79-6	500
Nickel Carbonly (Nickel Tetracarbonyl)	13463-39-3	150
Nitric Acid (94.5% by weight or greater)	7697-37-2	500
Nitric Oxide	10102-43-9	250
Nitroaniline (para Nitroaniline	100-01-6	5000
Nitromethane	75-52-5	2500
Nitrogen Dioxide	10102-44-0	250
Nitrogen Oxides (NO; NO(2); N2O4; N2O3)	10102-44-0	250
Nitrogen Tetroxide (also called Nitrogen Peroxide)	10544-72-6	250
Nitrogen Trifluoride	7783-54-2	5000
Nitrogen Trioxide	10544-73-7	250
Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)	8014-94-7	1000
Osmium Tetroxide	20816-12-0	100
Oxygen Difluoride (Fluorine Monoxide)	7783-41-7	100
Ozone	10028-15-6	100
Pentaborane	19624-22-7	100

CHEMICAL NAME	CAS*	TQ**
Peracetic Ac (concentration greater 60% Acetic Acid; also called Peroxyacetic Acid)	79-21-0	1000
Perchloric Acid (concentration greater than 60% by weight)	7601-90-3	5000
Perchloromethyl Mercaptan	594-42-3	150
Perchloryl Fluoride	7616-94-6	5000
Peroxyacetic Acid (concentration greater than 60% Acetic Acid; also called Peracetic Acid)	79-21-0	1000
Phosgene (also called Carbonyl Chloride)	75-44-5	100
Phosphine (Hydrogen Phosphide)	7803-51-2	100
Phosphorus Oxychloride (also called Phosphoryl Chloride)	10025-87-3	1000
Phosphorus Trichloride	7719-12-2	1000
Phosphoryl Chloride (also called Phosphorus Oxychloride)	10025-87-3	1000
Propargyl Bromide	106-96-7	100
Propyl Nitrate	627-3-4	2500
Sarin	107-44-8	100
Selenium Hexafluoride	7783-79-1	1000
Stibine (Antimony Hydride)	7803-52-3	500
Sulfur Dioxide (liquid)	7446-09-5	1000
Sulfur Pentafluoride	5714-22-7	250
Sulfur Tetrafluoride	7783-60-0	250
Sulfur Trioxide (also called Sulfuric Anhydride)	7446-11-9	1000
Sulfuric Anhydride (also called Sulfur Trioxide)	7446-11-9	1000
Tellurium Hexafluoride	7783-80-4	250
Tetrafluoroethylene	116-14-3	5000
Tetrafluorohydrazine	10036-47-2	5000
Tetramethyl Lead	75-74-1	1000
Thionyl Chloride	7719-09-7	250
Trichloro (chloromethyl) Silane	1558-25-4	100
Trichloro (dichlorophenyl) Silane	27137-85-5	2500
Trichlorosilane	10025-78-2	5000
Trifluorochloroethylene	79-38-9	10000
Trimethyoxysilane	2487-90-3	1500

Footnote* Chemical Abstract Service Number
Footnote** Threshold Quantity in Pounds (Amount necessary to be covered by this standard.)

[57 FR 7847, Mar. 4, 1992]

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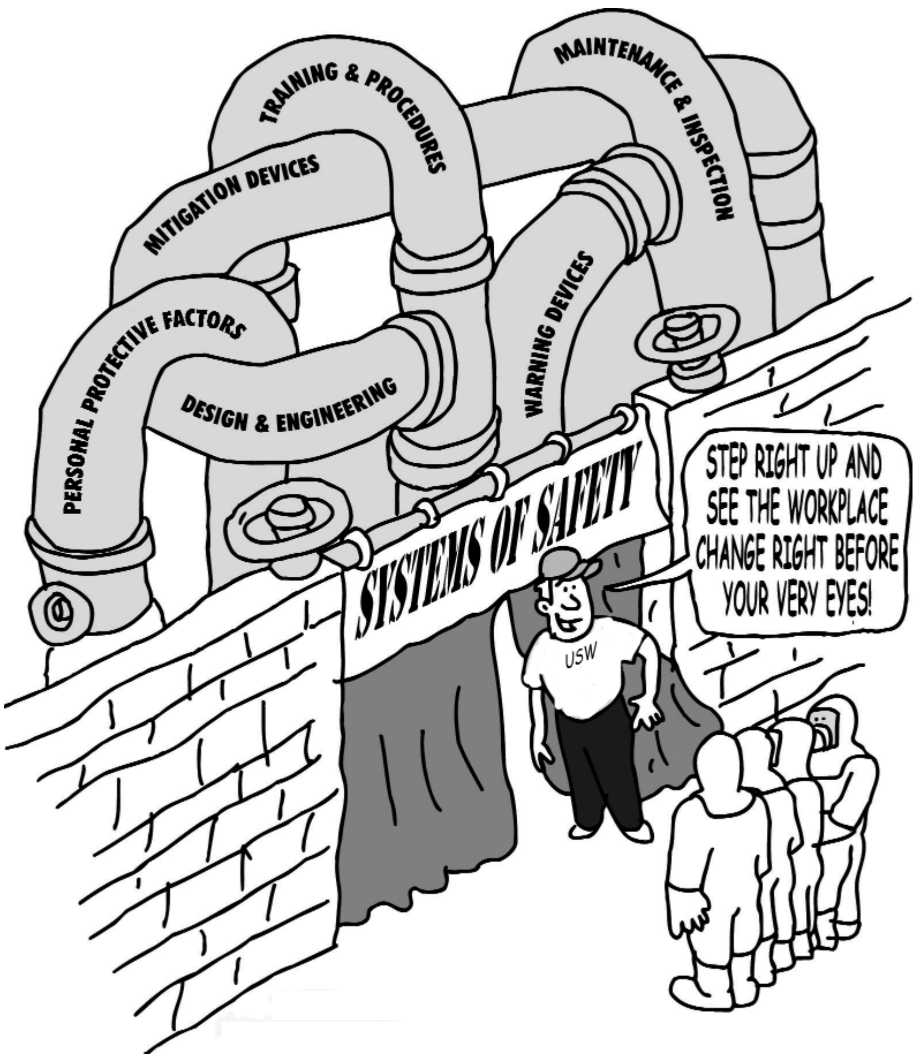
Activity 2: Systems of Safety and the PSM Standard

Purpose

To introduce the concept of Systems of Safety and accident prevention.

This Activity has two tasks.



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Task 1

Factsheet Reading Method for Task 1.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a scribe for this Task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

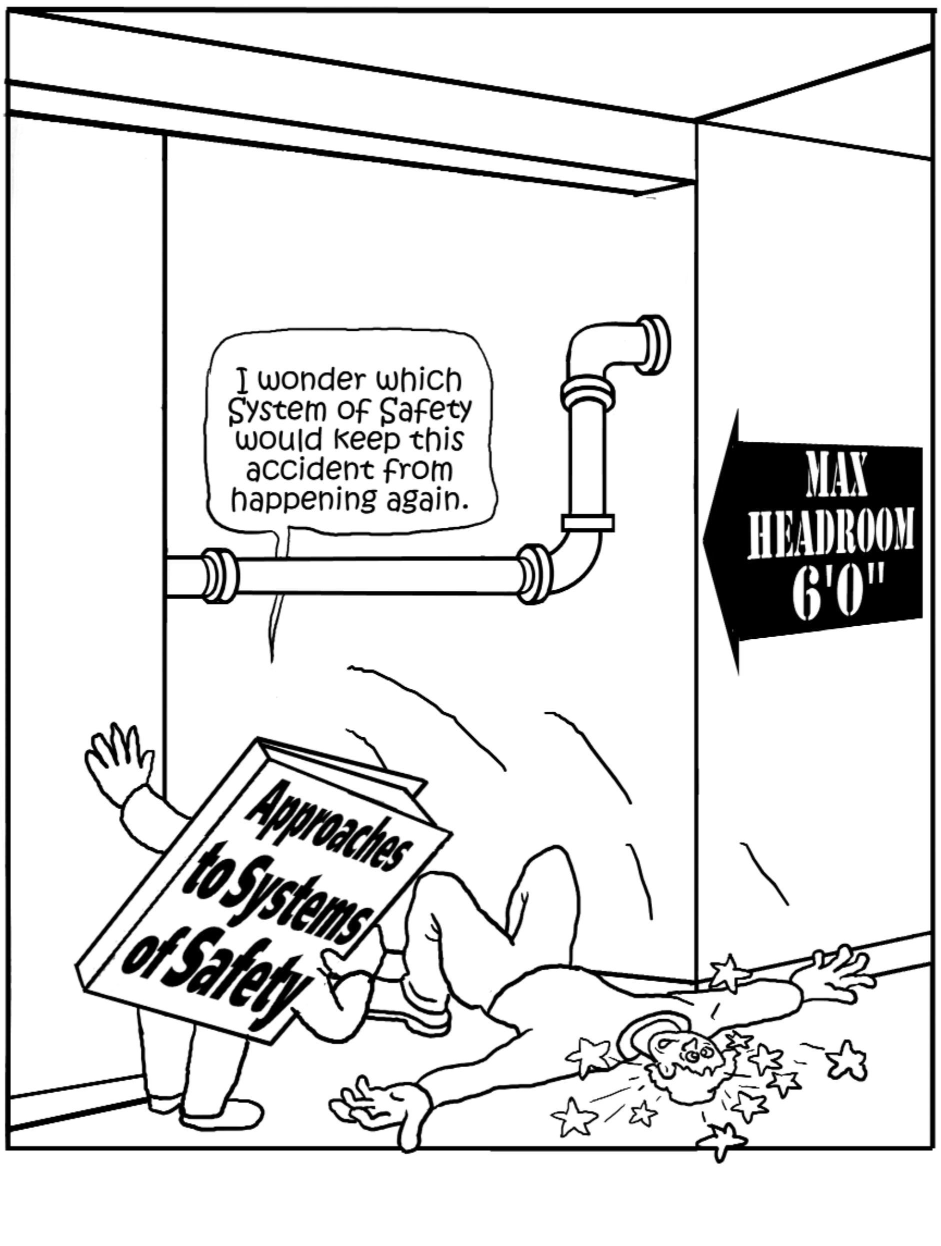
Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 1 to 9. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5; the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 9 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (1 through 9), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet #1
What Are Systems of Safety?

Systems of Safety are proactive systems that actively seek to identify, control and/or eliminate workplace hazards.

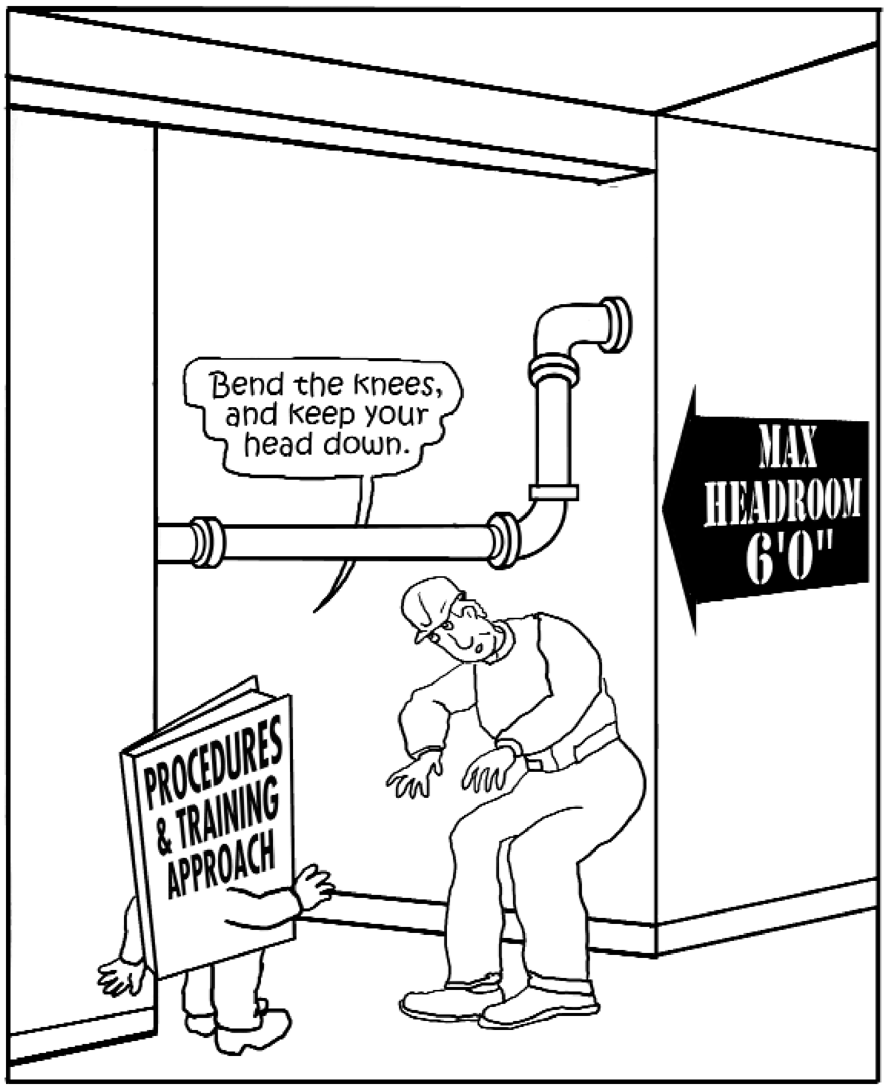


Factsheet #2
The Personal Protective Factors System

1. **Personal Decision-making and Actions**
   - Look and think critically at the workplace;
   - Work collectively to identify hazards; and
   - Contribute ideas, experience and know-how that will lead to correcting the system's flaws.
2. **Personal Protective Equipment (PPE) and Devices**
   - Wear PPE as necessary and required when higher levels of protection are not feasible.
3. **Stop Work Authority**
   - Authority is given to all individuals; and they are encouraged to stop work, equipment or processes due to unsafe conditions until a thorough Hazard Analysis can be performed.

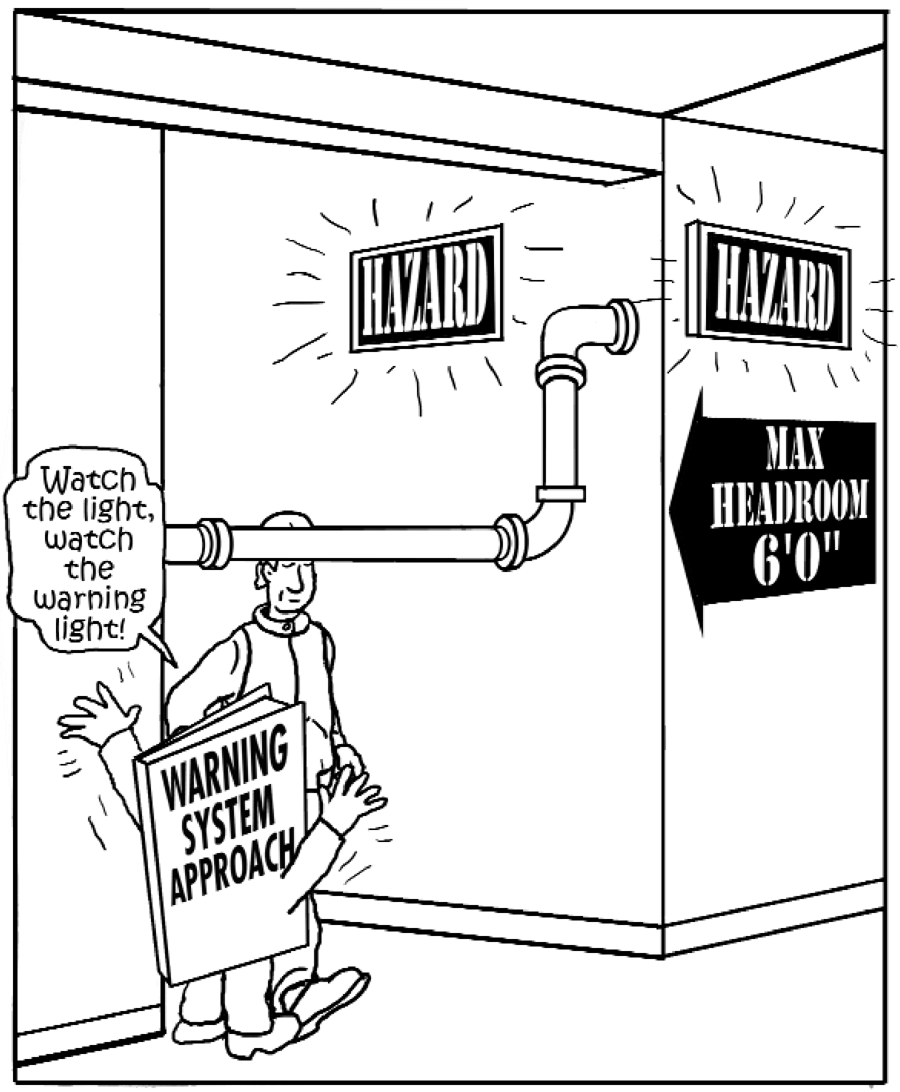
Factsheet #3
The Training and Procedures System

The operation and maintenance of processes that are dangerous require a system of written procedures and training. The greater the hazard, the greater is the need for Training and Procedures.



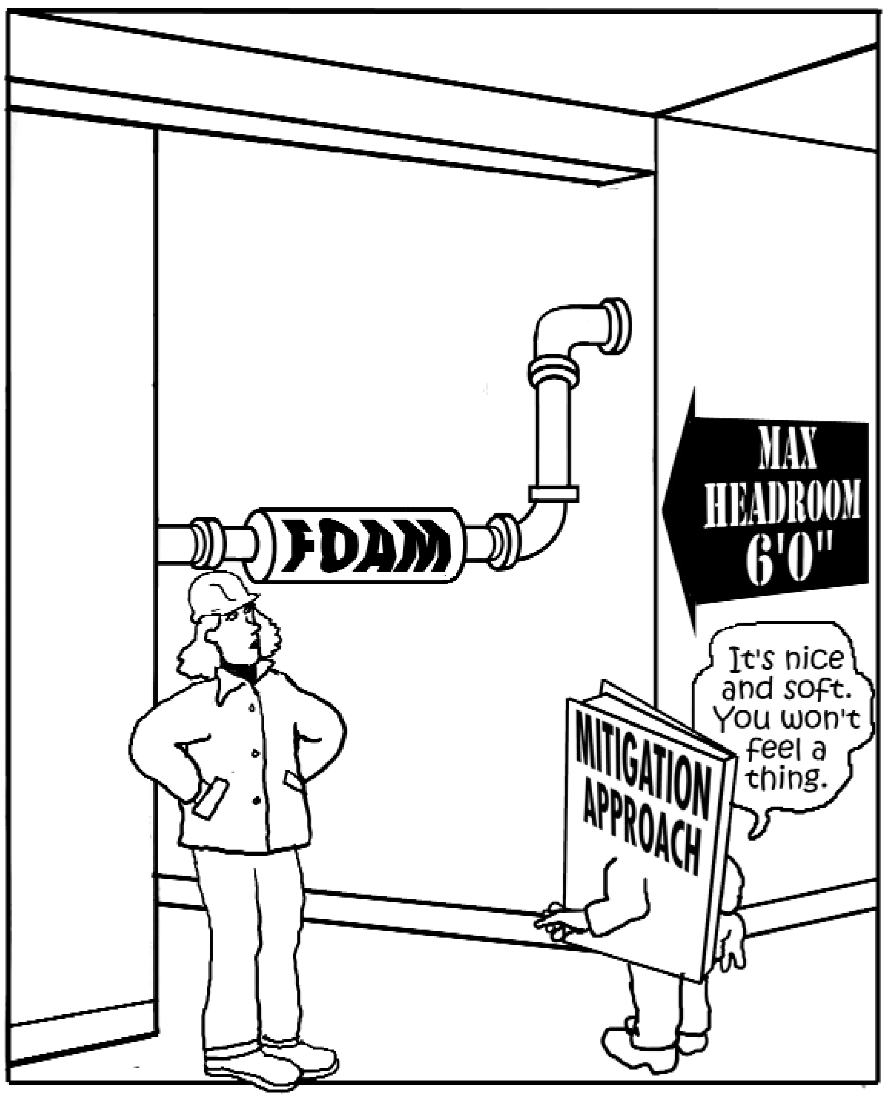
Factsheet #4
The Warning System

The Warning System of Safety includes the use of devices that warn of a dangerous or potentially dangerous situation. These devices require a person's intervention to control or mitigate the hazardous situation.



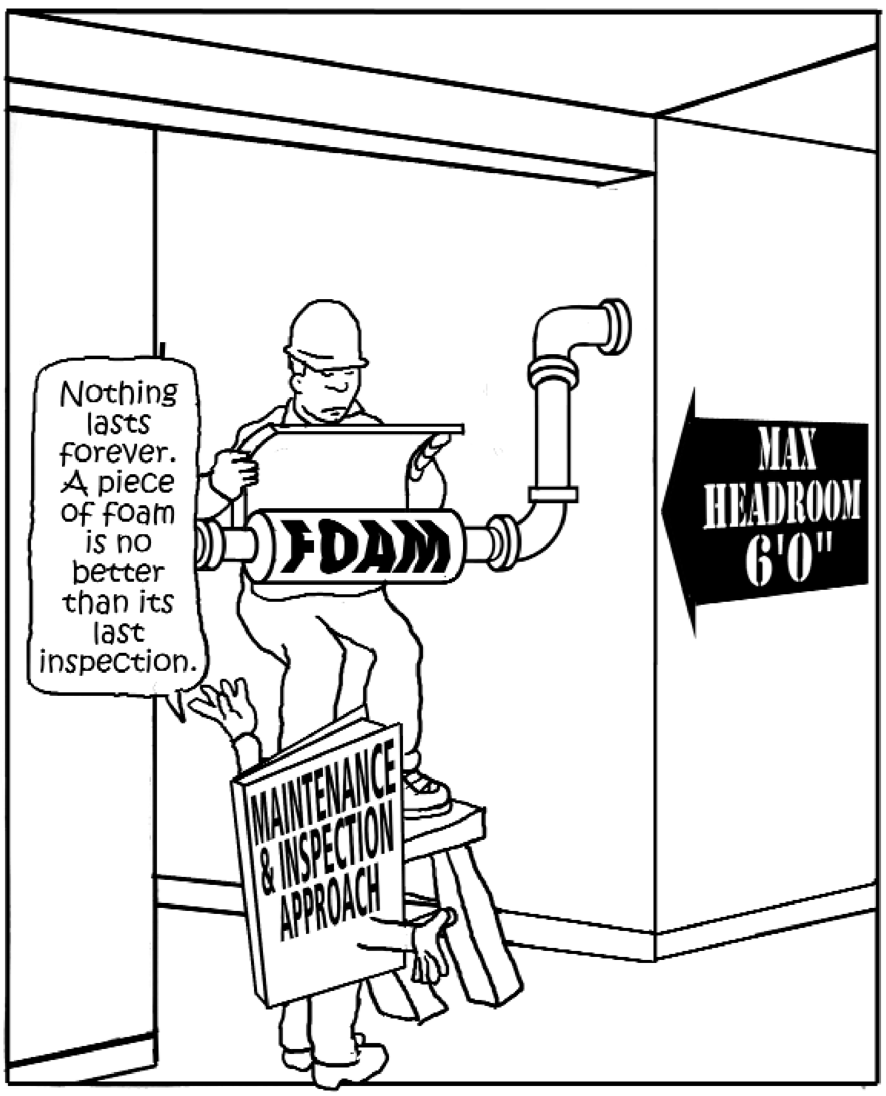
Factsheet #5
The Mitigation System

The Mitigation System of Safety involves the use of equipment that automatically acts to control or reduce the harmful consequences of hazardous incidents. Mitigation should be automatic and reliable.



Factsheet #6
The Maintenance and Inspection System

Properly designed equipment can turn into unsafe junk if it isn't properly maintained, inspected and repaired. If the phrase "if it ain't broke, don't fix it" is used within a workplace, the Maintenance and Inspection System is a failure. If you don't use preventive maintenance, then you end up doing breakdown maintenance.



Factsheet #7
Design and Engineering System of Safety

A central purpose of the Design System of Safety is to *eliminate hazards* through the selection of safe or low-risk processes and chemicals whenever possible.

One example of good design safety is the substitution of a less hazardous chemical such as sodium hypo-chlorite (bleach), for chlorine in treating cooling water. A release of toxic chlorine gas can travel in the wind for miles, whereas a spill of bleach is inherently less dangerous.

Factsheet #8
Eliminate the Hazard with the Design and Engineering System of Safety

You can design and engineer within any System of Safety; but a true Design and Engineering fix is the one which eliminates the hazard.

For example: A worker is exposed through inhalation to a hazardous chemical which was being used in a cleaning process. The worker's respirator leaked. Suggested fixes recommended were:

1. **Design** and make a new respirator for the worker to wear. Is this an effort to eliminate the hazard? **No!** It is a fix in the Personal Protective Factors System of Safety.
2. **Design** a new procedure which makes it less likely that the worker will be exposed. Is this an effort to eliminate the hazard? **No!** It is a fix in the Training and Procedures System of Safety.
3. **Design** a warning system to alert the worker when the concentration of the chemical reaches a certain point. Is this an effort to eliminate the hazard? **No!** It is a fix in the Warning Devices System of Safety.
4. **Design** a better ventilation system which will remove most of the dangerous fumes. Is this an effort to eliminate the hazard? **No!** It is a fix in the Mitigation System of Safety.
5. **Design** a better maintenance and inspection program to maintain the ventilation system, keep down tripping and slipping hazards and make the job safer overall. Is this an effort to eliminate the hazard? **No!** It is a fix in the Maintenance and Inspection System of Safety.
6. **Design** the cleaning process to use a cleaning agent that is not dangerous to workers. Is this an effort to eliminate the hazard? **Yes!** It is a fix in the **Design and Engineering System of Safety.**

Factsheet #9
Safety Systems and Subsystems (Examples)

Major Safety System	Design & Engineering	Maintenance & Inspection	Mitigation Devices	Warning Devices	Training & Procedures	Personal Protective Factors
Level of Prevention	**Highest—the first line of defense**			**Middle—the second line of defense**		**Lowest—the last line of defense**
Effectiveness	**Most Effective**	⟵	⟷	⟷	⟶	**Least Effective**
Goal	*To eliminate hazards*			*To further minimize and control hazards*		*To protect when higher level systems fail*
EXAMPLES OF SAFETY SUB-SYSTEMS**	**Technical** Design and Engineering of Equipment, Processes and Software Management of Change (MOC)** Chemical Selection and Substitution Safe Siting Work Environment HF **Organizational *(must address a root cause)*** Staffing HF Skills and Qualifications HF Management of Personnel Change (MOPC) Work Organization and Scheduling HF Work Load Allocation of Resources Buddy System Codes, Standards, and Policies**	Inspection and Testing Maintenance Quality Control Turnarounds and Overhauls Mechanical Integrity	Enclosures, Barriers Dikes and Containment Relief and Check Valves Shutdown and Isolation Devices Fire and Chemical Suppression Devices Machine Guarding	Monitors Process Alarms Facility Alarms Community Alarms Emergency Notification Systems	Operating Manuals and Procedures Process Safety Information Process, Job and Other Types of Hazard Assessment and Analysis Permit Programs Emergency Preparedness and Response Training Refresher Training Information Resources Communications Investigations and Lessons Learned Maintenance Procedures Pre-Startup Safety Review	Personal Decision-making and Actions HF Personal Protective Equipment and Devices HF Stop Work Authority

HF - Indicates that this subsystem is often included in a category called **Human Factors**.
* There may be additional subsystems that are not included in this chart. Also, in the workplace many subsystems are interrelated. It may not always be clear that an issue belongs to one subsystem rather than another.
** The Codes, Standards and Policies and Management of Change subsystems listed here are related to Design and Engineering. These subsystems may also be relevant to other systems; for example, Mitigation Devices. When these subsystems relate to systems other than Design and Engineering, they should be considered as part of those other system, not Design and Engineering.

Revised October 2006

Task 1 *(continued)*

Purpose Restated: To introduce the concept of Systems of Safety and accident prevention.

Scenario:

In the early 1970s, child safety experts found themselves in the midst of a serious problem. A growing number of children were being poisoned by accidental ingestion of prescription drugs. The numbers had begun to increase after World War II as these medications became more common in the home.

The experts tried different options to control the hazard:

- National advertising campaigns were launched on radio and television to teach parents about the importance of keeping medications away from children.
- Schools held special presentations for young school-age children to teach them about the hazards of medicines.
- Cabinet latches to prevent access to medicines and other harmful chemicals were developed and put on the market.
- Special warning messages were placed on medicine container labels.

While the incidence of children accidentally ingesting medications slowed after these efforts, deaths still continued to rise. It was not until the "childproof cap" was introduced that the incident rate dropped dramatically.

Discuss the following questions with members of your group. Select a scribe to report your answers back to the class.

1. Analyze the actions taken to eliminate this hazard. Which System of Safety did the action attempt to deal with? Be sure and give your reasons.

Action	SOS Targeted (one for each action)
1. National Advertising Campaign	A. Warning Devices B. Procedures and Training
2. Childproof Caps	A. Design and Engineering B. Mitigation Devices
3. Warning Labels	A. Warning Devices B. Procedures and Training
4. Cabinet Latches	A. Design and Engineering B. Mitigation Devices
5. School Presentations	A. Warning Devices B. Procedures and Training

Task 2

Factsheet Reading Method for Task 2.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

Select a new scribe for this Task.

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Factsheet #10
OSHA and Systems of Safety

The Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) Standard provides an example of how systems of safety are used in other hazardous industries. For instance, the PSM Standard requires that, at a minimum, companies formally establish certain systems and subsystems of safety. The chart below shows how some of OSHA's PSM requirements fit into a system of safety framework.

Maintenance and Inspection	Training and Procedures System	Design, Warning Devices and Mitigation Systems
Mechanical Integrity Subcontractors	Operating procedures Training Hot Work Emergency planning and response	Process safety information Process hazard analysis Management of change Pre-startup safety review

Factsheet #11
Systems vs. Symptoms

When attention is focused on worker injuries, we are only seeing the tip of the safety iceberg. Focusing on "unsafe behaviors" when a worker is injured does not take us down the road to prevention.

Worker injuries, unsafe conditions and accidents are symptoms of something wrong in management's systems of safety.

The root causes of incidents are found in management system failures such as faulty design or inadequate training which lead to worker injuries, illnesses and accidents.

Too many employers use injury and illness statistics (the ones they record in their OSHA 300 injury and illness log) as a key measure of safety in their workplaces. There are serious problems with this. Recent studies have demonstrated that OSHA 300 logs seriously under-record actual injuries and illnesses that take place in workplaces today.

.

But one of the biggest problems with using employer-kept injury and illness statistics as a key measure of workplace safety is that this can focus attention away from extremely hazardous conditions. The U.S. Chemical Safety and Hazard Investigation Board (CSB) illustrated this in the report of their investigation of the March 2005, explosion and fire at the BP refinery in Texas City. In the Executive Summary of the report, the CSB wrote:

> "One underlying cause [of the explosion and fire] was that BP used inadequate methods to measure safety conditions at Texas City. For instance, a very low personal injury rate at Texas City gave BP a misleading indicator of process safety performance. In addition, while most attention was focused on the injury rate, the overall safety culture and process safety management (PSM) program had serious deficiencies. Despite numerous previous fatalities at the Texas City refinery (23 deaths in 30 years prior to the 2005 disaster) and many hazardous material releases, BP did not take effective steps to stem the growing risk of a catastrophic event."

Process safety management involves the use of management systems to control hazards and reduce the number and seriousness of process-related incidents and accidents.

Accident prevention requires making changes in systems of safety.

Sources: Center for Chemical Process Safety, *Guidelines for Investigating Chemical Process Incidents*, New York: American Institute of Chemical Engineers, 1992; Rosenman, K.D., Kalush, A., Reilly, M.J., Gardiner, J.C., Reeves, M., Luo, Z., "How Much Work-related Injury and Illness is Missed by the Current National Surveillance system?," *Journal of Occupational and Environmental Medicine* 2006; 48:357-365; U.S. Chemical Safety and Hazard Investigation Board *Investigation Report: Refinery Explosion and Fire,* Report No. 2005-04-1-TX, March 2007.

Factsheet #12
Proactive vs. Reactive Systems

Corporations are re-engineering themselves and cutting costs.

How often have you heard the buzz words, "if it ain't broke, don't fix it?" Many corporate safety programs have been based on this reactive model.

The reactive safety model is the least effective method for preventing chemical releases and accidents.

This after-the-fact approach to safety creates a piecemeal safety program. Extensive standards are created after a disaster to address prevention of that particular type of event. If a disaster involving a particular process or chemical has not occurred yet, there are often few, if any, industry, trade association or government safety guidelines.

Proactive systems of safety are the best way to prevent disasters and injuries.

In contrast, effective systems of safety are based on the proactive identification and control of hazards before disasters and accidents take place. For example, in a proactive safety system, running pumps until they fail is totally unacceptable. It is recognized that if you are performing breakdown maintenance, what's really broken is the facility's preventive maintenance program.

Source: Harold Roland and Brian Moriarty, *System Safety Engineering and Management*, New York: John Wiley and Sons, 1983, pp. 8-9.

Factsheet #13
Worker Involvement Creates Strong Systems of Safety

OSHA recognizes in their PSM Standard that active worker and union involvement in the development and use of process systems of safety is essential for the prevention of disasters. Workers have a unique understanding of the hazards of the processes that they operate and maintain.

A report published by the U.S. Environmental Protection Agency makes the same point:

> ". . . operators have traditionally been more aware than management of the frequency, severity and nature of chemical incidents. Similarly, workers are often more aware of the ineffectiveness of personal protective equipment and other mitigation devices. Were the company's technological decision-making to be informed by such worker insights, primary prevention would be significantly encouraged."

Union involvement in joint labor-management health and safety committees and on subcommittees dealing specifically with the implementation of Process Safety Management, is an important way of operationalizing worker and union involvement that will make a difference in creating and maintaining safer and healthier workplaces.

Source: Ashford, Nicholas, *The Encouragement of Technological Change for Preventing Chemical Accidents*, MIT, EPA, 1993.

Factsheet #14
Finding the Root Cause

Safety professionals and government safety experts recognize the importance of identifying root causes and preventing accidents.

For example, the Center for Chemical Process Safety defines "root causes" as:

> "Management systems failures, such as faulty design or inadequate training, that led to an unsafe act or condition that resulted in an accident; underlying cause. If the root causes were removed, the particular incident would not have occurred."

The Environmental Protection Agency also emphasizes "root causes:"

> ". . . an operator's mistake may be the result of poor training, inappropriate standard operating procedures (SOPs) or poor design of control systems; equipment failure may result from improper maintenance, misuse of equipment (operating at too high a temperature) or use of incompatible materials. Without a thorough investigation, facilities may miss the opportunity to identify and solve the root problems."

What we see is above ground, but what really matters is sometimes hidden from initial view.

Sources: American Institute of Chemical Engineers, *Guidelines for Auditing Process Safety Management Systems*, Environmental Protection Agency Proposed Rule, Risk Management Programs for Chemical Accidental Release Prevention.

Factsheet #15
Profit-driven Decisions Can Cause Accidents

Root causes do not necessarily have immediate effects. It takes time for problems to take root. Corporate decisions made over the last decade in the name of profits are often the root cause of current and future "accidents."

Such decisions may include:

- Cutbacks in preventive maintenance;
- Less frequent equipment inspections;
- Inadequate training for employees and supervisors;
- The failure to report and investigate previous near-misses;
- Longer and longer intervals between preventive maintenance shutdowns;
- The use of skeleton crews for maintenance and operations;
- Increased use of untrained subcontractors; and
- Dangerous hot work on running units.

continued

Factsheet #15
Profit-driven Decisions Can Cause Accidents
(continued)

In their investigation report into the March 2005, refinery explosion and fire at the BP refinery in Texas City, the U.S. Chemical Safety and Hazard Investigation Board wrote:

> "Cost-cutting and failure to invest in the 1990s by Amoco and then BP left the Texas City refinery vulnerable to a catastrophe. BP targeted budget cuts of 25 percent in 1999 and another 25 percent in 2005, even though much of the refinery's infrastructure and process equipment were in disrepair. Also, operator training and staffing were downsized.
>
> ". . . Cost-cutting, failure to invest and production pressure from BP Group executive managers impaired process safety performance at Texas City."

Accidents don't just happen — they take time to mature.

Source: U.S. Chemical Safety and Hazard Investigation Board *Investigation Report: Refinery Explosion and Fire*, Report No. 2005-04-1-TX, March 2007.

Factsheet #16
What Are Root Causes?

Root causes are sometimes referred to as "basic" causes because they are the prime factors that cause an accident. There are almost always several root causes involved in an incident, accident or near-miss. For example, the root causes of an electrocution might include improperly designed or maintained equipment, poor lockout procedures or inadequate training. Root causes are always found in management safety systems. Effective prevention of similar incidents requires changing management systems.

Examples of Root Causes:

- Poor design of process units and equipment;
- Poor layout of control room indicators and controls;
- Difficult access to equipment;
- Unsafe siting and spacing of process units and equipment;
- Lack of preventive maintenance or inspection;
- Inadequate procedures or training for both normal and emergency situations;
- Excessive overtime; and
- Inadequate staffing levels.

Sources: Mine Safety and Health Administration, Accident Prevention, 1990, pp. 35-38; and Center for Chemical Process Safety, *Guidelines for Investigating Chemical Process Incidents*, New York: American Institute of Chemical Engineers, 1992, pp. 129-131.

Task 2 *(continued)*

Purpose Restated: To introduce the concept of Systems of Safety and accident prevention.

Scenario:

On January 28, 1986, the Space Shuttle Challenger lifted off on the 25th mission of the U.S. Shuttle program. The launch occurred at 11:38 a.m. EST and ended just 73 seconds later when the vehicle exploded in mid-air. The seven members of the crew — including Chrysta McAuliffe, a New Hampshire school teacher — were killed.

Investigation into the disaster indicated failure of an O-ring seal between two segments of the right solid rocket booster. This allowed hot propellant gasses to escape through the joint and impinge on the Shuttle's large external fuel tank and on a support strut attaching the solid rocket booster to the external tank. This resulted in an explosion and the nearly complete break up of the vehicle.

The investigation also uncovered the following facts:

a. Once the solid rocket boosters were ignited, the crew had no survivable abort options. There was no ability to separate an orbiter safely from thrusting boosters, and no ability for the crew to escape the vehicle during the first-stage ascent. Evidence indicates that some of the crew survived the mid-air explosion and were killed by the impact of Challenger crashing into the sea.

b. There had been earlier signs of trouble with the O-ring seals. Of 21 missions launched at temperatures above 61° F, four showed signs of O-ring thermal distress (erosion, blow-by and soot). Each of the three launches below 61° F resulted in one or more O-rings showing signs of thermal distress.

c. The temperature had dropped well below freezing during the night and had warmed to just 36° F at the time of the launch. No shuttle had ever been launched at temperatures below 53° F, though there was no temperature-based Launch Commit Criterion that prohibited this. However, engineers for the contractor supplying the O-rings for the solid rocket boosters expressed concerns that the O-rings might stiffen in the cold and lose their ability to seal properly.

d. Testing of the booster and its engine was performed with the booster in a horizontal position, mounted on a support structure rather than in a vertical position as in flight.

e. During the '70s and '80s, the balanced budget forces in Congress severely limited NASA's budget. Between 1970 and the 1986 Challenger launch, NASA had trimmed away 71 percent of its Safety, Reliability and Quality Assurance staff; and their primary contractor had reduced SR & QA staff from 130 to 84.

f. Organizational changes at Kennedy Space Center had placed supervision of Safety, Reliability and Quality Assurance staff under the very organizations whose efforts they were intended to monitor.

g. The year 1986 was to be a breakthrough year for NASA. Fifteen missions were scheduled, six more than in 1985, NASA's best year to date. In January, activity was frantic. Workers and managers were working on three missions simultaneously. Spare parts and manpower were in short supply.

h. People who made the final decision to go ahead with the mission were unaware of the recent history of problems concerning the O-rings and the joint, and were unaware of the contractor engineers' written warning advising against the launch.

continued

Sources: "Rogers Commission Report to the President," 1986; Fran Locher Freiman and Neil Schlager, *Failed Technology, True Stories of Technological Disasters*, Gale Research International Limited, Vol. 1, 1995; and Diane Vaughan, *The Challenger Launch Decision*, University of Chicago Press, 1996.

Task 2 *(continued)*

1. List the systems of safety involved in each paragraph and the flaws in each system. The scribe at each table should record your response. You can list more than one system or flaw for each paragraph.

Flaw(s)	System(s)	Subsystem(s)
a.		
b.		
c.		
d.		
e.		
f.		
g.		
h.		

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Summary: Systems of Safety

1. Proactive Systems of Safety are the key to preventing disasters and injuries.

2. Major Systems of Safety include:
   - Design and Engineering;
   - Maintenance and Inspection;
   - Mitigation Devices;
   - Warning Devices;
   - Training and Procedures; and
   - Personal Protective Factors.

3. The Design and Engineering System can provide primary prevention by eliminating the possibility of a serious accident.

   The other Systems of Safety provide secondary prevention by reducing the probability or severity of an accident.

4. Each plant may have different structures and names for its Systems of Safety, but all plants have Systems of Safety.

5. Active worker and union involvement in Systems of Safety are essential for these systems to be effective.

6. Understanding the hierarchy of systems of safety (with Design as the primary system) enables workers to become active participants in developing and implementing safe work practices (training and procedures).

7. The most effective controls of health and safety hazards are those which are integrated or designed into the process, such as engineering controls.

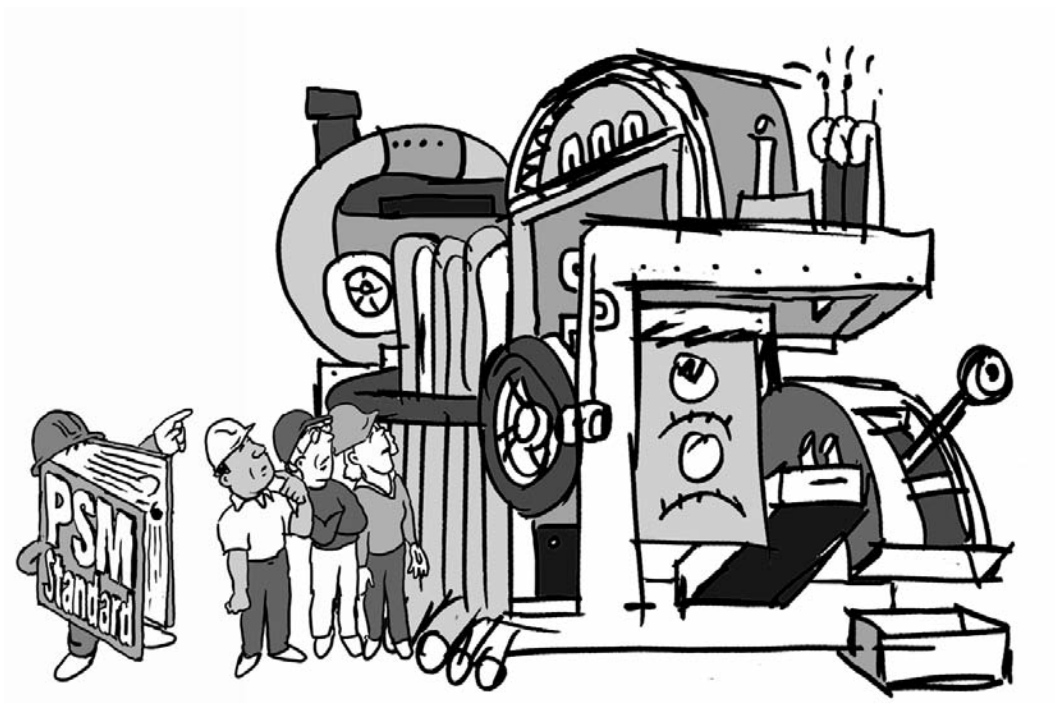
Activity 3: Mechanical Integrity

Purpose

To become familiar with the OSHA performance-based requirements for a plant “mechanical integrity” program.

To examine the causes and solutions of “breakdown” maintenance.

This Activity has two tasks.



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Task 1

Factsheet Reading Method for Task 1.

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Factsheet #1
Maintenance Myths Most Often Heard

Here are some commonly-used excuses for not following safe mechanical integrity practices and examples of the consequences of not doing so:

It's only temporary:

A leak developed on one of the six in-line reactors. All six were connected with 28-inch diameter pipes and expansion bellows. The leaking reactor was bypassed with a 20-inch pipe with two elbows and the expansion bellows were left intact.

The pipe was not supported properly; it was resting on scaffolding. Because of the bellows, it was free to rotate or "squirm" and in the process it failed, killing 28 people and destroying the plant.

It's ready to go:

A pump was being removed for repair. When the case bolts were being removed, benzene started spraying and an explosion followed, killing one new employee and burning others. There were no blinds installed; they were relying on block valves to hold.

It's factory set; no need to test it:

In an automatic fire-fighting system, a small explosive charge cut a rupture disc and released the fire-fighting agent, Halon. The manufacturer said it was not necessary to test. To test would require the loss of the Halon, which was very expensive.

The buyer insisted on the test even with the added expense. The smoke detectors worked; but when the explosive charge was activated, the rupture disc was not activated. The manufacturer was in error.

Sources: Accident at Amoco Chemicals related by Glenn Erwin, Health and Safety Coordinator, OCAW (now USW); and Trevor A. Kletz, *What Went Wrong? Case Histories of Process Plant Disasters*, Houston: Gulf Coast Publishing Company, Second Edition, November 1989.

Factsheet #2
More Maintenance Myths

It's a diesel, so it's explosion proof:

Flammable hydrocarbon leaked while maintenance was being performed. A diesel engine operating in the area began to race. The driver tried to stop it by isolating the fuel supply, the usual way to stop a diesel engine, but without success. The fuel was being sucked into the air intake. Finally a flashback occurred and the hydrocarbon ignited, killing two workers.

Go ahead and use this one; it'll work:

- A carbon steel valve was painted with aluminum paint instead of using a stainless steel valve. It corroded rapidly.
- A leak on a refinery pump, which was followed by a fire, was due to incorrect hardness of the bolts used by the manufacturer.
- Checks carried out on the materials delivered for a new ammonia plant showed that 5,480 items (1.8 percent of the total) were delivered in the wrong material.
- The wrong electrodes had been used for 72 welds on the tubes of a fired heater.

I don't need an operator; I'm just going to look:

A maintenance foreman was asked to look at a faulty cooling water pump. He decided that, to prevent damage to the machine, it was essential to reduce its speed immediately. He did so, but did not tell any of the operators. The cooling water rate fell; the process was upset; and a leak developed on a cooler.

Don't worry, Charlie, it's on computer control:

In 1983, the Russians shot down a Korean Airlines aircraft which had strayed off course. It is believed to have been off-course because the wrong data (longitude) had been entered by the engineer into the navigation system. There were 269 people killed.

Sources: Accident at Amoco Chemicals related by Glenn Erwin, Health and Safety Coordinator, OCAW (now USW); and Trevor A. Kletz, *What Went Wrong? Case Histories of Process Plant Disasters*, Houston: Gulf Coast Publishing Company, Second Edition, November 1989.

Factsheet #3
Work Order Backlog: #1 Warning Sign

Most companies have in writing very good preventive maintenance (PM) plans on equipment. But in reality, as the work orders pile up, they are unable to keep their PMs caught up.

According to a spot survey of a typical plant employing approximately 100 maintenance employees, there was a backlog of 1,045 work orders.

To make matters worse, preventive maintenance work orders are usually treated as having a lower priority than most work orders.

The problem is compounded by the fact that most companies do not employ enough maintenance workers to stay on top of the regular work orders, much less the PMs.

A huge backlog of work orders is a sign that the Mechanical Integrity (MI) program is not doing what it is intended to, and it may be considered a violation of the performance-based PSM Standard.

Factsheet #4
If It Ain't Broke . . .

Many organizations consciously decide to Run to Failure (RTF). RTF is rarely less costly than preventing failure. An organization that manages using RTF twists the old cliché, "If it ain't broke, don't fix it." Unfortunately, this approach can lead to catastrophe.

"An ounce of prevention is worth a pound of cure" is a better maxim:

- A $10 seal may wind up costing thousands of dollars, not to mention death and injury.
- The normal rule of thumb is that corrective (breakdown) costs are four to five times more expensive than preventive costs.

Source: *Total Productive Maintenance*, Marshall Institute, Inc. (2900 Yonkers Road, Raleigh, NC).

Factsheet #5
Understaffing Leads to Problems: A Case Study

During testimony on the PSM Standard, one OCAW (now USW) member described some of the effects that the reduction of maintenance workers had at his plant.

Maintenance staff cut in half:

"The staffing of the Mobil Beaumont refinery has steadily decreased in the past ten years. **The Beaumont refinery had over 2,000 hourly employees, of which 1,200 were permanent maintenance employees when I went to work there 20 years ago. We now have less than 600 maintenance workers."**

The effects don't hit you overnight:

"Maintenance workforce reductions are not something that hit you overnight. The effects are gradual; but as time marches on, the reductions become more and more obvious."

"Running maintenance today in both quality and quantity is much worse than 10–15 years ago. Pumps and compressors are not maintained. They cannot be properly maintained when the people are not there to do the work."

The potential for disaster is present:

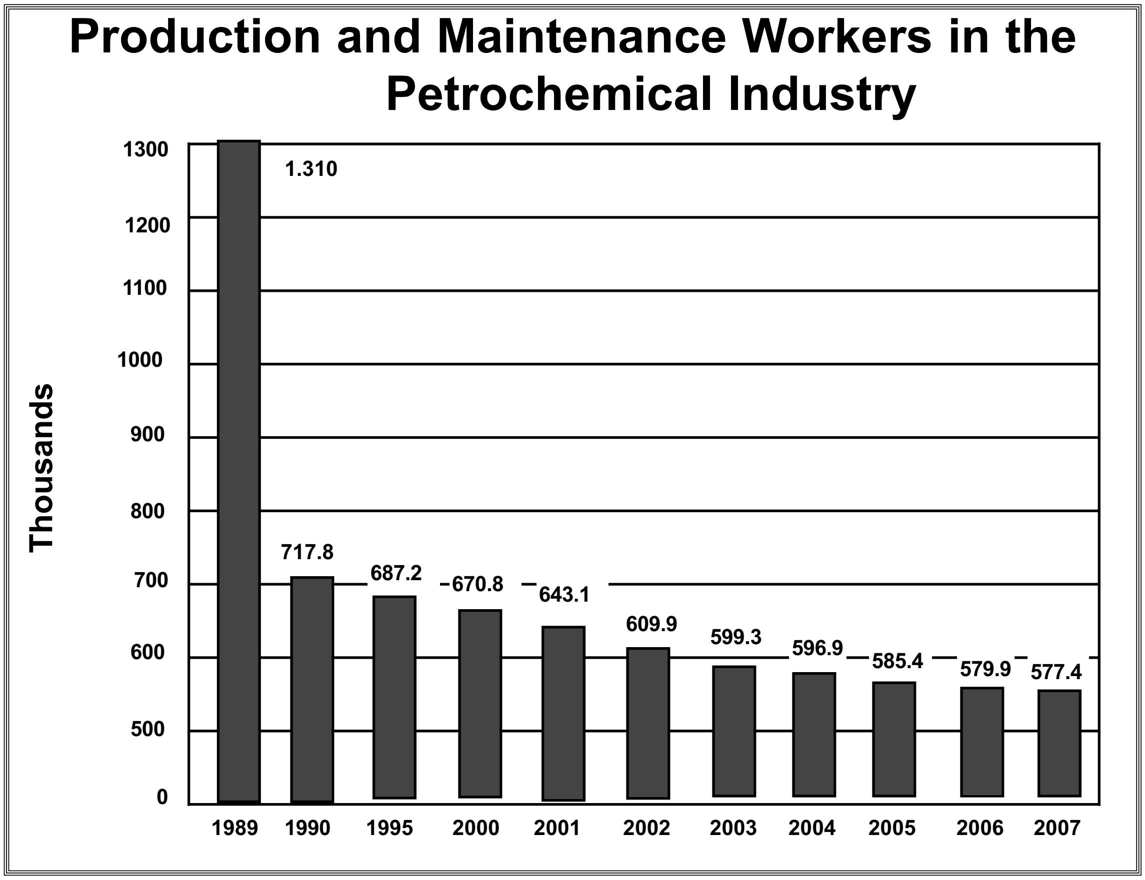
"Leaks of all sorts: oil, chemicals, which include toluene, ketone, etc., are not addressed in a timely manner. **The limited amount of maintenance people are kept busy doing work necessary to maintain production; and the less important problems, in the company's judgment, are left unattended."**

Years after this 1991 testimony, the problem of understaffing and related extended working hours was highlighted by the U.S. Chemical Safety and Hazard Investigation Board (CSB) in their 2007 Investigation Report of the March, 2005, BP refinery explosion and fire in Texas City. The incident occurred during the startup of an isomerization (ISOM) unit when a raffinate splitter tower was overfilled. Among the underlying factors the CSB identified that resulted in overfilling the tower was "ISOM operators were likely fatigued from working 12-hour shifts for 29 or more consecutive days."

Source: Testimony given before OSHA from OCAW (now USW) member Jimmy Herrington, Local 4-243, February 24, 1991 [Emphasis added.]; U.S. Chemical Safety and Hazard Investigation Board's *Investigation Report: Refinery Explosion and Fire*, Report No. 2005-04-1-TX, March, 2007.

Factsheeet #6
Maintenance Downsizing

The number of production and maintenance workers in the petrochemical industry has been dropping since 1989.



But, along with these workforce reductions came an increase in production.

Industrial Production Indexes (1997 = 100)

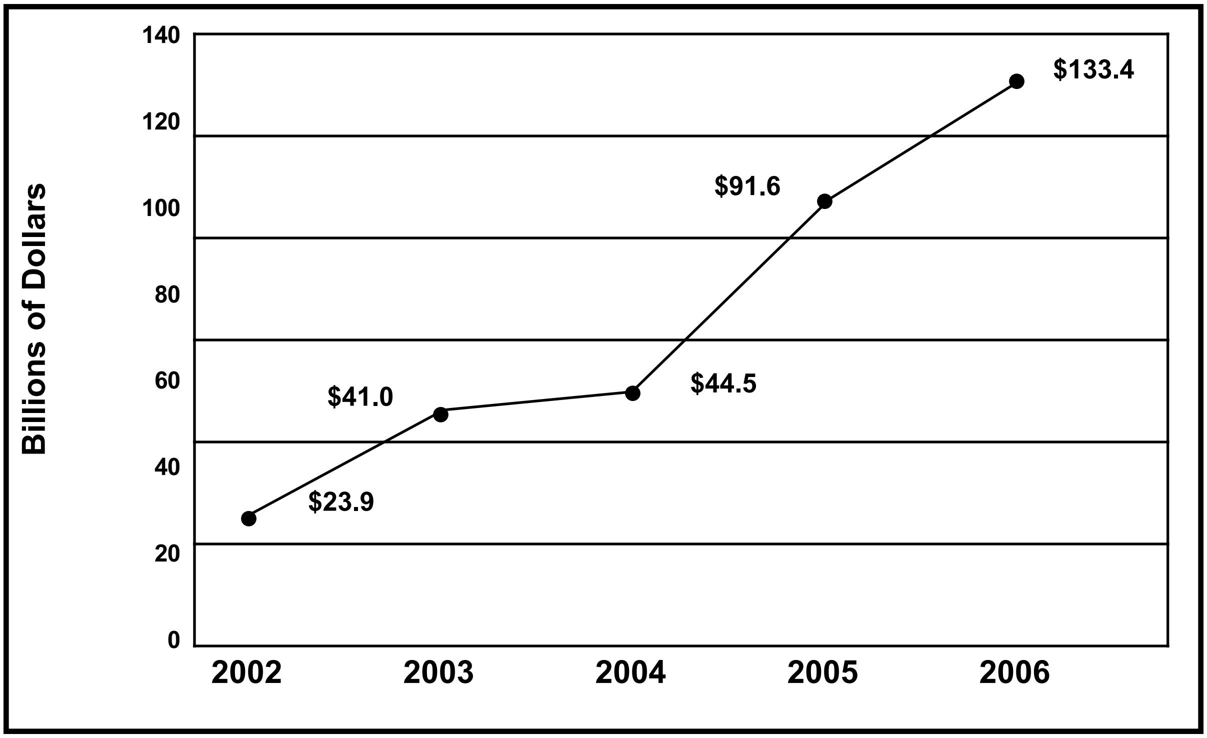
Year	Petroleum and Coal Products	Chemicals
1990	86.9	86.7
1995	89.8	92.5
2000	96.9	105.3
2001	101.4	103.4
2002	105.9	107.9
2003	106.0	107.2
2004	109.7	110.3
2006	110.0	108.0
2006	110.3	110.3

continued

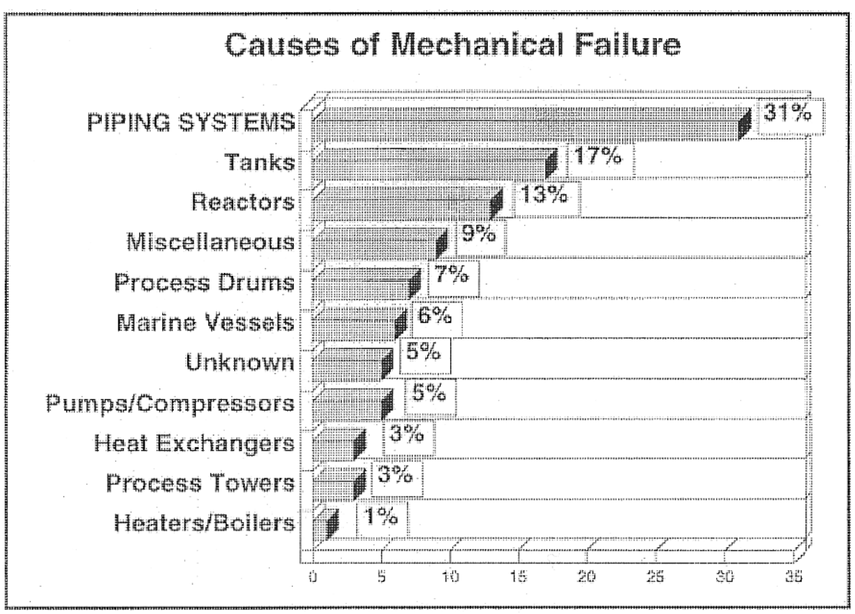
Sources: U.S. Department of Labor, *Handbook of Employment and Earnings U.S. Labor Statistics*, ninth edition, Lanham, MD: Bernan Press, March 2008; and U.S. Census Bureau, *Statistical Abstract of the United States*: 2006.

Factsheeet #6
Maintenance Downsizing *(continued)*

While the results have included soaring corporate profits.



They have also included mechanical systems failing:



Sources: U.S. Department of Commerce, Survey of Current Business, June issues; and Garrison, W. E., PE, *Large Property Damage Losses in the Hydrocarbon-Chemical Industries: A Thirty-Year Review*, Twelfth Edition, Chicago: Marsh and McLennan Protection Consultants.

Factsheet #7
Longer Time between Turnarounds Leads to Danger

Prior to the 1970s, the average length of time between turnarounds was one year. Now this period is much greater, with the duration between turnarounds sometimes as long as five years. This longer length of time means that some equipment, which can only be repaired when the unit is shut down, has to wait.

A typical result of long turnaround times is that process units are run under dangerous conditions that would not have been acceptable years ago. A true life example is told in the "calculated risks" story below:

The Calculated Risks:

> "A[n] . . . example of calculated risks occurred prior to a scheduled turnaround on the FCC. This fluid catalytic cracking unit had turnarounds put off time and again, because corporate needed it to meet gasoline demands. The expansion joint . . . was found to have a hole in it. The company dealt with this by installing a camera on the expansion joint so the operator could monitor the hole. The unit should have been shut down. It would have been shut down ten years ago; however, a decision was made to continue running the unit despite the potential of very radical consequences."

Source: OCAW (now USW) member Jimmy Herrington, Loca1 4-243, testimony before OSHA, February 24, 1991.

Task 1 *(continued)*

Purposes Restated:

To become familiar with the OSHA performance-based requirements for a plant "mechanical integrity" program.

To examine the causes and solutions of "breakdown" maintenance.

Scenario:

During the night shift on unit "A" at OilChem, the process operator, Debbie, noticed a severe vibration on E-101 "G" air-cooled exchanger. She radioed the control room and asked the Board Operator, Jim, to write a work order to get the bearings replaced.

Jim filled out the work order and gave it to his Foreman, Bob.

Bob made a notation in the unit log book that the bearings were bad and forwarded the work order to the unit supervisor for approval. Bob and his crew were finishing up their night rotation and were starting their days off.

When Ernest, the Unit Supervisor, arrived on the day shift, he assigned it a priority "2" (complete within a week) because it was cool outside and he knew they could run without it. Besides, the maintenance crew was already busy repairing the centrifuge which was a priority "1" (overtime authorized).

At 3:00 a.m. on the following day, the bearing failed on E-101 "G" causing such a vibration that a pressure gauge leaked, causing a fire.

During the investigation that followed, it was found the vibration switch had failed to trip the fan off the line. It had been wired wrong, probably since the time of installation.

Task:

List ways this fire could have been prevented.

Task 2

Factsheet Reading Method for Task 2.

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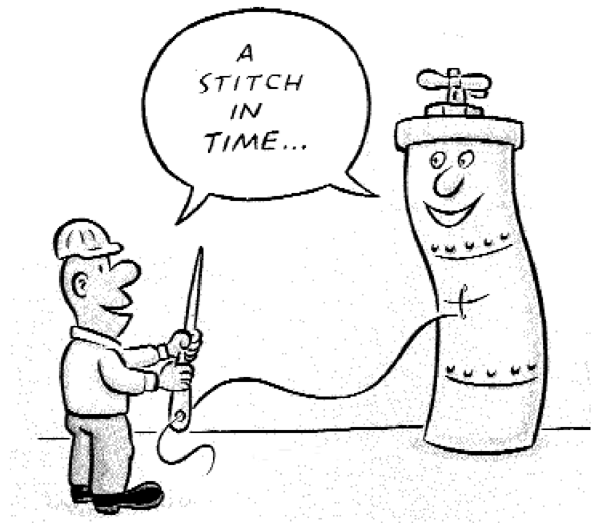
Factsheet #8
What the Standard Covers

The requirements of the Standard apply to six specific types of process equipment where failure is likely to be catastrophic.

These types of equipment, used in the handling of highly hazardous chemicals are:

1. Pressure vessels and storage tanks;
2. Piping systems (including valves and other components);
3. Relief and vent systems and devices;
4. Emergency shutdown systems;
5. Controls (monitoring devices and sensors, alarms and interlocks); and
6. Pumps.



Source: OSHA Process Safety Management Standard 29 CFR 1910.119, 57 FR 6406, February 24, 1992.

Factsheet #9
The PSM Standard Is a Performance-based Standard: A Review from Activity 1

Performance-based Standard:

The PSM Standard is a performance-based standard. That means it is goal-oriented and the effectiveness of a certain program is what to look for. The specifications are not spelled out, just the desired results.

It gives each facility flexibility to design their program to match their needs as long as the outcome prevents or minimizes spills, fires and explosions.

Specification-based Standards:

Some OSHA standards are specification-based standards. That means they give exact rules for compliance such as height of a guard rail, lengths of pipe, exact limits of exposure, etc.

Your work experience is your guide:

Another way to understand the accident prevention requirement of a performance standard is to think in terms of our five senses. We can look and listen for hazards; we can feel for vibrations and smell for leaks; and, at times, we may even be alerted by our sense of taste. But the most important sense we bring to the job is our work experience; in other words, our horse sense.

The question you should ask yourself when reviewing your company's PSM program is:

Will this program, as it is written and applied, help to prevent accidents? If the answer is "no," then the company is not complying with the spirit and intent of the law.

For example, if management develops a preventive maintenance program (PM) but assigns the PM work orders the lowest priority, your work experience tells you that there is really no PM program at all.

Factsheet #10
Why Preventive Maintenance?

It's the Law!

OSHA: The recent OSHA law is fully enforceable and violators are subject to fines and jail time.

EPA: The Environmental Protection Agency has rules to cover preventive maintenance programs within its Risk Management Plan proposal.

If You Don't, It Costs $$$.

The BP Texas City refinery explosion and fire in March 2005, is a painful example of the cost of failing to perform preventive maintenance. This disaster happened in part because several instruments were out of service and the operators had no way of knowing that a critical unit was being overfilled with highly flammable liquids. Timely and proper maintenance might have saved the lives of 15 workers and prevented another 180 from being injured. It also might have saved BP from financial losses that have thus far totaled over $1.5 billion.

It Pays.

According to some corporate managers, there are some very positive benefits from Process Safety Management:

> "Process safety management is intended to help you recognize, understand and control all your process hazards. If you do that, you're going to understand and control your business; it runs better . . . it's more efficient and your quality's higher."

continued

Factsheet #10
Why Preventive Maintenance? *(continued)*

Remember, this is a performance-based standard. It does not spell out the specifics, just the desired results. The goal or desired results of the Mechanical Integrity (MI) element of the Standard is designed to prevent accidents through the proper maintenance of equipment. Common sense and experience are important tools that we can use when determining whether or not an MI system is fulfilling the intent of the PSM Standard.

Sources: *Federal Register*, Vol. 58, No. 201, October 20, 1993; Ray Brandes, retired director of safety for ICI Americas; and U.S. Chemical Safety and Hazard *Investigation Board Investigation Report: Refinery Explosion and Fire*, Report No. 2005-04-1-TX, March 2007.

Factsheet #11
A Look at the List

This list illustrates just a few examples of the human cost to both workers and the community caused by industry's failure to properly maintain process equipment.

Piping: (Internal Corrosion of Overhead Piping)

May 5, 1988 — An explosion and fire at a Shell Oil Refinery in Norco, Louisiana, killed seven OCAW (now USW) Local 4-750 workers and injured 22 others. Some 2,500 residents had to be evacuated from nearby areas.

Vessel Failure: (Reactor)

August 1992 — Three workers were injured and a group of motorists suffered respiratory injuries from ammonia inhalation when an explosion ripped through the Arcadian Chemical Corporation in Lake Charles, Louisiana.

Equipment Failure: (Air Fin Exchanger)

October 1992 — An explosion at the Texaco Refinery in Wilmington, California, injured 16 workers and required the evacuation of residents within a one-mile area when an air fin exchanger failed due to unmonitored corrosion.

Wrong Piping: (Feed line elbow)

August 2, 1993 — A fire at a Baton Rouge, Louisiana, refinery occurred when an elbow made of carbon steel instead of the required chrome alloy steel ruptured. Damage was estimated at $48 million.

Overfilled vessel: (Blowdown drum)

March 2005 — A blast at the BP Texas City refinery which killed 15 and injured 180 people followed budget cuts of 25 percent from 1998 to 2000 at the plant. A blowdown drum overfilled and alarms and gauges that were supposed to warn of the problem did not work properly.

Factsheet #12
Mechanical Failure, Largest Cause of Loss!

A 30-year study of accidents in the petrochemical industry revealed that incidents which resulted in "large property damage losses" were most often caused by mechanical failure in the process equipment (41 percent of the time). The most recent update of this study shows piping failures and leaks; cryogenic plant equipment failure; and weather conditions as major causes.

Source: Garrison, W. E., PE, *Large Property Damage Losses in the Hydrocarbon-Chemical Industries: A Thirty-Year Review*, Twelfth Edition, Chicago: Marsh and McLennan Protection Consultants; and *The 100 Largest Losses*: 1972-2001, Twentieth Edition, 2003.

Factsheet #13
But Surely All Employees Receive the Same Company Safety Training!

After the Phillips 66 Houston Chemical Complex explosion in 1989, which killed 23 workers and injured 232 others, OSHA commissioned a team of experts to study the use of contractor labor in the petro-chemical industry. One of the main concerns of the study (called the John Gray Report) was to determine the extent and type of health and safety training that contract workers received.

The survey conducted for the John Gray Report showed that only 62 percent of contract workers reported that they received nine or more hours of company training in the last year, whereas 81 percent of the direct hires reported nine or more hours of training.

This finding led to the following comment in the report:

> " . . . the quality of the labor force in this industry is declining and the number of employees who are associated with higher accident rates (younger, less tenure, less education) is increasing. One implication of this is obvious: The need for increased education and training investments in this workforce is substantial."

Source: John Gray Institute, *Managing Workplace Safety and Health: The Case of Contract Labor in the U.S. Petrochemical Industry*, Lamar University System, July 1991, p. 77.

Factsheet #14
Training Is Inadequate

Another flaw in mechanical integrity programs is that most training is inadequately suited to the complexity and responsibilities required of the job.

Two common approaches are used to training in industry:

1. "Some companies have hired consultants at great expense to set up a training program. They have written elaborate programs that assume employees know nothing and teach them every skill they feel should be known. I have heard of a 30-year machinist sent to school for four hours to learn how to read a rule. This is a waste of money and very degrading to the employees."
2. "Other companies refuse to spend anything on training so they show a 30-minute videotape followed by a short lecture and call you trained. The employees are on their own to learn and it really shows."

Source: Glenn Erwin, Health and Safety Coordinator OCAW (now USW), presented to OSHA, VPP Conference 1993, San Antonio, Texas.

Factsheet #15
OSHA's Elements for an MI Program

According to OSHA, the necessary elements of a good mechanical integrity (MI) program are:

- Establish and implement written procedures to maintain the integrity of process equipment.
- Train employees and contractors involved in maintaining the integrity of equipment.
- Perform periodic inspection and testing, following "recognized and generally accepted good engineering practices (RAGAGEP)" and document that inspections have been done.
- Correct equipment deficiencies before further use or in a safe and timely manner.
- Develop a quality assurance program to ensure that:
    - o Equipment for new plants is suitable for use in the process, and is properly installed;
    - o All maintenance materials, spare parts and equipment are suitable for intended use.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Task 2 *(continued)*

Purposes Restated:

To become familiar with the OSHA performance-based requirements for a plant "mechanical integrity" program.

To examine the causes and solutions of "breakdown" maintenance.

Answer the following questions:

1. List the ways in which mechanical integrity has improved or declined in your plant.

2. Using the performance-based analysis (see Factsheet 9) list some of the ways that you think the PSM Standard could help resolve the mechanical integrity problems in your plant.

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Summary: Mechanical Integrity

1. Preventive maintenance programs should be established, funded and staffed to sufficient levels to avoid the need for "breakdown" maintenance.
2. Turnarounds need to be held often enough to avoid "breakdown" maintenance. Units need to stay down until scheduled repairs are completed.
3. All maintenance work should be performed by trained and experienced craftsmen.
4. Requirements for, and documentation of, contractor training should be equivalent to that of regular employees.
5. All maintenance work must be done using proper equipment, installation procedures, safety devices and according to applicable codes and standards.
6. The consequences of not having a good mechanical integrity program can be devastating to us and our fellow workers.
7. Having a comprehensive written mechanical integrity program which is not followed is the equivalent of having no program at all.
8. If your workplace frequently experiences "breakdown" maintenance your mechanical integrity program is not working.

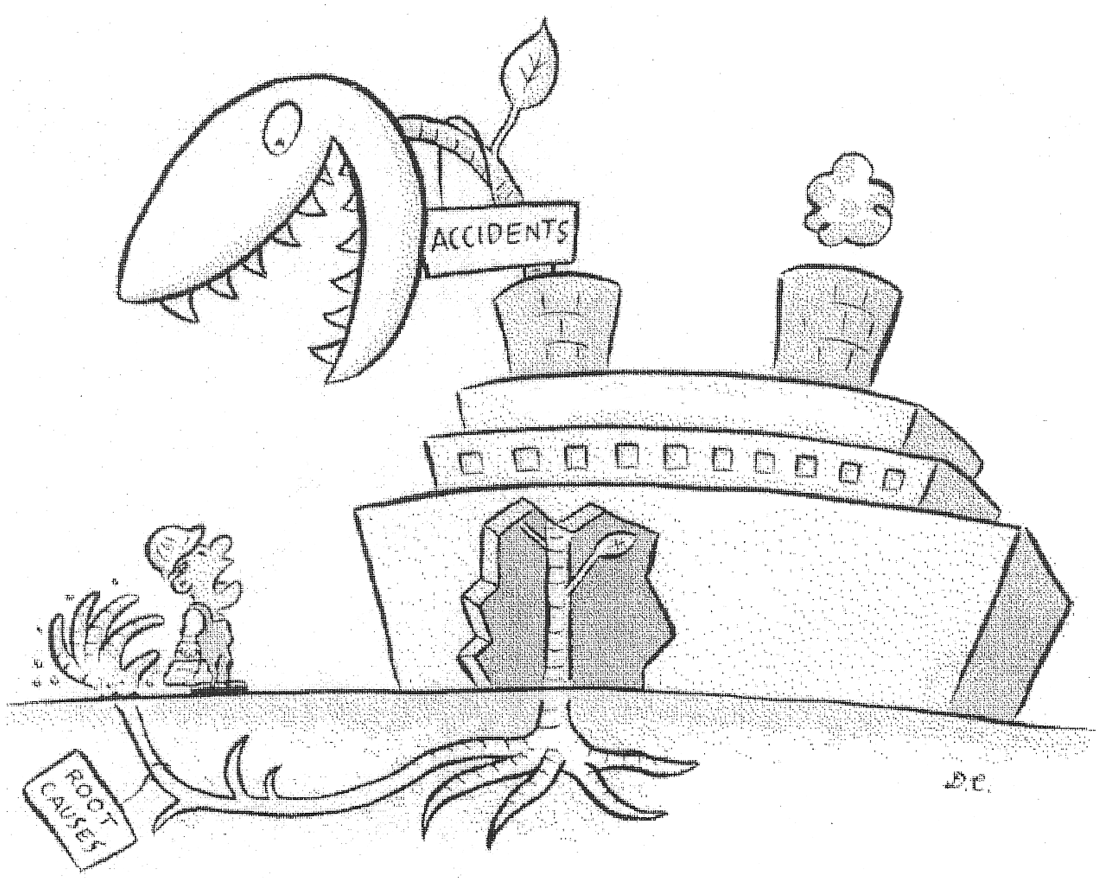
Activity 4: Incident Investigation

Purpose

To learn about conducting accident, incident and near-miss investigations, focusing on root causes.

To determine what constitutes a good investigation team.

This Activity has three tasks. Each task is designed to build on the one before it.



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Task 1

Factsheet Reading Method for Task 1.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a scribe for this task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 1 to 6. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5; the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 6 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (1 through 6), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet #1
The Best Time To Investigate Is Before the Incident!

When the sirens blow and ambulances roll, it’s pretty obvious that an investigation is needed. Unfortunately, the injuries and the damage have already happened. How much better would it be if we could investigate and correct hazards before the major events happen?

Warning signs are all around us. We call them, “close calls,” “dings,” “fender benders” and “thank goodness no one was there” moments. They are the near-misses and minor incidents that foretell major events.

These events must be actively sought out so your investigators can go to work. All employees should be trained to recognize and encouraged to report such events. A system must be put in place to analyze these reports and flag those with potential for more serious harm.

OSHA’s PSM Standard (29 CFR 1910.119, Section m) states,

> “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.”

Let’s fix the hazard before it hurts!

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119(m), 57 FR 6356, February 24, 1992.

Factsheet #2
OSHA Requires a Comprehensive Investigation

The Process Safety Management Standard requires the following regarding incident investigation:

1. An investigation shall be initiated as soon as possible, but no later than 48 hours following the incident.
2. An incident investigation team shall be established and shall include:
   - At least one person with knowledge about the process involved.
   - A contract employee if the incident involved work of the contractor.
   - Other persons with knowledge and experience to thoroughly investigate and analyze the incident.
3. A report will be prepared which includes:
   - Date of incident;
   - Date investigation began;
   - Description of incident;
   - Factors that contributed to the incident; and
   - Recommendations from the investigation.
4. The Employer is required to establish a system to promptly address the incident report findings and recommendations, documenting all resolutions and corrective actions.

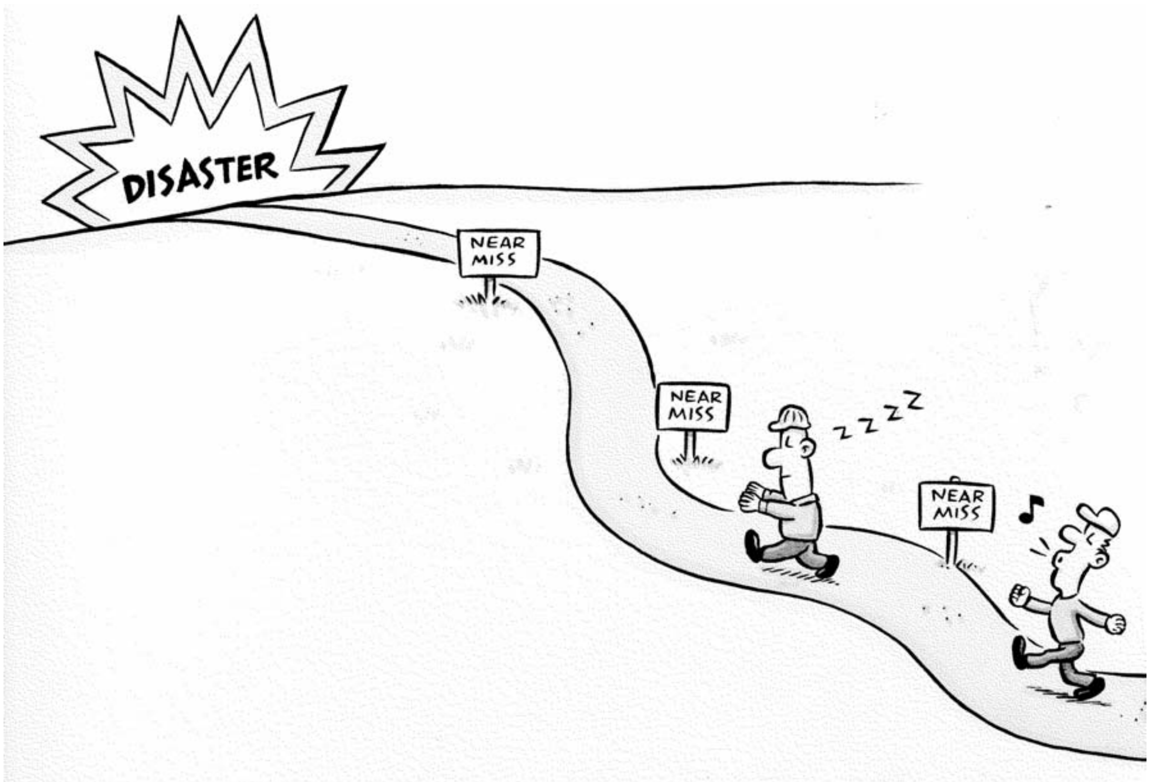
5. Incident reports shall be reviewed with all affected personnel whose job tasks are relevant to the investigation, including contract employees, where applicable.
6. Reports shall be retained for five (5) years.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119(m), 57 FR 6356, February 24, 1992.

Factsheet #3
Investigate "Near-misses" — Help Avoid Disasters

Disasters are usually preceded by warnings.

These warnings are serious incidents or "near-misses" that tell us something is wrong.



Factsheet #4
The Best Investigation Team Is at the Site

OSHA states in the non-mandatory appendix that:

- Employers need to develop in-house capability to investigate incidents that occur at their facility.
- 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-skilled 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 members of the team.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992, Appendix, p. 6415.

Factsheet #5
Elements of a Good Incident Investigation Agreement

The best time to decide how to handle a situation is rarely at the moment it happens. The same is true for putting together a joint investigation process. Coming to a joint agreement (in writing) on all aspects of investigation, well before any investigation has to take place, will head off major problems for both union and management in the future. Here are some things to consider:

- What is the make-up of the team?
- How are members selected? (The union should select the hourly members and management select salaried members.)
- How and under what conditions can they be replaced?
- How will members be compensated? Relieved from regular work duties?
- How will members be notified of an incident? (Call in? Notice given within a specified amount of time?)
- Definition of events to be investigated. (Consider automatic triggers such as an injury, fires requiring ER response, etc.)
- Who can call for an investigation in less clear cases? (Any investigator? Union and company chairs of team? Union president and plant manager?)
- How to ensure that the investigation will identify root causes of an incident/accident or near-miss and not blame workers.
- How recommendations that come from the investigation will be tracked until completed.

Factsheet #6
Joint Health and Safety Committees Are a Ready-made Team

The Joint Health and Safety Committee can be a ready-made team to investigate, allowing the company and union to substitute those with a unit or specific knowledge, as prescribed in the Standard.

As a member of an investigation team you will need:

Training:

- Techniques of investigation;
- How to conduct interviews of witnesses;
- How to compile pertinent documentation; and
- Report writing.

Time:

Committee members will need the necessary time to fulfill their duties. Great pressure is placed on committee members from two areas because of the time needed.

- Immediate supervisor: How often have you heard "not another meeting" from your foreman? Management must make the priority of investigations clear to first-line supervisors.
- Coworkers: When committee members are taken away from their normal work duties among the other workers, it can cause resentment. In the short term, Union leadership needs to make sure the members recognize the value to the union when coworkers are involved in investigations. In the long term, the best way to deal with this problem is to ensure adequate staffing so that excessive workloads don't result for those left on the job when some members are involved in these investigations.

Task 1 *(continued)*

Purposes Restated:

To learn about conducting accident, incident and near-miss investigations, focusing on root causes.

To determine what constitutes a good investigation team.

Scenario:

During the startup of T-111 (dehydro tower), a relief valve lifted and sprayed the process operator, Joe, with heating oil. Fortunately, the oil was not up to temperature and he was not seriously hurt.

Connie (the board operator) gave the following statement before she left on vacation:

> "I was working the board that night. We were ready to start up the dehydro tower T-111, so I opened the control valve; but I didn't see any flow recorded or temperature increase. I called Joe and asked him to check the system out. I saw the flow startup then fall right back off. Joe started hollering on his radio that he needed some help. I could tell by his voice something was wrong. Pat was right beside me in the control room and he ran out immediately. Pat radioed back in and said Joe had been sprayed with heating oil and he was taking him to shower. I did as I was told; that is all I know."

Joe was the outside operator and Pat was the foreman.

Task:

Using the scenario, the diagram on the next page and the factsheet for hot oil on page 137, answer the following questions:

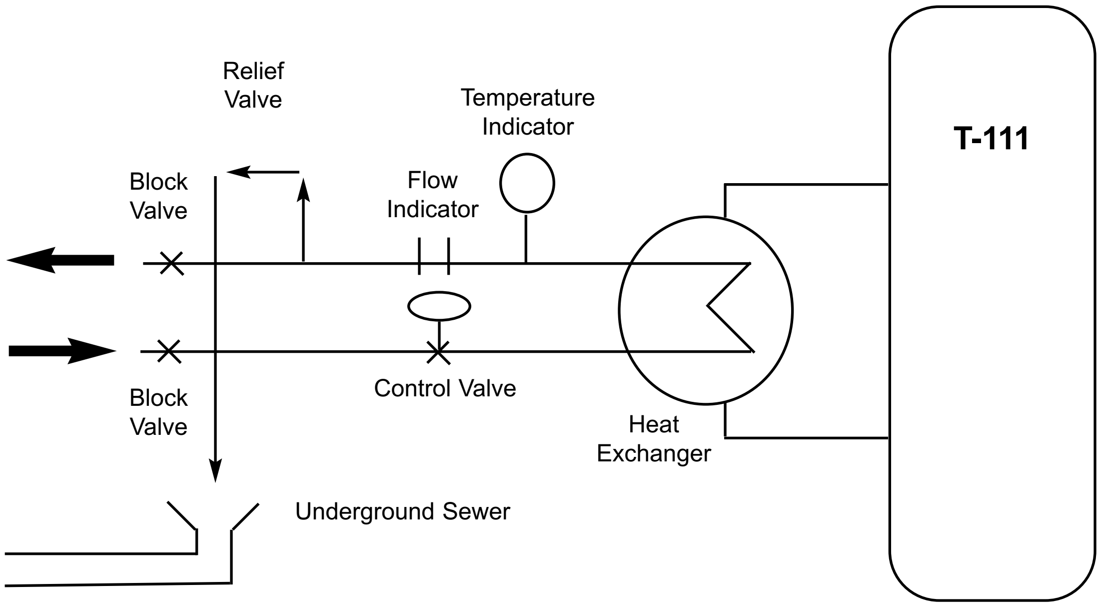
1. Does this incident require an investigation? Why or why not? If so, how soon should it be investigated?

2. According to the OSHA PSM Standard, is a worker representative required to be a member of the investigation team? In your opinion, what does a good investigation team look like?

3. How are incident investigations conducted in your plant? Who is on the team?

continued

Task 1 *(continued)*



Chemical Factsheet for Hot Oil	
Product Name	OilChem Hot Oil #1.
Application and Use	Premium quality heat transfer oil for open and closed systems.
Product Description	Mixture of saturated and unsaturated hydrocarbons derived from paraffinic distillate.
Emergency 24 Hr.	(454) 555-help
Regulated Components	Not Applicable.
Physical & Chemical	Physical state: Liquid Spec Gravity: 0.880 at 15.5º C Viscosity: 28.00cst at 40º C Boiling Point: 293º C Odor Threshold: not available Appearance: Yellow oil
Health Hazard	Negligible at normal temp (up to 38º C).
Eye Contact	Irritation, but will not injure tissue.
Skin Contact	Prolonged contact may irritate the skin.
Ingestion	Low toxicity.
First Aid Measures	
Eye Contact	Flush eyes with large amount of water.
Skin Contact	Wash affected area using soap and water.
Ingestion	DO NOT induce vomiting. Get medical help.

Task 2

Factsheet Reading Method for Task 2.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a new scribe for this task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand for the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 7 to 11. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 7 and 11; the person to their left will be responsible for Factsheet 8, etc. The numbers that you have assigned yourself correspond to Factsheets 7 through 11 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (7 through 11), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet #7
Active Listening Is the Key to a Good Investigation

> "You start a question, and it's like starting a stone. You sit quietly on the top of a hill: and away the stone goes, starting others."
>
> -Robert Louis Stevenson

A good first question is:

> "Can you tell us what happened?"

It is almost impossible to find all the information by asking a set of specific questions. As the person tells their version of the accident or incident, listen very carefully!

As their viewpoint is expressed, new questions are raised and will need to be addressed.

Tips for a Group Interview:

- Discuss potential questions before the witness arrives.
- Appoint main speaker for the group.
- Talk to witnesses as soon as possible.
- Explain purpose; try to put witness at ease.
- Let witness speak freely, but try to keep on track.
- Ask open-ended questions that allow the witness to fully describe the events, details and sequences as he or she saw them. "What happened next?" and "What did you hear?" are examples of open-ended questions.
- Take notes — a tape recorder is not recommended.
- Identify in notes parts of testimony that were personally witnessed and parts that are hearsay.

Source: OSHA Training Institute's Advanced Accident Investigation (Course #202).

Factsheet #8
A Good Investigation Avoids Hasty Conclusions

During your investigation interviews, an often-used second question is: "Can you explain to us a little more about . . .?"

Phrase each question so it will allow for the most information possible. Avoid questions that can be answered "Yes" or "No."

When they have finished their response, give them three or four seconds before asking the next question. This allows them to expound further if they need to and they do not feel rushed.

If a person feels rushed, they will only give you the high points of the facts. We are looking for in-depth answers.

> "The worst mistake an investigator can make is to jump to conclusions. You must be sure not to develop tunnel vision and fail to explore all possibilities."

Source: Interview with Steve Wodka, attorney specializing in workers injured on the job.

Factsheet #9
Was This Accident Predictable?

In each investigation, be sure to determine if anything has ever happened similar to this occurrence.

A wise person once said: "If we do not learn from our mistakes of the past, we are doomed to repeat them."

Many times this is true within the petrochemical industry. Those who have worked in a plant for several years have seen things repeated all too often.

This will be especially helpful during the recommendation phase of the investigation.

It may point to even larger system problems.

Factsheet #10
Keeping an Accurate Record Is Important

One of the most important things all members of the committee can do is take notes!

An experienced member of several investigations tells of his committee's favorite approach to note taking.

> "Every member of the committee is assigned the job of taking notes. When we start the interview, we have a lead person to begin. Their job is to set a relaxed atmosphere."
>
> "They are not required to take notes while asking questions; all of the other committee members take notes."
>
> "After the lead person is finished, other committee members are asked if they have any questions. As they talk to the one being interviewed, the rest of the committee members continue to keep notes."
>
> "This keeps the person at ease because the one asking the questions is able to look at them and make it more personal."
>
> "We do not use a tape recorder because we feel it makes most people uncomfortable and less apt to give their true and open thoughts about what happened."

Source: Interview with former OCAW (now USW) member Bob Hill, Local 4-449.

Factsheet #11
Preparation = Information

Before you arrange interviews with the affected or injured parties, be sure to collect all the pertinent information available.

MSDSs should be requested and reviewed. You will need to know what was being worked with if a chemical was involved.

P&IDs (Process and Instrumentation Diagrams) should be gathered by someone from the area and reviewed with the team members.

Field sketches should be made as soon as possible, detailing all relevant information.

Standard Operating Procedures are used for most jobs and will give you some insight into the normal procedure.

Process Safety Information is required under paragraph (d) of the PSM Standard to be available prior to conducting a process hazard analysis on any unit. This information can be of great benefit to the investigation team.

The more you understand the area, background or process, the smoother the investigation will go.

A Checklist for Fact Finding:

- Visit the scene before it is disturbed.
- Sample unknown spills, vapors, residues, etc.
- Prepare visual aids — photographs, sketches, maps, etc.
- Interview witnesses ASAP, privately, away from other witnesses.
- Check out equipment as it is disassembled.
- Review all information sources.

continued

Factsheet #11
Preparation = Information *(continued)*

- Preserve or document incident-related items such as failed equipment; and
- Document sources of information in report.

Develop a "time line" of events which occurred before, during and after the incident.

Task 2 *(continued)*

Purposes Restated:

To learn about conducting accident, incident and near-miss investigations, focusing on root causes.

To determine what constitutes a good investigation team.

Your task will be to interview the supervisor and the operator. Your two instructors will assume the roles of Joe and Pat.

In your group, review the scenario on page 134 and refer to Factsheets 7 through 11. Then develop a list of questions you would like to ask.

Each table will be allowed to ask one question, then one follow-up question. After that, we will move to the next table on a rotational basis until you have completed all of your questions.

Questions for Joe:

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

Questions for Pat:

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

continued

Task 2 *(continued)*

Develop a list of who else you would want to interview or re-interview.

1.

2.

3.

Interview Worksheet

Notes from interview with Joe:

Notes from interview with Pat:

Task 3

Factsheet Reading Method for Task 3.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a new scribe for this task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 12 to 15. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 12; the person to their left will be responsible for Factsheet 13, etc. The numbers that you have assigned yourself correspond to Factsheets 12 through 15 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (12 through 15), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet #12
Why Finding the Root Cause Is Important: A Review from Activity 2

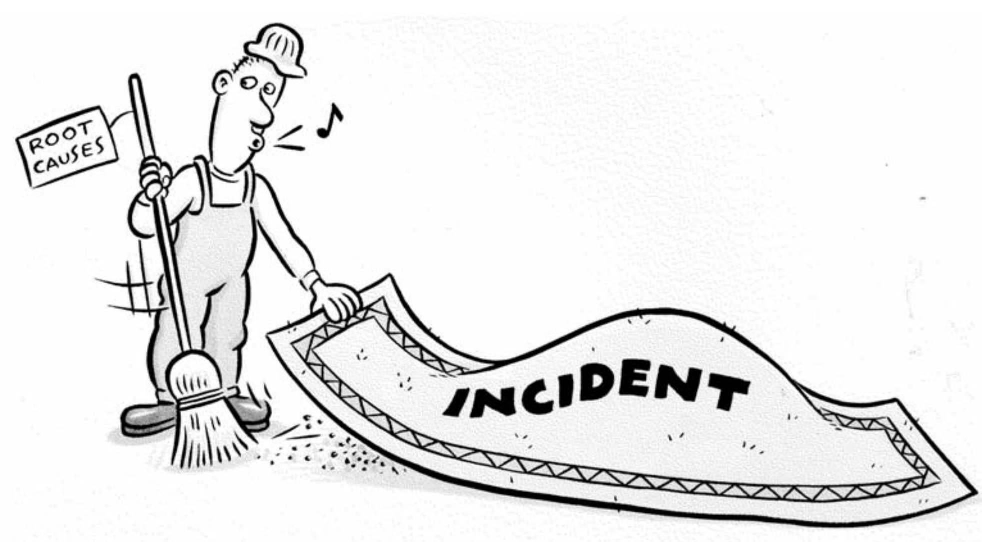
The Center for Chemical Process Safety defines "root causes" as:

> "Management systems failures, such as faulty design or inadequate training, that led to an unsafe act or condition that resulted in an accident; underlying cause. If the root causes were removed, the particular incident would not have occurred."

The Environmental Protection Agency also emphasizes "root causes:"

> ". . . an operator's mistake may be the result of poor training, inappropriate SOPs or poor design of control systems; equipment failure may result from improper maintenance, misuse of equipment (operating at too high a temperature) or use of incompatible materials. Without a thorough investigation, facilities may miss the opportunity to identify and solve the root problems."

What we see is above ground but what really matters is sometimes hidden from initial view.



Sources: American Institute of Chemical Engineers, *Guidelines for Auditing Process Safety Management Systems, Environmental Protection Agency Proposed Rule, Risk Management Programs for Chemical Accidental Release Prevention.*

Factsheet #13
Root Cause Analysis Should Lead to Corrective Action

After the interviewing and investigating is complete, it is time to decide the root causes.

Usually there will be a number of causes, not just one thing.

The team will list all root causes that the members can see leading up to the incident.

You want to be sure the team recognizes all factors.

It is important to build consensus on the causes, not by voting, but through open and free discussion.

The decision should not be rushed or controlled by a strict authoritarian leader. The leader at this point must be a facilitator, encouraging members to express their views and thoughts.

Recommendations should be made and tracked to completion for each root cause identified.

Each phase builds upon the other:

Fact-finding (Investigation — Interviews — Research)

Root Causes (Contributing Factors)

Corrective Actions (Recommendations)

Factsheet #14
Profit-driven Decisions Can Cause Accidents: A Review from Activity 2

Root causes do not necessarily have immediate effects. It takes time for problems to take root. Corporate decisions made over the last decade in the name of profits are often the root cause of current and future "accidents."

Such decisions may include:

- Cutbacks in preventive maintenance;
- Less frequent equipment inspections;
- Inadequate training for employees and supervisors;
- The failure to report and investigate previous near-misses;
- Longer and longer intervals between preventive maintenance shutdowns;
- The use of skeleton crews for maintenance and operations;
- Increased use of untrained subcontractors; and
- Dangerous hot work on running units.

In their investigation report into the March 2005, refinery explosion and fire at the BP refinery in Texas City, the U.S. Chemical Safety and Hazard Investigation Board wrote,

> *"Cost-cutting and failure to invest in the 1990s by Amoco and then BP, left the Texas City refinery vulnerable to a catastrophe. BP targeted budget cuts of 25 percent in 1999 and another 25 percent in 2005, even though much of the refinery's infrastructure and process equipment were in disrepair. Also, operator training and staffing were downsized.*
>
> *". . . Cost-cutting, failure to invest and production pressure from BP Group executive managers impaired process safety performance at Texas City."*

Accidents don't just happen — they take time to mature.

Source: U.S. Chemical Safety and Hazard Investigation Board *Investigation Report: Refinery Explosion and Fire*, Report No. 2005-04-1-TX, March 2007.

Factsheet #15
Is Human Error the Root Cause?

In one sense, the answer is "yes." Production processes are designed and managed by human beings. Unit managers answer to corporate executives, who in turn answer to boards of directors. Bad decisions at the top of the organizational chart can have devastating consequences at the bottom. As the U.S. Chemical Safety and Hazard Investigation Board (CSB) put it in its report on the March, 2005, BP refinery explosion and fire, "Cost-cutting, failure to invest and production pressure from BP Group executive managers impaired process safety performance at Texas City." These were not inadvertent mistakes, but deliberate and knowing decisions.

However, people who talk about human error usually mean errors by unit operators, front-line workers or accident victims. The questions then become: (1) Are process safety failures ***primarily*** caused by the mistakes of unit operators, front-line workers and accident victims; and (2) even if such mistakes are not a major root cause, can we do anything to make them less likely or less serious?

The CSB has investigated and reported on scores of chemical accidents. In almost every case, they located the root causes in failures of the process safety system, not in mistakes by front-line workers. Texas City was no exception. The workers killed were contractors, who had no say whatsoever in how the plant was run. The operators were the victims of faulty instrumentation, outmoded systems for handling vented liquids and a host of factors beyond their control.

This is not to say that how an employee does his or her job is unimportant. Well-trained, committed and alert operators and maintenance personnel are essential. But, a system that depends on employees doing their jobs perfectly at all times is bound to fail. As Al Champanis, safety expert and former Professor of Human Factors Engineering at Johns Hopkins University, put it:

> *"Everyone, and that includes you and me, is at some times careless, complacent, overconfident and stubborn. At times each of us becomes distracted, inattentive, bored and fatigued. We occasionally take chances, we misunderstand, we misinterpret and we misread. These are completely human characteristics. . . . Because we are human, and because all of these traits are fundamental and built into each of us, the equipment, machines and systems that we construct for our use have to be made to accommodate us the way we are, and not vice versa."*

Some employers think that the answer to human error is rigorous discipline. But if every employee is punished for every mistake, employees will stop reporting accidents, near misses and process upsets. People will work hurt, finishing the shift and treating the injury at home. The union and company will not get the information they need to avoid similar accidents in the future. Australian safety expert Andrew Hopkins maintains that discipline should only be used in cases of malice, defiance or recklessness. Hopkins also suggests applying the "similar employee" test: would another employee in the same situation with the same training have made the same mistake? If the answer is "yes," the fault is not with the employee.

continued

Factsheet #15
Is Human Error the Root Cause? *(continued)*

To the extent that operator error is a problem at all, it can be addressed in three ways. All three are important:

- First, we should ensure that all employees are well trained and have the right tools, equipment and instrumentation.
- Second, we should eliminate the factors that lead to mistakes — fatigue from excess overtime, excessive and conflicting job demands from understaffing and poor overall process design.
- Finally, we have to recognize that despite our best efforts, mistakes will occur.

The ultimate solution is to design the process so that a single mistake does not cause a catastrophic accident. This is sometimes called "fail-safe" design. A fail-safe system is not one that never fails — a fail-safe system is one that fails safely, by shutting down safely rather than causing a release. Fail-safe systems are an important part of process safety management.

Sources: Hopkins, Andrew, "*Safety, Culture and Risk*," CCH Australia; and Chapanis, Al, Former Professor of Human Factors Engineering Department, Johns Hopkins University.

Task 3 *(continued)*

Purpose Restated: To learn about conducting accident, incident and near-miss investigations, focusing on root causes.

Using the responses to the questions from the interview with Joe and Pat from Task 2 and Factsheets 12 through 15, complete the Incident or Near-miss form below.

Note: At the end of this Activity, we have provided the SARA Extremely Hazardous Substance list on pages 159 to 169.

Incident or Near-miss

Company Name: ____

Date and Time of Incident: ______________________________________

City and State: ________________ Union Local No.: ________________

Process Involved (e.g.., fractionation) :____________________________

___ Pump or compressor ___ Piping

___ Process Vessel (describe) ______________________________

___ Instrumentation ___ Storage Tank

___ Exchanger ___ Furnace

___ Electrical ___ Relief Valve

___ Other (describe)

Hazardous materials involved (toxins and flammables). List quantities released:

____

____

Was there an emergency team response? _____

Was there a fire? _____

continued

Task 3 *(continued)*

Was there an explosion? _____

Was the release reportable under the SARA Title III Extremely Hazardous Substance List? _____

Injuries and fatalities (describe):

____

____

Employees: Number of OSHA recordables: ______

Contractors: Number of OSHA recordables: ______

Public: Number of persons who sought emergency medical treatment: _______

Describe what happened: ____

____

____

What Safety Systems failed (circle any that apply)? Please explain:

____

____

____

____

____

____

Primary prevention:

Design and Engineering

Secondary prevention systems:

Training or Procedures

Maintenance or Inspections

Mitigation

Warning Devices

Personal Protective Factors

Contractor Systems

Other System (Please describe________________________________

Lesson(s) Learned: Please describe what action(s) was (were) taken to prevent a recurrence of the incident or near-miss:

____

____

____

Summary: Incident Investigation

1. All incidents, near-misses and accidents need to be reported and investigated.
2. The Joint Union and Management Safety Committee is a good team for conducting investigations.
3. Investigation teams should be trained in the techniques of investigation, the art of interviewing, needed documentation and report writing.
4. Investigations should seek root causes of incidents and not blame workers for system failures.
5. The fear of discipline is a major obstacle to having an effective incident reporting and investigation program.
6. In any incident, if just one of the two root causes were absent, the incident would not have occurred.
7. A good investigation starts immediately, but it must be started no later than 48 hours after the incident.
8. A good incident investigation will lead to the identification of system(s) that failed and its correction.

Appendix A to Part 355 -- The List of Extremely Hazardous Substances and Their Threshold Planning QuantitiesTitle
40 -- Protection of Environment
Home29 CFR40 CFR49 CFRFederal RegisterMSDS SearchPurchase CFR e-Books

Appendix A to Part 355 -- The List of Extremely Hazardous Substances and Their
Threshold Planning Quantities
[Alphabetical Order]

CAS No.	Chemical name	Notes	Reportable quantity * (pounds)	Threshold planning quantity (pounds)
75-86-5	Acetone Cyanohydrin.	....	10	1,000
1752-30-3	Acetone Thiosemicarbazide.	....	1,000	1,000/10,000
107-02-8	Acrolein..........	....	1	500
79-06-1	Acrylamide........	l	5,000	1,000/10,000
107-13-1	Acrylonitrile.....	l	100	10,000
814-68-6	Acrylyl Chloride..	h	100	100
111-69-3	Adiponitrile......	l	1,000	1,000
116-06-3	Aldicarb..........	c	1	100/10,000
309-00-2	Aldrin............	....	1	500/10,000
107-18-6	Allyl Alcohol.....	....	100	1,000
107-11-9	Allylamine........	....	500	500
20859-73-8	Aluminum Phosphide	b	100	500
54-62-6	Aminopterin.......	....	500	500/10,000
78-53-5	Amiton............	....	500	500
3734-97-2	Amiton Oxalate....	....	100	100/10,000
7664-41-7	Ammonia...........	l	100	500
300-62-9	Amphetamine.......	....	1,000	1,000
62-53-3	Aniline...........	l	5,000	1,000
88-05-1	Aniline, 2,4,6-Trimethyl-.	....	500	500
7783-70-2	Antimony Pentafluoride.	....	500	500
1397-94-0	Antimycin A.......	c	1,000	1,000/10,000
86-88-4	ANTU..............	....	100	500/10,000
1303-28-2	Arsenic Pentoxide.	....	1	100/10,000
1327-53-3	Arsenous Oxide....	h	1	100/10,000
7784-34-1	Arsenous Trichloride.	....	1	500
7784-42-1	Arsine............	....	100	100
2642-71-9	Azinphos-Ethyl....	....	100	100/10,000
86-50-0	Azinphos-Methyl...	....	1	10/10,000
98-87-3	Benzal Chloride...	....	5,000	500

98-16-8	Benzenamine, 3-(Trifluoromethyl)-.	....	500	500
100-14-1	Benzene, 1-(Chloromethyl)-4-Nitro-.	....	500	500/10,000
98-05-5	Benzenearsonic Acid.	....	10	10/10,000
3615-21-2	Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-.	g	500	500/10,000
98-07-7	Benzotrichloride..	....	10	100
100-44-7	Benzyl Chloride...	....	100	500
140-29-4	Benzyl Cyanide....	h	500	500
15271-41-7	Bicyclo[2.2.1]Heptane-2-Carbonitrile, 5-Chloro-6-((((Methylamino)Carbonyl)Oxy)Imino)-, (1s-(1-alpha,2-beta,4-alpha,5-alpha,6E))-.	....	500	500/10,000
534-07-6	Bis(Chloromethyl) Ketone.	....	10	10/10,000
4044-65-9	Bitoscanate.......	....	500	500/10,000
10294-34-5	Boron Trichloride.	....	500	500
7637-07-2	Boron Trifluoride.	....	500	500
353-42-4	Boron Trifluoride Compound With Methyl Ether (1:1).	....	1,000	1,000
28772-56-7	Bromadiolone......	....	100	100/10,000
7726-95-6	Bromine...........	l	500	500
1306-19-0	Cadmium Oxide.....	....	100	100/10,000
2223-93-0	Cadmium Stearate..	c	1,000	1,000/10,000
7778-44-1	Calcium Arsenate..	....	1	500/10,000
8001-35-2	Camphechlor.......	....	1	500/10,000
56-25-7	Cantharidin.......	....	100	100/10,000
51-83-2	Carbachol Chloride	....	500	500/10,000
26419-73-8	Carbamic Acid, Methyl-, O-(((2,4-Dimethyl-1, 3-Dithiolan-2-yl)Methylene)Amino)-.	d	1	100/10,000
1563-66-2	Carbofuran........	....	10	10/10,000
75-15-0	Carbon Disulfide..	l	100	10,000
786-19-6	Carbophenothion...	....	500	500
57-74-9	Chlordane.........	....	1	1,000
470-90-6	Chlorfenvinfos....	....	500	500
7782-50-5	Chlorine..........	....	10	100

24934-91-6	Chlormephos.......	....	500	500
999-81-5	Chlormequat Chloride.	h	100	100/10,000
79-11-8	Chloroacetic Acid.	....	100	100/10,000
107-07-3	Chloroethanol.....	....	500	500
627-11-2	Chloroethyl Chloroformate.	....	1,000	1,000
67-66-3	Chloroform........	l	10	10,000
542-88-1	Chloromethyl Ether	h	10	100
107-30-2	Chloromethyl Methyl Ether.	c	10	100
3691-35-8	Chlorophacinone...	....	100	100/10,000
1982-47-4	Chloroxuron.......	....	500	500/10,000
21923-23-9	Chlorthiophos.....	h	500	500
10025-73-7	Chromic Chloride..	....	1	1/10,000
62207-76-5	Cobalt, ((2,2[prime]-(1,2-Ethanediylbis (Nitrilomethylidyne)) Bis(6-Fluorophenolato)) (2-)-N,N[prime],O,O[prime])-.	....	100	100/10,000
10210-68-1	Cobalt Carbonyl...	h	10	10/10,000
64-86-8	Colchicine........	h	10	10/10,000
56-72-4	Coumaphos.........	....	10	100/10,000
5836-29-3	Coumatetralyl.....	....	500	500/10,000
95-48-7	Cresol, o-........	....	100	1,000/10,000
535-89-7	Crimidine.........	....	100	100/10,000
4170-30-3	Crotonaldehyde....	....	100	1,000
123-73-9	Crotonaldehyde, (E)-.	....	100	1,000
506-68-3	Cyanogen Bromide..	....	1,000	500/10,000
506-78-5	Cyanogen Iodide...	....	1,000	1,000/10,000
2636-26-2	Cyanophos.........	....	1,000	1,000
675-14-9	Cyanuric Fluoride.	....	100	100
66-81-9	Cycloheximide.....	....	100	100/10,000
108-91-8	Cyclohexylamine...	l	10,000	10,000
17702-41-9	Decaborane(14)....	....	500	500/10,000
8065-48-3	Demeton...........	....	500	500
919-86-8	Demeton-S-Methyl..	....	500	500
10311-84-9	Dialifor..........	....	100	100/10,000
19287-45-7	Diborane..........	....	100	100
111-44-4	Dichloroethyl ether.	....	10	10,000
149-74-6	Dichloromethylphenylsilane.	....	1,000	1,000
62-73-7	Dichlorvos........	....	10	1,000
141-66-2	Dicrotophos.......	....	100	100
1464-53-5	Diepoxybutane.....	....	10	500
814-49-3	Diethyl Chlorophosphate.	h	500	500
71-63-6	Digitoxin.........	c	100	100/10,000

2238-07-5	Diglycidyl Ether..	....	1,000	1,000
20830-75-5	Digoxin...........	h	10	10/10,000
115-26-4	Dimefox...........	....	500	500
60-51-5	Dimethoate........	....	10	500/10,000
2524-03-0	Dimethyl Phosphorochlorido thioate.	....	500	500
77-78-1	Dimethyl sulfate..	....	100	500
75-78-5	Dimethyldichlorosi lane.	h	500	500
57-14-7	Dimethylhydrazine.	....	10	1,000
99-98-9	Dimethyl-p-Phenylenediamine.	....	10	10/10,000
644-64-4	Dimetilan.........	d	1	500/10,000
534-52-1	Dinitrocresol.....	....	10	10/10,000
88-85-7	Dinoseb...........	....	1,000	100/10,000
1420-07-1	Dinoterb..........	....	500	500/10,000
78-34-2	Dioxathion........	....	500	500
82-66-6	Diphacinone.......	....	10	10/10,000
152-16-9	Diphosphoramide, Octamethyl-.	....	100	100
298-04-4	Disulfoton........	....	1	500
514-73-8	Dithiazanine Iodide.	....	500	500/10,000
541-53-7	Dithiobiuret......	....	100	100/10,000
316-42-7	Emetine, Dihydrochloride.	h	1	1/10,000
115-29-7	Endosulfan........	....	1	10/10,000
2778-04-3	Endothion.........	....	500	500/10,000
72-20-8	Endrin............	....	1	500/10,000
106-89-8	Epichlorohydrin...	l	100	1,000
2104-64-5	EPN...............	....	100	100/10,000
50-14-6	Ergocalciferol....	c	1,000	1,000/10,000
379-79-3	Ergotamine Tartrate.	....	500	500/10,000
1622-32-8	Ethanesulfonyl Chloride, 2-Chloro-.	....	500	500
10140-87-1	Ethanol, 1,2-Dichloro-, Acetate.	....	1,000	1,000
563-12-2	Ethion............	....	10	1,000
13194-48-4	Ethoprophos.......	....	1,000	1,000
538-07-8	Ethylbis(2-Chloroethyl)Amine.	h	500	500
371-62-0	Ethylene Fluorohydrin.	c, h	10	10
75-21-8	Ethylene Oxide....	l	10	1,000
107-15-3	Ethylenediamine...	....	5,000	10,000
151-56-4	Ethyleneimine.....	....	1	500
542-90-5	Ethylthiocyanate..	....	10,000	10,000
22224-92-6	Fenamiphos........	....	10	10/10,000
115-90-2	Fensulfothion.....	h	500	500
4301-50-2	Fluenetil.........	....	100	100/10,000

7782-41-4	Fluorine..........	k	10	500
640-19-7	Fluoroacetamide...	j	100	100/10,000
144-49-0	Fluoroacetic Acid.	....	10	10/10,000
359-06-8	Fluoroacetyl Chloride.	c	10	10
51-21-8	Fluorouracil......	....	500	500/10,000
944-22-9	Fonofos...........	....	500	500
50-00-0	Formaldehyde......	l	100	500
107-16-4	Formaldehyde Cyanohydrin.	h	1,000	1,000
23422-53-9	Formetanate Hydrochloride.	d, h	1	500/10,000
2540-82-1	Formothion........	....	100	100
17702-57-7	Formparanate......	d	1	100/10,000
21548-32-3	Fosthietan........	....	500	500
3878-19-1	Fuberidazole......	....	100	100/10,000
110-00-9	Furan.............	....	100	500
13450-90-3	Gallium Trichloride.	....	500	500/10,000
77-47-4	Hexachlorocyclopen tadiene.	h	10	100
4835-11-4	Hexamethylenediami ne, N,N[prime]- Dibutyl-.	....	500	500
302-01-2	Hydrazine.........	....	1	1,000
74-90-8	Hydrocyanic Acid..	....	10	100
7647-01-0	Hydrogen Chloride (gas only).	l	5,000	500
7664-39-3	Hydrogen Fluoride.	....	100	100
7722-84-1	Hydrogen Peroxide (Conc > 52%).	l	1,000	1,000
7783-07-5	Hydrogen Selenide.	....	10	10
7783-06-4	Hydrogen Sulfide..	l	100	500
123-31-9	Hydroquinone......	l	100	500/10,000
13463-40-6	Iron, Pentacarbonyl-.	....	100	100
297-78-9	Isobenzan.........	....	100	100/10,000
78-82-0	Isobutyronitrile..	h	1,000	1,000
102-36-3	Isocyanic Acid, 3,4- Dichlorophenyl Ester.	....	500	500/10,000
465-73-6	Isodrin...........	....	1	100/10,000
55-91-4	Isofluorphate.....	c	100	100
4098-71-9	Isophorone Diisocyanate..	....	100	500
108-23-6	Isopropyl Chloroformate.	....	1,000	1,000
119-38-0	Isopropylmethylpyr azolyl Dimethylcarbamate.	d	1	500
78-97-7	Lactonitrile......	....	1,000	1,000
21609-90-5	Leptophos.........	....	500	500/10,000
541-25-3	Lewisite..........	c, h	10	10

58-89-9	Lindane...........	....	1	1,000/10,000
7580-67-8	Lithium Hydride...	b	100	100
109-77-3	Malononitrile.....	....	1,000	500/10,000
12108-13-3	Manganese, Tricarbonyl Methylcyclopentad ienyl.	h	100	100
51-75-2	Mechlorethamine...	c	10	10
950-10-7	Mephosfolan.......	....	500	500
1600-27-7	Mercuric Acetate..	....	500	500/10,000
7487-94-7	Mercuric Chloride.	....	500	500/10,000
21908-53-2	Mercuric Oxide....	....	500	500/10,000
10476-95-6	Methacrolein Diacetate.	....	1,000	1,000
760-93-0	Methacrylic Anhydride.	....	500	500
126-98-7	Methacrylonitrile.	h	1,000	500
920-46-7	Methacryloyl Chloride.	....	100	100
30674-80-7	Methacryloyloxyeth yl Isocyanate.	h	100	100
10265-92-6	Methamidophos.....	....	100	100/10,000
558-25-8	Methanesulfonyl Fluoride.	....	1,000	1,000
950-37-8	Methidathion......	....	500	500/10,000
2032-65-7	Methiocarb........	....	10	500/10,000
16752-77-5	Methomyl..........	h	100	500/10,000
151-38-2	Methoxyethylmercur ic Acetate.	....	500	500/10,000
80-63-7	Methyl 2-Chloroacrylate.	....	500	500
74-83-9	Methyl Bromide....	l	1,000	1,000
79-22-1	Methyl Chloroformate.	h	1,000	500
60-34-4	Methyl Hydrazine..	....	10	500
624-83-9	Methyl Isocyanate.	....	10	500
556-61-6	Methyl Isothiocyanate.	b	500	500
74-93-1	Methyl Mercaptan..	l	100	500
3735-23-7	Methyl Phenkapton.	....	500	500
676-97-1	Methyl Phosphonic Dichloride.	b	100	100
556-64-9	Methyl Thiocyanate	....	10,000	10,000
78-94-4	Methyl Vinyl Ketone.	....	10	10
502-39-6	Methylmercuric Dicyanamide.	....	500	500/10,000
75-79-6	Methyltrichlorosil ane.	h	500	500
1129-41-5	Metolcarb.........	d	1	100/10,000
7786-34-7	Mevinphos.........	....	10	500
315-18-4	Mexacarbate.......	....	1,000	500/10,000
50-07-7	Mitomycin C.......	....	10	500/10,000
6923-22-4	Monocrotophos.....	....	10	10/10,000

2763-96-4	Muscimol..........	....	1,000	500/10,000
505-60-2	Mustard Gas.......	h	500	500
13463-39-3	Nickel Carbonyl...	....	10	1
54-11-5	Nicotine..........	c	100	100
65-30-5	Nicotine Sulfate..	....	100	100/10,000
7697-37-2	Nitric Acid.......	....	1,000	1,000
10102-43-9	Nitric Oxide......	c	10	100
98-95-3	Nitrobenzene......	l	1,000	10,000
1122-60-7	Nitrocyclohexane..	....	500	500
10102-44-0	Nitrogen Dioxide..	....	10	100
62-75-9	Nitrosodimethylamine.	h	10	1,000
991-42-4	Norbormide........	....	100	100/10,000
0	Organorhodium Complex (PMN-82-147).	....	10	10/10,000
630-60-4	Ouabain...........	c	100	100/10,000
23135-22-0	Oxamyl............	d	1	100/10,000
78-71-7	Oxetane, 3,3-Bis(Chloromethyl)-.	....	500	500
2497-07-6	Oxydisulfoton.....	h	500	500
10028-15-6	Ozone.............	....	100	100
1910-42-5	Paraquat Dichloride.	....	10	10/10,000
2074-50-2	Paraquat Methosulfate.	....	10	10/10,000
56-38-2	Parathion.........	c	10	100
298-00-0	Parathion-Methyl..	c	100	100/10,000
12002-03-8	Paris Green.......	....	1	500/10,000
19624-22-7	Pentaborane.......	....	500	500
2570-26-5	Pentadecylamine...	....	100	100/10,000
79-21-0	Peracetic Acid....	....	500	500
594-42-3	Perchloromethylmercaptan.	....	100	500
108-95-2	Phenol............	....	1,000	500/10,000
4418-66-0	Phenol, 2,2[prime]-Thiobis(4-Chloro-6-Methyl)-.	....	100	100/10,000
64-00-6	Phenol, 3-(1-Methylethyl)-, Methylcarbamate.	d	1	500/10,000
58-36-6	Phenoxarsine, 10,10[prime]-Oxydi-.	....	500	500/10,000
696-28-6	Phenyl Dichloroarsine.	h	1	500
59-88-1	Phenylhydrazine Hydrochloride.	....	1,000	1,000/10,000
62-38-4	Phenylmercury Acetate.	....	100	500/10,000
2097-19-0	Phenylsilatrane...	h	100	100/10,000
103-85-5	Phenylthiourea....	....	100	100/10,000
298-02-2	Phorate...........	....	10	10

4104-14-7	Phosacetim........	....	100	100/10,000
947-02-4	Phosfolan.........	....	100	100/10,000
75-44-5	Phosgene..........	l	10	10
732-11-6	Phosmet...........	....	10	10/10,000
13171-21-6	Phosphamidon......	....	100	100
7803-51-2	Phosphine.........	....	100	500
2703-13-1	Phosphonothioic Acid, Methyl-, O-Ethyl O-(4-(Methylthio) Phenyl) Ester.	....	500	500
50782-69-9	Phosphonothioic Acid, Methyl-, S-(2-(Bis(1Methylethyl)Amino)Ethyl) O-Ethyl Ester.	....	100	100
2665-30-7	Phosphonothioic Acid, Methyl-, O-(4-Nitrophenyl) O-Phenyl Ester.	....	500	500
3254-63-5	Phosphoric Acid, Dimethyl 4-(Methylthio)Phenyl Ester.	....	500	500
2587-90-8	Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester.	c, g	500	500
7723-14-0	Phosphorus........	b, h	1	100
10025-87-3	Phosphorus Oxychloride.	....	1,000	500
10026-13-8	Phosphorus Pentachloride.	b	500	500
7719-12-2	Phosphorus Trichloride.	....	1,000	1,000
57-47-6	Physostigmine.....	d	1	100/10,000
57-64-7	Physostigmine, Salicylate (1:1).	d	1	100/10,000
124-87-8	Picrotoxin........	....	500	500/10,000
110-89-4	Piperidine........	....	1,000	1,000
23505-41-1	Pirimifos-Ethyl...	....	1,000	1,000
10124-50-2	Potassium Arsenite	....	1	500/10,000
151-50-8	Potassium Cyanide.	b	10	100
506-61-6	Potassium Silver Cyanide.	b	1	500
2631-37-0	Promecarb.........	d, h	1	500/10,000
106-96-7	Propargyl Bromide.	....	10	10
57-57-8	Propiolactone, Beta-.	....	10	500
107-12-0	Propionitrile.....	....	10	500
542-76-7	Propionitrile, 3-Chloro-.	....	1,000	1,000

70-69-9	Propiophenone, 4-Amino-.	g	100	100/10,000
109-61-5	Propyl Chloroformate.	....	500	500
75-56-9	Propylene Oxide...	l	100	10,000
75-55-8	Propyleneimine....	....	1	10,000
2275-18-5	Prothoate.........	....	100	100/10,000
129-00-0	Pyrene...........	c	5,000	1,000/10,000
140-76-1	Pyridine, 2-Methyl-5-Vinyl-.	....	500	500
504-24-5	Pyridine, 4-Amino-	h	1,000	500/10,000
1124-33-0	Pyridine, 4-Nitro-,1-Oxide.	....	500	500/10,000
53558-25-1	Pyriminil.........	h	100	100/10,000
14167-18-1	Salcomine.........	....	500	500/10,000
107-44-8	Sarin.............	h	10	10
7783-00-8	Selenious Acid....	....	10	1,000/10,000
7791-23-3	Selenium Oxychloride.	....	500	500
563-41-7	Semicarbazide Hydrochloride.	....	1,000	1,000/10,000
3037-72-7	Silane, (4-Aminobutyl)Diethoxymethyl-.	....	1,000	1,000
7631-89-2	Sodium Arsenate...	....	1	1,000/10,000
7784-46-5	Sodium Arsenite...	....	1	500/10,000
26628-22-8	Sodium Azide (Na(N[INF]3[/INF])).	b	1,000	500
124-65-2	Sodium Cacodylate.	....	100	100/10,000
143-33-9	Sodium Cyanide (Na(CN)).	b	10	100
62-74-8	Sodium Fluoroacetate.	....	10	10/10,000
13410-01-0	Sodium Selenate...	....	100	100/10,000
10102-18-8	Sodium Selenite...	h	100	100/10,000
10102-20-2	Sodium Tellurite..	....	500	500/10,000
900-95-8	Stannane, Acetoxytriphenyl-.	g	500	500/10,000
57-24-9	Strychnine........	c	10	100/10,000
60-41-3	Strychnine Sulfate	....	10	100/10,000
3689-24-5	Sulfotep..........	....	100	500
3569-57-1	Sulfoxide, 3-Chloropropyl Octyl.	....	500	500
7446-09-5	Sulfur Dioxide....	l	500	500
7783-60-0	Sulfur Tetrafluoride.	....	100	100
7446-11-9	Sulfur Trioxide...	b	100	100
7664-93-9	Sulfuric Acid.....	....	1,000	1,000
77-81-6	Tabun.............	c, h	10	10
7783-80-4	Tellurium Hexafluoride.	k	100	100
107-49-3	TEPP..............	....	10	100

13071-79-9	Terbufos..........	h	100	100
78-00-2	Tetraethyllead....	c	10	100
597-64-8	Tetraethyltin.....	c	100	100
75-74-1	Tetramethyllead...	c, 1	100	100
509-14-8	Tetranitromethane.	....	10	500
10031-59-1	Thallium Sulfate..	h	100	100/10,000
6533-73-9	Thallous Carbonate	c, h	100	100/10,000
7791-12-0	Thallous Chloride.	c, h	100	100/10,000
2757-18-8	Thallous Malonate.	c, h	100	100/10,000
7446-18-6	Thallous Sulfate..	....	100	100/10,000
2231-57-4	Thiocarbazide.....	....	1,000	1,000/10,000
39196-18-4	Thiofanox.........	....	100	100/10,000
297-97-2	Thionazin.........	....	100	500
108-98-5	Thiophenol........	....	100	500
79-19-6	Thiosemicarbazide.	....	100	100/10,000
5344-82-1	Thiourea, (2-Chlorophenyl)-.	....	100	100/10,000
614-78-8	Thiourea, (2-Methylphenyl)-.	....	500	500/10,000
7550-45-0	Titanium Tetrachloride.	....	1,000	100
584-84-9	Toluene 2,4-Diisocyanate.	....	100	500
91-08-7	Toluene 2,6-Diisocyanate.	....	100	100
110-57-6	Trans-1,4-Dichlorobutene.	....	500	500
1031-47-6	Triamiphos........	....	500	500/10,000
24017-47-8	Triazofos.........	....	500	500
76-02-8	Trichloroacetyl Chloride.	....	500	500
115-21-9	Trichloroethylsilane.	h	500	500
327-98-0	Trichloronate.....	k	500	500
98-13-5	Trichlorophenylsilane.	h	500	500
1558-25-4	Trichloro(Chloromethyl)Silane.	....	100	100
27137-85-5	Trichloro(Dichlorophenyl) Silane.	....	500	500
998-30-1	Triethoxysilane...	....	500	500
75-77-4	Trimethylchlorosilane.	....	1,000	1,000
824-11-3	Trimethylolpropane Phosphite.	h	100	100/10,000
1066-45-1	Trimethyltin Chloride.	....	500	500/10,000
639-58-7	Triphenyltin Chloride.	....	500	500/10,000
555-77-1	Tris(2-Chloroethyl)Amine.	h	100	100
2001-95-8	Valinomycin.......	c	1,000	1,000/10,000
1314-62-1	Vanadium Pentoxide	....	1,000	100/10,000
108-05-4	Vinyl Acetate	1	5,000	1,000

	Monomer.			
81-81-2	Warfarin..........	....	100	500/10,000
129-06-6	Warfarin Sodium...	h	100	100/10,000
28347-13-9	Xylylene Dichloride.	....	100	100/10,000
58270-08-9	Zinc, Dichloro(4,4-Dimethyl-5((((Methylamino) Carbonyl) Oxy)Imino)Pentane nitrile)-, (T-4)-.	....	100	100/10,000
1314-84-7	Zinc Phosphide....	b	100	500

Only the statutory or final RQ is shown. For more information, see 40 CFR table 302.4.

otes:

This chemical does not meet acute toxicity criteria. Its TPQ is set at 10,000 pounds.

This material is a reactive solid. The TPQ does not default to 10,000 pounds for non-powder, non-molten, nonsolution form.

The calculated TPQ changed after technical review as described in the technical support document.

Indicates that the RQ is subject to change when the assessment of potential carcinogenicity and/or other toxicity is completed.

Statutory reportable quantity for purposes of notification under SARA sect 304(a)(2).

[Reserved]

New chemicals added that were not part of the original list of 402 substances.

Revised TPQ based on new or re-evaluated toxicity data.

TPQ is revised to its calculated value and does not change due to technical review as in proposed rule.

The TPQ was revised after proposal due to calculation error.

Chemicals on the original list that do not meet toxicity criteria but because of their high production volume and recognized toxicity are considered chemicals of concern (``Other chemicals'').

61 FR 20479, May 7, 1996, as amended at 68 FR 52984, Sept. 8, 2003]

General Description of an OSHA Recordable Injury or Illness:

Which work-related injuries and illnesses should you record?

Record those work-related injuries and illnesses that result in:

- Death;
- Loss of consciousness;
- Days away from work;
- Restricted work activity or job transfer; or
- Medical treatment beyond first aid.

Source: "An Overview: Recording Work-Related Injuries and Illnesses," http://www.osha.gov/recordkeeping/new-osha300form1-1-04.pdf, page 1, accessed November 5, 2007.

Activity 5: An Introduction to Process Hazard Analysis (PHA)

Purpose

To understand how process hazard analysis can be used as a tool to prevent accidents.

To learn about the importance of considering worst-case scenarios.

This Activity has two tasks.

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Task 1

Factsheet Reading Method for Task 1.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a scribe for this task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 1 to 7. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 1 and 5; the person to their left will be responsible for Factsheets 2 and 6, etc. The numbers that you have assigned yourself correspond to Factsheets 1 through 7 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (1 through 7), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet 1
What Is a Process Hazard Analysis?

A PHA is defined as:

- A systematic effort designed to identify and analyze hazards associated with the processing or handling of highly hazardous materials; and
- A method to provide information which will help workers and employers in making decisions that will improve safety.

A PHA analyzes:

- The potential causes and consequences of fires, explosions and releases of toxic chemicals; and
- The equipment, instrumentation, human actions and other factors which might affect the process.

A PHA attempts to determine:

- The failure points, methods of operations and other factors that can potentially lead to accidents.

A PHA team:

- Should include engineers, operators, supervisors and other workers who have knowledge of the standards, codes, specifications and regulations which apply to the process being studied.

Source: Adapted from OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992, Appendix C.

Factsheet #2
Common PHA Methods

The following is a list of some of the common methods used to evaluate process hazards.

Checklists

This method uses established codes, standards and well-understood hazardous operations as a checklist against which to compare a process. A good checklist is dependent on the experience level and knowledge of those who develop it.

What If

This approach uses a multi-skilled team to create and answer a series of "what-if" type questions. This method has a relatively loose structure and is only as effective as the quality of the questions asked and the answers given.

Hazard and Operability Study (HAZOP)

A structured, systematic review that identifies equipment that is being used in a way that it was not designed to be, and which might create hazards or operational problems. HAZOPs are usually conducted by a multi-skilled team that studies piping and instrument diagrams. Each pipeline and vessel is evaluated for certain limitations and deviations in flow, temperature, pressure, etc.

Failure Mode and Effect Analysis (FMEA)

A systematic study of the consequences of failure (breakdown) of certain operational hardware such as transmitters, controllers, valves, pumps, rotometers, etc.

Fault-Tree Analysis

This method draws a picture (model) that shows what undesirable outcomes might result from a specific initiating event (for example, a pipe rupture in a pipe rack). It uses graphics and symbols to show the possible order of events which might result in an accident. This method is sometimes used in accident investigations to determine probable cause.

Source: The Workplace Health Fund, *Blueprint for Prevention*, Washington, D. C.

Factsheet #3
The Most Hazardous Processes Are First

OSHA requires employers to perform a PHA on each process covered by the law. The purpose of the PHA is to identify and evaluate the hazards of the process, and ways or methods to control them.

The most hazardous processes must be evaluated first. All PHAs must be completed as soon as possible. Also, all PHAs must be updated and revalidated at least every five years.

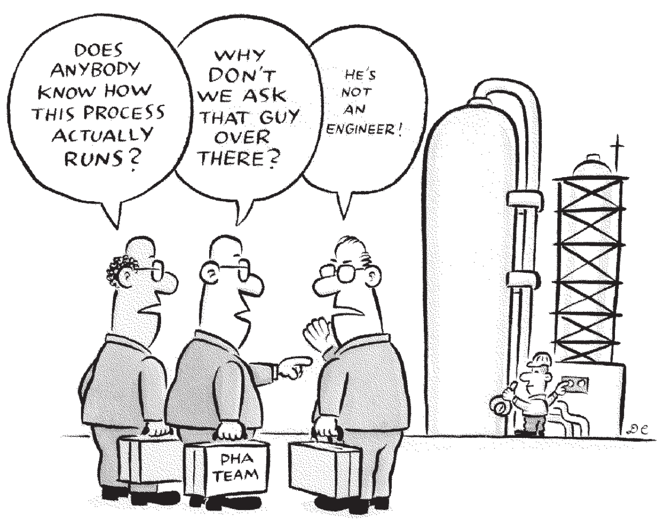
Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #4
Process Experience Is a Must

A process hazard analysis cannot be done by just anyone. According to OSHA, PHAs must be performed by a team with process and engineering knowledge and include at least one employee experienced in running the process. Also, one member of the team must have experience with the PHA method being used.

PHAs must address all of the following issues:

- The hazards of the process;
- Previous incidents which could have been catastrophic;
- Engineering and administrative controls;
- The consequences of failure of engineering and administrative controls;
- Facility siting;
- Human factors; and
- The range of possible safety and health effects caused by the failure of controls.



Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #5
What Are Engineers Trained to Do?

Often it is the hourly workers who have the best understanding of the safety hazards involved in a process. But the management staff of oil and chemical plants consists largely of people with degrees in chemical engineering. They may be poorly qualified to oversee safety and health programs.

Traditionally, production managers have not received training in safety issues and even safety managers often are unfamiliar with primary prevention opportunities.

Source: Ashford, Nicholas, *The Encouragement of Technological Change for Preventing Chemical Accidents*, MIT and EPA Report, 1993, pp. viii-18.

Factsheet #6
Take Action and Follow-through

It is not enough for the employers to just assure that PHAs have been conducted. They must do something about their findings. The employer must establish a system or set of procedures that will promptly deal with the findings of the PHA team and recommendations. Any actions taken to correct hazards uncovered by the PHA must be communicated to the workers in the area and to any other workers who might be affected.

OSHA sets specific timelines for the completion of PHAs. However, OSHA has no equivalent time requirements for the implementation of PHA recommendations. Follow-up is a critical part of any PHA, yet this is usually the weakest link in the process. Sometimes recommendations are "resolved" by the area manager just saying "no."

Some diligent companies prepare quarterly status reports on PHA recommendations and include this in their audit program. Worker safety representatives should be involved in each step of the follow-up. An effective process safety program includes workers on the front end and on the follow-up.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #7
New Guidelines for the PSM Standard

After several unions, including OCAW (now USW), challenged OSHA's guidelines for following up on PHA recommendations in court, OSHA issued the following revised guidelines for their PSM compliance directive:

> "Where a recommendation is rejected, the employer must communicate this to the team, and expeditiously resolve any subsequent recommendation of the team. An employer can justifiably decline to adopt a recommendation where the employer can document in writing and based upon adequate evidence that one or more of the following conditions exist:
>
> 1. The analysis upon which the recommendation is based contains material factual errors.
> 2. The recommendation is not necessary to protect the health and safety of the employer's own employees or the employees of contractors.
> 3. An alternative measure would provide a sufficient level of protection.
> 4. The recommendation is infeasible."

A joint labor-management health and safety committee or joint process safety management committee is a ready-made body for reviewing the resolution of recommendations.

Source: OSHA PSM Compliance Directive, September 13, 1994.

Task 1 *(continued)*

Purposes Restated: To understand how process hazard analysis can be used as a tool to prevent accidents.

Scenario:

Recently, the K-l polymerization unit at OilChem Corporation exploded, killing three workers. An investigation showed that a pressure control system on a feed line to the reactor, which was designed to keep the feed under pressure and in a liquid state, failed, allowing the feed to vaporize. The vaporized feed continued to flow into the reactor. The flow control meter on the feed line did not register the vaporized feed as a flow, causing the operator to believe that a high-level alarm on the reactor was false. As a result, the operator by-passed the safety interlock on the feed line, causing the vessel to over-pressurize and explode.

OilChem claims that they were in compliance with the PSM Standard and that they were in the process of conducting the required PHAs.

The initial OSHA investigation uncovered the following facts:

- The K-l unit was the oldest processing unit on the site.
- The K-l unit had a history of having the most runaway chemical reactions of any unit on the site.
- The pressure control system on the feed-stock line had a history of repeated failures.
- The level control alarm was bypassed continuously because of its poor reliability.
- The pressure relief system was inadequately designed for the chemical process run in the reactor.
- OilChem had completed PHAs on all of the site's storage tanks. None of the chemical processes on site had been PHA-ed.
- There was no employee involvement in the development of the PHA priority list.

continued.

Task 1 *(continued)*

Your group has been appointed to the incident investigation team.

Task:

Now that you have discussed Factsheets 1 though 7, in your group answer the following questions:

1. According to the PSM Standard, what did OilChem do wrong?

2. Would a PHA on the K-l unit have uncovered any of the root causes of the accident? If so, what PHA method or combination of methods should have been used (see Factsheet 2) and what causes would they have exposed?

3. Is OilChem required by OSHA to fix faults in design or operating procedures identified by a PHA? (See Factsheets 5, 6 and 7.) What do you think an effective program for PHA recommendations should look like?

Task 2

Factsheet Reading Method for Task 2.

The Small Group Activity Method places workers at the center of the learning experience. It is designed to draw on two bodies of knowledge: the knowledge and experiences workers bring into the room and the factsheets contained in your workbooks.

The factsheet method, described below, builds upon this knowledge through the introduction of new ideas and concepts.

The process is as follows:

First, select a scribe for this task.

Each of you will be assigned a small number of factsheets to read. You will then share this new information with your table.

The idea is for each of you to understand the information contained in your factsheets and to describe it to the others in your group.

Your trainer will assign your individual factsheets in the following way:

Starting with the scribe and moving to the left, count out loud from 8 to 12. Keep going around the table until all numbers (factsheets) are distributed. For example, if there are four people at your table, the scribe will have self-assigned Factsheets 8 and 12; the person to their left will be responsible for Factsheet 9, etc. The numbers that you have assigned yourself correspond to Factsheets 8 through 12 on the following pages.

Once everyone has read their assigned factsheets individually, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. No notes need to be taken during this discussion. The factsheets should be explained in the order they were assigned (8 through 12), as many times factsheets build on previous factsheets. Once this process is complete, your trainer will read the scenario and the task. In this way we all start at the same place and with the same information.

Factsheet #8
The Case for Worst-case Scenarios

Some companies consider only worst-credible scenarios rather than looking at the much more extreme worst-case scenarios. They argue that worst-case incidents are so improbable that they are virtual impossibilities. However, experience with numerous chemical industry disasters has shown that what was thought to be impossible happens all too often.

The Environmental Protection Agency has published, in their "Risk Management Plan Standard," a requirement that worst-case assessments be conducted on hazardous processes. These assessments must assume that all back-up safety systems have failed to work. Their examples include:

- A transfer hose with no shutoffs fails, resulting in the release of the contents of the vessel or tank it is attached to;
- Tank piping with no shutoffs fails, resulting in the total release of the tank contents;
- A flame impingement on a vessel which results in the vessel's failing; and
- A severe vessel over-pressurization caused by contamination, a runaway reaction or overheating which causes a venting to the atmosphere or a vessel failure.

Source: 40 CFR Part 68, *Accidental Release Prevention Requirements: Risk Management Programs under the Clean Air Act*, Section 112(r)(7).

Factsheet #9
Is the Worst-case Release Only 10 Minutes Long?

An indication of industry’s resistance to the development of worst-case scenarios surfaced during a trial application of the EPA’s proposed Risk Management Plan rule.

Chemical plants in the Kanawha Valley of West Virginia participated in a trial program in June 1994. The companies released maps which showed what worst-case vapor plume releases would look like. Some of the plumes stretched more than 30 miles over local towns.

But rather than concentrating on the worst-case scenarios, the companies focused on “more probable release scenarios” in which vapor clouds might travel only a couple of miles. According to an official at the Oxy Chem Corporation, the EPA’s worst case definition was “just not credible.” The industries assumed that a worst-case release would not last more than 10 minutes.

But the manager of the DuPont facility admitted that “if you go back in history and see large pieces of equipment have opened up, you cannot say it will never happen.”

Source: Hallock, Richard “Technic of Operations Review Analysis Determines Cause of Accident/Incident,” *Pollution Engineering,* September 1994, pp. 37-39.

Factsheet #10
The Best Case for Worst-case Scenarios

Worst-case scenarios do happen and the consequences are severe: death, injury, community evacuation and the losses of hundreds of jobs. The best case for doing worst-case scenarios is that a tragedy like the one below might be avoided.

"The CSB (U.S. Chemical Safety and Hazard Investigation Board) findings describe the drastic effects of corporate cost-cutting at the Texas City refinery, where maintenance and infrastructure deteriorated over time, setting the stage for the disaster."

On March 23, 2005, the BP Texas City refinery experienced severe explosions and fires that resulted in 15 deaths and 180 injuries. The accident was the worst industrial accident in the U.S. since 1990.

The explosion and fire were the result of pressure build up during the isomerization unit startup. Liquid was discharged into a disposal blowdown drum with a stack open to the atmosphere — a violation of the company's own Texas City refinery safety standards.

Source: The quote is by U.S. Chemical Safety and Hazard Investigation Board Chairman, Carolyn W. Merritt, "News Conference Statements," October 31, 2006. Additional information on the Texas City disaster is available at: www.csb.gov.

Factsheet #11
Unconfined Vapor Cloud Explosions

Most PHAs assume that only one piece of equipment fails and becomes involved in a fire or explosion. Guidelines for the safe spacing of chemical plant equipment, published by Factory Mutual, an industry insurance company, assume that more serious scenarios, called "unconfined vapor cloud explosions," are very unlikely. Therefore, spacing and construction guidelines do not consider the possibility of unconfined vapor explosions damaging multiple pieces of equipment or entire process units.

However, in recent years these worst-case scenarios are taking place with increasing frequency.

- In Lemont, Illinois, 17 people died when an amine absorber vented its contents from a crack. The resulting explosion lifted the 38-ton tower over nearby homes, landing one-third of a mile away.
- In Pasadena, Texas, 23 people died when contract workers mistakenly opened a valve, releasing polyethylene. The explosion destroyed the entire polyethylene plant and sent debris six miles into the community.
- In Sterlington, Louisiana, eight people died when a nitroparaffins plant exploded and was leveled. A dome weighing several tons landed nearly one mile away.
- In Wilmington, California, in 1992, a vapor cloud resulting from a rupture of a corroded 6-inch elbow and release of hydrobarbon/ hydrogen mixture resulted in a three-day fire and $96 million in damages.
- In Richmond, California, in 1999, 300 firefighters were needed to extinguish a fire resulting from a vapor cloud igniting caused by the failure of a valve bonnet in a hydrocracker. Damage was estimated at $79 million.

Sources: Robert E. Wages, "Testimony on OSHA's Proposed Safety Standard for Highly Hazardous Chemicals, Houston, TX, 1991," *New Solutions*, Fall 1991, pp. 98-100; and *The 100 Largest Losses: 1972-2001*, Twentieth Edition, Marsh's Risk Consulting Practice, 2003.

Factsheet #12
Who Is Driving the Process Safety Bus?

Companies often label PHA reports and recommendations as being confidential. They may fear that the information would cause public relations or future liability problems. OSHA requires that the reports and recommendations are made available to the union and employees, including contractor employees whose safety might be impacted. There is no requirement that the information is shared with other similar facilities or community safety agencies.

Prevention of disasters is not possible when important process safety information is not shared with those who would benefit from receiving it.

The public benefits of conducting PHAs are illustrated in the following quote:

> "Talking honestly about what could happen during a chemical accident gives stakeholders the opportunity to explain their emergency preparedness roles. Sharing worst-case scenarios with the community will lead to a higher state of readiness and keep pressure on industry and government to do a better job."
>
> -James Markris, Director,
> EPA Emergency Preparedness Office

Source: Bureau of National Affairs, *Environment Reporter*, January 28, 1994, p. 1702.

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Task 2 *(continued)*

Purposes Restated: To understand how process hazard analysis can be used as a tool to prevent accidents.

To learn about the importance of considering worst-case scenarios.

Scenario:

OilChem and USW Local 2008 have formed a team to do a PHA of a polystyrene unit. In the past, PHA teams have examined only fire potentials as their basis for considering the risk of chemical releases. The new team has been discussing whether or not to expand their review to include unconfined vapor cloud explosions or other worst-case incidents.

The team is having trouble reaching a consensus on what to do. Some team members have stated that worst-case incident reviews are a waste of time and money, and that they will only serve to scare the surrounding community into demanding that the plant be shut down.

Task:

In your groups, answer the following questions:

1. Do you agree or disagree with the team members who do not want to do worst-case incident reviews? Please explain why or why not.

2. Turning now to your own facilities, what do you think is the most serious worst-case accident that could happen? Would a PHA of the equipment involved in the accident you described help to prevent it from happening? Please explain why.

Summary: An Introduction to Process Hazard Analysis (PHA)

1. PHAs are methods to systematically determine process hazards.
2. Most PHAs do not examine worst-case scenarios. Experience has shown that these catastrophic events do happen and should be studied in a PHA.
3. The subjectivity and experience levels of PHA team members have a large impact on the effectiveness of the team. Worker representatives on PHA teams play a crucial role due to their unique knowledge of process facilities.
4. If an employer rejects a recommendation for a PHA, they must document why they did not implement the recommendation.
5. Safety information contained in PHA reports should be shared with all employees, contractors and communities who could benefit from receiving this information.

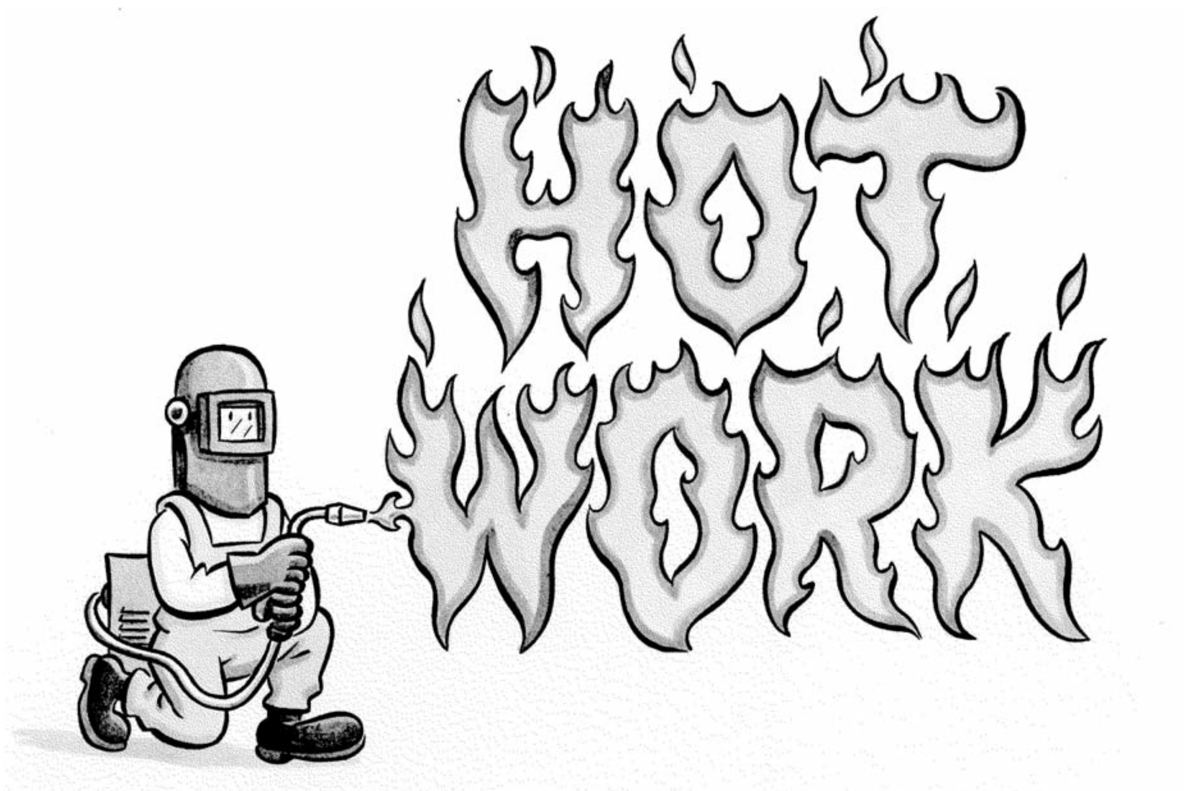
Activity 6: Hot Work

Purpose

To understand hot work.

To learn the elements of a good hot work program.

This Activity has one task.



This material was developed by the United Steelworkers Tony Mazzocchi Center for Safety, Health and Environmental Education and produced by the Steelworkers Charitable and Educational Organization, funded in whole or in part with federal funds from the Occupational Safety and Health Administration, U.S. Department of Labor, under grant number SH-16632-07-60-F-42. These materials do not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products or organizations imply endorsement by the U.S. Government.

Task

Factsheet Reading Method for Task.

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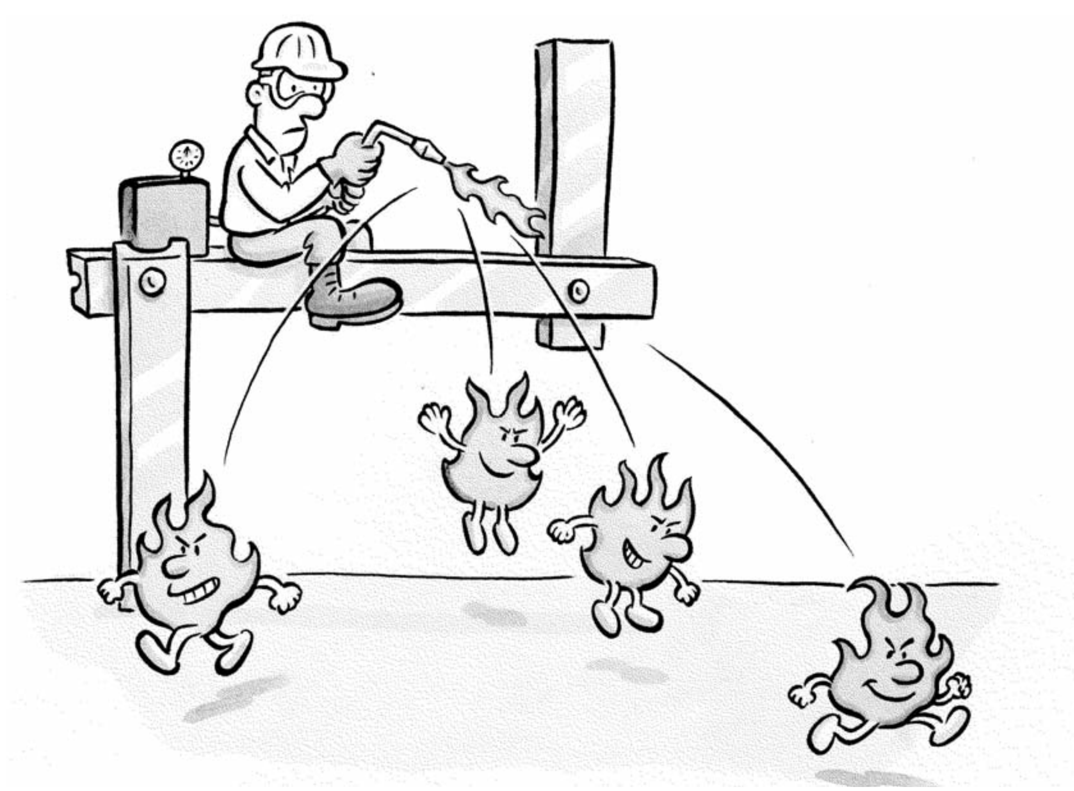
Factsheet #1
What Is Hot Work and Why Is It Hazardous?

OSHA defines hot work as: "work involving electric or gas welding, cutting, brazing or similar flame or spark-producing operations." We should be concerned about hot work because:

- In our plants a spark invites disaster because of the tremendous potential for flammable vapors or gases to be present.
- When we cut, weld or grind in our facilities, literally thousands of ignition sources in the form of sparks and hot slag are created.
- Sparks and slag can scatter throughout an area where hot work is going on — sometimes up to 35 feet or more.
- Sparks and slag can also pass through cracks, gratings, doors, drains, open hatches and other openings in walls, floors or vessels, creating fire/explosion hazards in sometimes distant areas.



Source: NFPA 51B "Fire Prevention in Use of Cutting and Welding Processes," 1989.

Factsheet #2
Hot Work May Be More Than You Expect

Anything combustible or flammable can be ignited by hot work. Welding, cutting and brazing are pretty obvious; but what about those other "flame or spark-producing operations" that OSHA talks about?

- Grinding, sanding and sand blasting;
- Metal-on-metal contact, metal-on-concrete contact;
- Internal combustion engines;
- Electric tools, such as drills or saws;
- Cameras, battery-powered instruments, radios, etc.; and
- Even your clothing can cause static sparks.

If your hot work permit system does not address these sources, it is not giving you the protection the law requires.

When you check out an area before doing hot work, it's natural to focus on the hazards of the process (solvent vapors, flammable gases and explosive dust-in-air mixtures, etc.). But wait; it's easy to overlook other combustible materials in a hot work area. It pays to check the area out thoroughly.

Move it!

Move combustible materials at least 35 feet from the hot work area. If they can't be moved, they must at least be protected with flame-proofed covers or shielded with metal or asbestos guards or curtains. Edges of covers at the floor should be tight to prevent sparks from going under them. Combustible flooring should be wet down or protected by fire-resistant shields. Cover floor drains, trenches, sewer boxes, etc.

Source: OSHA 1910.252(a); and NFPA 51B "Fire Prevention in Use of Cutting and Welding Processes," 1989.

Factsheet #3
Hot Work: Your Last Resort

In many chemical plants and refineries, it has become routine to do hot work in process areas — often with the units still running. Call it increased production demands, profit maximization or whatever, the current trend in our industry is to take the least amount of time possible to do maintenance work. Planned shutdowns and turnarounds for maintenance are held much less frequently than in the past. Even when such work is scheduled, the length of time allowed is enough to take care of only the most serious work orders.

But remember, it is almost always safer to move that piece of equipment out of the process area to a safe place before doing hot work on it.

Source: Based on interviews with former OCAW (Now USW) members in the video, "Out of Control," produced by the Organizing Media Project and available from the Apex Press, New York, NY.

Factsheet #4
Where There's Smoke There Should Be a Fire Watch!

When hot work is being performed the sparks fly — literally!

Sparks produced by hot work operations like grinding, cutting or welding are often spread over a large area. This makes it impossible for grinders, welders or torch operators to do their work and watch for fires too. OSHA says a fire watch must be assigned to the job if there is a chance of more than just a minor fire. In our plants, no fire is minor. Consider the following real-life examples:

- Rouseville, PA: A welding operation on a stairway to a tank was prepped and permitted in the morning. The area was gas-tested and found to be clear of any LEL levels. The liquid in the tank was not considered flammable as it was a mixture of water and various products from the vacuum truck recovered spills. As the day warmed up and conditions changed, flammable vapors formed and began rising off the tank. The vapors were ignited and three contractors were killed.
- Delaware City, DE: A welding operation was taking place on a catwalk on a tank. The work crew had been repairing a catwalk on a sulfuric acid storage tank when a spark from their hot work ignited flammable vapors in one of the tanks. This tank had holes in its roof and shell due to corrosion. The tank collapsed and one of the contract workers was killed; eight others were injured.

Factsheet #5
What's a Fire Watch?

A fire watch is someone who . . . umm . . . well . . . er . . . watches!

He or she continuously monitors the hot work area for fires that may be caused by flying sparks and any changes in the surrounding conditions that may make the hot work unsafe. The key word here is continuously. This is not a job to be given to an operator or mechanic who already has another job to do.

A fire watch is well trained.

Fire watches must be trained in using fire-extinguishing equipment, including "hands on" practice with training fires. They must also be trained in the facility's emergency procedures (i.e., sounding an alarm, evacuation routes, etc.) as outlined in the plant's written emergency response plan.

A fire watch knows what to do and when to do it.

If a fire occurs, the fire watch must warn the hot work crew and sound the plant alarm. The fire watch may try to extinguish a fire only when it is obviously within the capacity of the fire extinguishing equipment available and only if the fire watch has been properly trained.

A fire watch must cover all areas where sparks might travel.

If there are floor or wall openings, open ductwork, gratings, open sewer drains or any other way a spark may travel to another level or area, more personnel need to be assigned as fire watches.

It's not over even when it's over.

When the hot work ends, the fire watch must continue for at least another 30 minutes.*

*OSHA 1910.252 (a) (III) (4) (8).

Factsheet #6
Hot Work Permits: No Guarantee of Safety

A hot work permit is only as good as the information included on it and the skills of the person issuing it. Several factors have to be considered before issuing a permit:

Explosive atmospheres

Hot work obviously can't be done near explosive atmospheres. The area should be checked with a combustible gas analyzer at different levels. Even if the air is clear, will it stay that way? Continuous monitoring should be standard practice.

Nearby combustibles

Move combustible materials in the area 35 feet from the hot work area. If impractical, protect them with flame-proof covers or guards.

Fire protection equipment

Inspect all fire equipment and do not allow hot work in sprinklered buildings if that protection is impaired.

Safe condition of surrounding areas

If something is going on near a hot work area that could create a hazardous condition, those operations must be made safe until the hot work is finished. If there are floor openings, gratings, wall openings or open ductwork or conveyors that could allow sparks from the hot work to be carried into another area, they must be covered or blocked.

Notification of all persons involved

Operators on nearby units, supervisors, maintenance or other workers nearby and contractors must be aware of the hot work going on and of the related hazards. Posting a notice or sign is recommended also.

Establishment of a fire watch

A trained fire watch attendant (more than one if necessary) must be on duty at the hot work site until at least 30 minutes after the hot work is completed.

In addition, a hot work permit must include the date and time the work is authorized and identify the equipment to be worked on. The permit must be kept on file until the hot work operation is completed.

Remember, if the nature of the job changes (e.g., another craft becomes involved, new equipment is used or conditions surrounding the job change), a new hot work permit should be issued.

Sources: OSHA 1910.119; and NFPA 51B "Fire Prevention in Use of Cutting and Welding Processes," 1989.

Factsheet #7
Combustible Gas Analyzers

How do you tell if an area is clear of flammable gases or vapors? Most plants use combustible gas analyzers. These are usually small, hand-held units that test the air and give a reading expressed in percent lower explosion limit (LEL). Often analyzers for oxygen and other contaminants are combined in the same unit.

Percent Lower Explosion Limit (LEL)
Flammable gas will ignite only when the mixture of gas and air is in the right ratio. Too little gas and the mixture is too lean to burn, too much gas and the mixture is too rich.

What concentration is safe?
OSHA is unfortunately silent on this issue under PSM. But in OSHA's Confined Space Standard they specify a maximum percent LEL of 10 percent for work inside a confined space. However, some plants will not do hot work if any positive reading at all shows up on an analyzer. Others use readings of one percent or three percent of the LEL as their cut-off point.

How often is enough?
Most plants only sample when the permit is issued. A few repeat the monitoring at regular time periods. The best protection is offered by continuous monitoring. This can be done by area monitors with noticeable alarms or by equipping fire watches (after proper training) with analyzers during the hot work.

Sources: OSHA 1910.146; and National Safety Council, *Accident Prevention Manual for Business and Industry*, 10th Edition, Itasca, IL: The National Safety Council, 1992.

Factsheet #8
Monitoring the Monitors

Monitoring results are only as good as the equipment being used and the training and experience of those using it. So be sure that:

- Only experienced, trained workers use a combustible gas monitor.
- Units have fully charged batteries.
- The analyzer is intrinsically safe (explosion proof).
- Units are calibrated on a regular basis and that calibration is checked daily.

And remember that:

- Monitors will give false low readings if the sample vapor is very high in concentration. If the oxygen level is low, monitors will give false low readings of flammable vapors.
- Liquids or steam drawn into the unit will give false readings and may damage the unit. Hydrogen will also affect readings.
- Monitors do not give instantaneous readings. They require as long as 30 seconds to perform the analysis. If an auxiliary pump and tubing are used to sample a confined space or other area, allow at least two more seconds per foot of sample tubing for the sample to reach the monitor.
- If the results of any analyzer are suspect in any way, retest with another unit immediately.
- Some gases are heavy, some aren't. Be sure testing is done at several different levels.
- For the most protection, insist on continuous monitoring.

Source: National Safety Council, *Accident Prevention Manual for Business and Industry*, 10th Edition, Itasca, IL: The National Safety Council, 1992.

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Task *(continued)*

Purposes Restated:

To understand what hot work is.

To learn the elements of a good hot work program.

Scenario:

Art and Ray were sent to the Tank Farm to replace bearings on an isopropanol pump located on the alcohol pad. They found the bearings "frozen" in place. When Art told his supervisor they would have to pull the pump, he said, "Let's see if we can't pull those bearings in place; we've got too much downtime in that area already." First they tried to loosen the bearings with a bearing heater, a powerful electric heat gun, without success. Ray then called a welder who heated the casing with her torch until the bearings came free. While the welder was there, the supervisor had her weld brackets on an I-beam so he could install a "Warning-Flammable Area" sign.

A piece of slag from the welding rolled into a nearby pile of damp wooden shims. After the mechanics and the welder left the area, the wood began to smolder and then burst into flames. At the same time an operator began to charge ethanol to his unit by remote computer control. The ethanol transfer pump started to leak around its mechanical seal creating a pool of alcohol on the pad. The vapors from the pool traveled towards the fire, which then ignited them.

The fire spread instantly to the pump and grew in intensity as the heat increased the size of the leak. The tank farm operator saw the fire, sounded the alarm and attacked the fire with an extinguisher. She was overcome by vapors and fell unconscious. Quick response by the inplant emergency response team saved her life and stopped a potentially disastrous fire.

Task:

Your group is the OilChem, USW Joint Safety Committee. Discuss the incident and, based upon your experience and on the factsheets you just reviewed, answer the following questions.

1. What you think could have been done to prevent this fire? Make a list and explain why.

2. Are there any changes or improvements that should be made to the hot work program in your plant? Please list and explain.

Summary: Hot Work

1. Hot work is any job that can cause a fire.
2. The hot work permit is an important tool in the hot work system; but it does not make unsafe work safe.
3. A permit must be issued before the hot work begins. The proper permit will record that safety requirements have been met and the results of the monitoring for combustibles (percent LEL).

4 The person authorized to issue a permit should check the area of the hot work for:

- Explosive atmospheres;
- Nearby combustibles;
- Fire protection equipment;
- Safe condition of surrounding areas;
- Notification of all persons involved; and
- Establishment of a fire watch.

5. The worker performing the hot work cannot do his job and watch the area too. At least one well-trained fire watch should be posted in each hot work area.
6. Hot work areas should always be monitored for flammable gases before hot work is performed. But the highest level of protection is given by continuously monitoring the hot work area.
7. Any time you do hot work in a process area you take a risk. Work like this should only be a last resort. Remove the job to a safe site whenever possible.

Activity 7: Training

Purpose

To familiarize ourselves with the requirements for training within the PSM Standard.

To understand that the purpose of health and safety training is to develop skills to be used on the job — not just for a certificate of completion.

This Activity has one task.

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Task 1

Factsheet Reading Method for Task 1.

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Factsheet #1
PSM Standard Section (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.

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 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 the paragraph. The employer shall prepare a record which contains the identity of the employee, the date of the training and the means used to verify that the employee understood the training.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #2
Who Is "Involved in Operating the Process?"

When OSHA proposed this section of the Standard there was a lot of debate about who should be covered.

There is still some controversy as to the training needs of managers and supervisors.

Some companies contend that managers and supervisors only require training in supervision skills since they have completed college.

Others question how a college education prepares a person for a specific petrochemical process. They further argue that a person could not possibly be able to instruct or give direction to workers if they do not have at least the same training, and that they should have more.

So OSHA gives us their definition:

> "To apply to only those employees, including managers and supervisors, who are actually involved in 'operating' the process."

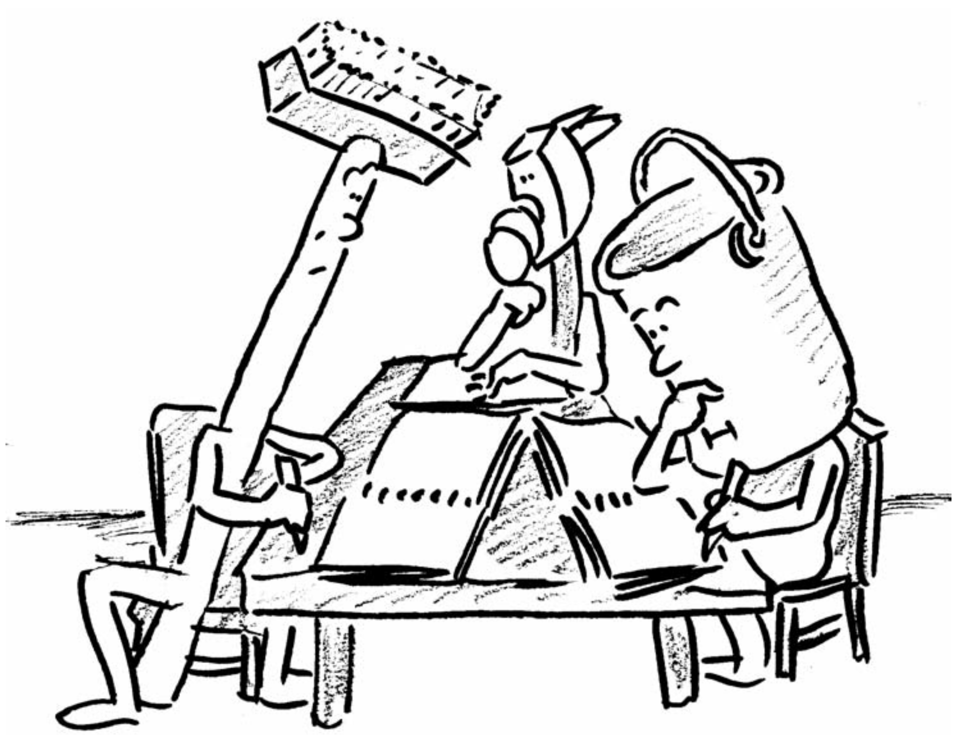
Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992, p. 6381.

Factsheet #3
Maintenance Personnel Must Receive Training Too!

There are also training requirements for maintenance workers listed within the Mechanical Integrity (j) portion of the Standard:

> "The employer shall train each employee involved in maintaining the ongoing 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 task in a safe manner."

This means skills training is required along with an overview of the process.



Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #4
Even Contractors Have to Be Trained!

There are also requirements for contractors (see PSM Standard section (h) — contractors):

> "The contract employer shall assure that each contract employee is trained in the work practices necessary to safely perform his/her job."

It is the responsibility of the Company to insure that the Contractor is giving its employees training.

We have all heard of examples where contractors simply were not skilled or trained within the job they are assigned to perform. A complete history of the training and verification of the contractor's understanding of the training must be kept on file.

Note: Workers and union representatives have the right to review this file. Under the PSM Standard, in the employee involvement section 29 CFR 1910.119(c)(3) states,

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

More than a process, safety overview is needed to fulfill this requirement. It requires a history to verify the skills necessary to be considered a machinist, electrician or any other crafts person.

Source: OSHA Process Safety Management Standard, 29 CFR 1910.119, 57 FR 6356, February 24, 1992.

Factsheet #5
The Myth of "Safety First"

Training for production is the number one reason that companies implement training programs.

According to a survey in which manufacturing firms were asked directly why they had decided to implement their programs:

Reasons Manufacturing Firms Implement Training Programs	
To reduce errors and waste.	54%
As a benefit to workers.	46%
Because a subsidy became available.	46%
Because of pressure from customers.	43%
Because it was needed as a result of changes in production.	40%
As a part of a transformation of corporate culture.	29%
Because it was needed as a result of new technology.	29%
Because it was required by customers.	29%
Because training became available.	26%
Because of changes in the available work force.	26%
To attract new workers.	23%
To attract new customers.	23%
To meet new health and safety requirements.	23%
To meet new certifications.	20%
To meet increased competition.	20%
Because of an agreement with labor.	20%
Because workers identified the need.	17%

Source: "Workplace Education for Hourly Workers," *Journal of Policy Analysis and Management*, Winter 1994.

Factsheet #6
Training for Production Is Not Enough: Health and Safety Must Be Included

As a result of an investigation by OSHA of an explosion at an oil refinery, the company was issued several citations. The citation for failure to properly train employees is as follows:

Citation:

The initial training program for employees involved in operating a process did not include emphasis on:

1. Specific safety and health hazards of the process;
2. Emergency operations including shutdown; and
3. Safe work practices.

The employer did not train all K-l technicians and shift supervisors on the potential hazards, equipment and system limitations and associated safeguards of the K-l polymerization unit.

In settlement of the training issue the company agreed to train each employee involved in the process in:

a. An overview of the process;

b. Operating procedures;

c. Actions taken pursuant to:

    1. Process Hazard Analysis;
    2. Incident Investigation Reports.

   The training will emphasize the specific safety and health hazards of the process . . .

Factsheet #7
Some Have Reasons for Not Training

Firms without education programs were asked to indicate the most important reasons for not having training programs.

Reasons Manufacturing Firms Don't Have Training Programs	
Do not feel the need for such a program.	52%
Believe that the program would cost too much.	41%
Don't have the personnel infrastructure to deal with it.	33%
Too busy to deal with training.	22%
Don't know what skills their employees need or how to arrange for those skills to be taught.	40%
Philosophically opposed to such a program.	29%
Believe the turnover is too high to enable the firm to recoup its investment in the program.	29%

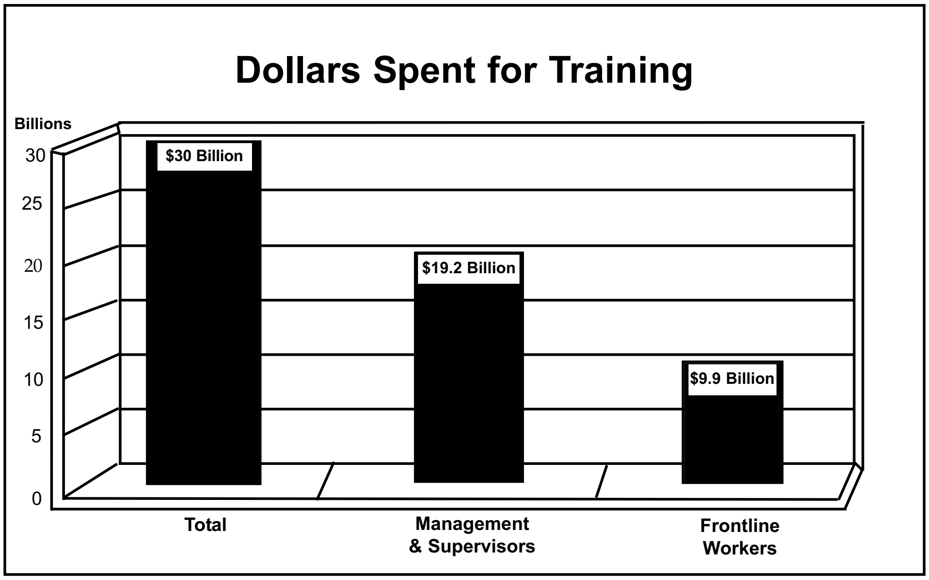
But the bottom line is . . . money!

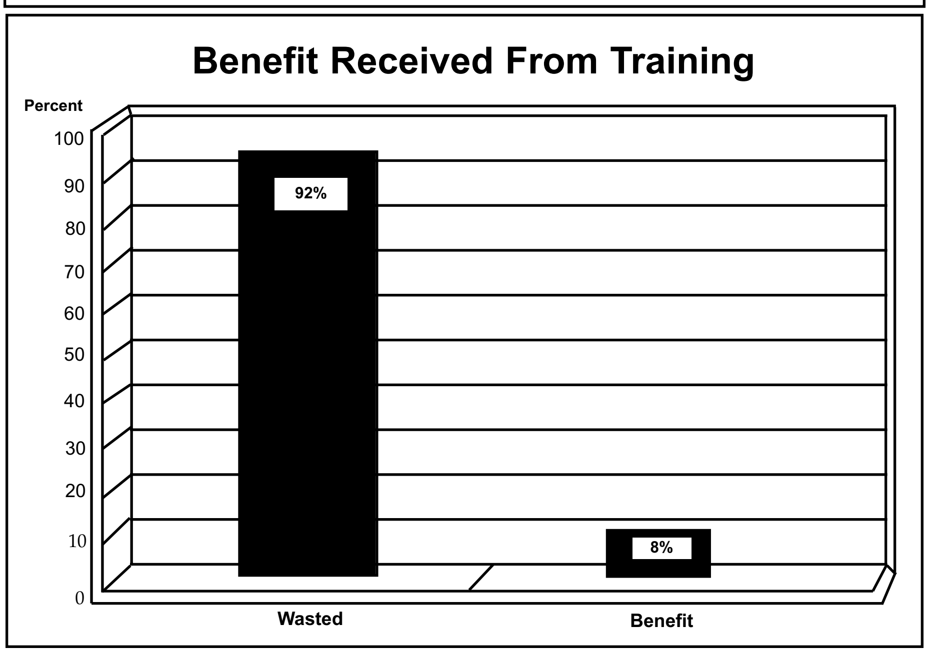
Source: "Workplace Education for Hourly Workers," *Journal of Policy Analysis and Management*, Winter 1994.

Factsheet #8
Training $$$ Must Not Be Wasted

Industry spends a lot for training, but too often it is spent on the wrong people and for training that is of little use.

> **"Of the estimated $30 billion spent by employers on formal training, about one-third is apportioned to front-line workers, and only eight percent of them benefit by it."**





Source: Commission on the Skills of the American Workforce, "America's Choice: High Skill or Low Wages!," as reviewed in the *Monthly Labor Review*, November 1990.

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Task 1 *(continued)*

Task 1 Training Activity

In your group discuss the following questions. As you answer each question, jot down which factsheet(s) helped you arrive at your answer. Your scribe will record your answers to report back to the class.

1. Who (job classifications) is the employer required to train on a process under the PSM Standard?

2. Who should be included in the discussion about how often to offer refresher training for a particular job?

3a. At your worksite are operators, supervisors, maintenance workers and contractors all trained adequately on process specific safety?

3b. If your answer to 3a was "Yes," please explain. If your answer was "No," please describe what improvements are needed in your current training system to make it work properly.

4. Your table is a group of workers involved on Process A. You have recently requested more intensive safety training about the operation of the process for yourselves and for the contractors working in your area. The plant manager's response was this, "I am concerned about adding more training because our time and our costs are already stretched; but if you build a good case for it, we'll do it."

How would you argue the value of spending more time and resources on more training?

Summary: Training

1. The PSM Standard tries to ensure that all employees involved with the process are trained. This means operators, foremen and supervisors. If you do the work, tell someone how to do the work or decide what work is to be done, you must be trained.

2. All maintenance personnel must be trained. Direct-hire and contractors must be trained before they repair equipment.

3. Maintenance foremen and supervisors must be held to the same standard as operations foremen and supervisors. A foreman cannot oversee the rebuilding of a gas-fired turbine by a machinist if his or her training is for welding or accounting.

4. Employees must be allowed to use their training and education to make decisions. Who better to act than the one who does the work?

5. All training should focus on health and safety skills, not just production skills.

UNITED STEELWORKERS

Training Project: Process Safety Management in Oil Refineries

Date: ______________________

1. Overall, how would you rate this health and safety training session?

____ Excellent ____ Good ____ Adequate (O.K.) ____ Fair ____ Poor

Comments: ____

____

2. Were the teaching methods effective?

____ Yes ____ No ____ Don't know

Comments: ____

____

3. Were the materials, hand-outs and/or activities useful?

____ Yes ____ No ____ Don't know

Comments: ____

____

4. Will the information you received in the training program be useful on the job and/or in your health and safety work?

____ Yes ____ No ____ Don't know

Comments: ____

____

5. What would have made this a better/more useful health and safety training program?

____

____

____

Please turn the page.

6. On what additional health and safety topics would you like further information and/or training? (Optional: include your name, local union, district, address and email so that we can contact you.)

7. Additional comments:

Appendix A: Supplemental Information
(To be used with Activity 4, Task 2.)

General Information

- We have no written procedures for lining up a reboiler; the process is too simple to need them written down.
- About five years ago this very same thing happened so we circulated a bulletin to open the outlet first. We had already started up and didn't want to shut down to repair the relief valve. We figured it was okay; it didn't lift while we were running.

For Joe: Outside Operator

- Employed for four (4) years; and during all of them he's been assigned to this unit.
- Has worked 16 12-hour shifts in a row.
- Connie called me on the radio and asked me to see why T-111 wasn't heating up and showed no flow.
- I saw the block valves were closed and the control valve was wide open.
- I started opening the block valves, when all of a sudden, the hot oil started spraying everywhere.
- I hurried up and closed the valve and radioed for help; I was covered with oil.
- You could see the oil was coming up from the hub; I guess the relief valve had lifted.
- When Pat showed up, he told me to get a shower and clean coveralls.
- I’ve lined that system up before.
- My relief didn't say anything about T-111 or the valves.
- There were no tags to indicate it was not supposed to be put into service.
- I don't know of anything wrong with this system.

For Pat: Unit Foreman

- Employed for 18 years; and during all of them Pat's been assigned to this unit.
- I believe Joe is a very good operator.
- I was inside with Connie when she called Joe on the radio and asked him to check out the system.
- When I heard Joe call for help, I immediately went outside.
- There was a lot of oil on the slab. I called for another operator to come and wash the area down.
- What I think happened was that Joe opened the inlet block valve first and the pressure caused the relief valve to lift.
- He should have opened the outlet first. This way it would have never lifted.
- I think a one-day suspension is sufficient to impress on him how important it is to line up the outlet first.
- Joe is thoroughly trained.