Naphtha Fire Kills 4 and Severely Injures 1

Lessons Learned

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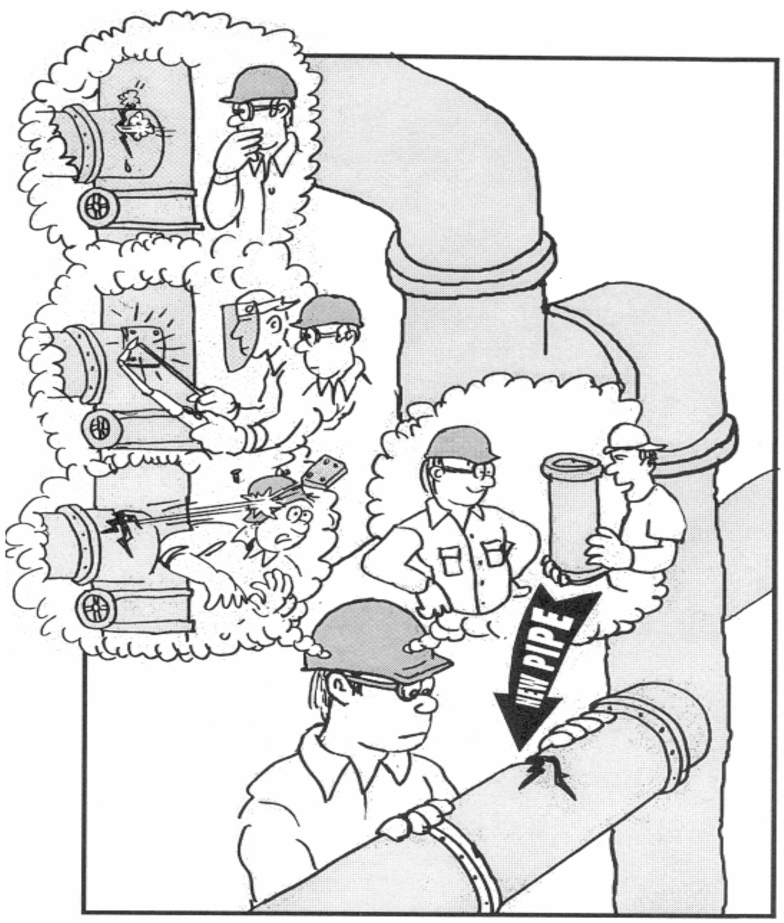
Purpose

To conduct a small group “lessons learned” activity to share information gained from incident investigations.

To understand “lessons learned” through a systems of safety viewpoint.



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The incident and recommendations made are from an actual USW represented facility. These recommendations are a product of the site’s analysis of the incident and not meant to represent the USW official view on the topic(s). In fact, one of the goals of this exercise is evaluate the recommendations made and to suggest improvements.

Introduction

One Hour "Lessons Learned" Safety Training Activity

This is a Small Group Activity Method (SGAM) exercise. It is designed for use in toolbox style meetings where a group of craft persons, operators, or other small group is assembled for a safety training session. The whole group should be further divided into smaller discussion groups of four to six people.

The tone of the meetings should be informal to create as much discussion as possible within the groups and among the groups. Active participation by group members is essential for this exercise to be successful.

If you plan to present a Lessons Learned Activity and have not been trained in the USW worker trainer program, you should contact the USW Health, Safety & Environment Department:
Phone (412) 562-2581
email: safety@steelworkers-usw.org for trainer information.

For this exercise, each person in the group should have their own copy of this activity printed in its entirety. The exercise consists of three tasks. Each task is designed to provoke thought and generate discussion about the incident at hand. Each discussion group should designate a scribe to keep notes and report back to the facilitator and class after each task. When the exercise is completed, review the Summary on page 13.

Definitions of terms used in this exercise are provided throughout the activity. A glossary of terms is also provided in the appendix.

The incident(s) depicted in this activity are based upon real occurrences. The names of persons and corporations are fictitious.

Task 1

Please read the following scenario:

A line from the naphtha draw on a crude tower to a naphtha stripper tower developed a pinhole leak on an elbow about 112 feet up the tower. Inspection determined the entire line was severely corroded and required replacement. The corrosion was determined to have resulted from a desalter that had been operating over its rated capacity for an extended period of time. Multiple attempts to isolate the line were made over the course of the next 13 days but all were unsuccessful. During this time span, the leak reoccurred even though the block valves were closed and it was noted that the line was warm to the touch. Each time the leak reoccurred, the valves were tightened more and the leak would subside. It was later determined that a bypass valve had been operated in an open position for an extended time span causing erosion of its seats. This caused it to leak. Attempts to drain the piping were also unsuccessful due to a hard tar like substance that plugged portions of the line as well as the bleeder valves needed to drain the line. Attempts to drill out the bleeder resulted in the drill bit breaking in the hard material.

On the day of the incident, supervisors, operators, and maintenance workers were aware that the piping contained liquid naphtha and that the crude unit was still in operation. The operator and maintenance workers inspected the job site and reviewed the equipment conditions. It was identified on the work permit that the line required draining. The permit was signed and issued.

To drain the line, a half barrel was placed under a low point flange on the line. The flange was to be opened and the naphtha in the piping would spill into the barrel. A vacuum truck was placed in position to suck the naphtha out of the barrel as it filled. This attempt to drain the line was also unsuccessful as the line would not completely empty.

The maintenance supervisor judged that the naphtha level was at a certain height in the line by tapping on the line and listening for differences in the sound. He decided that the upper section of piping should be cut out and removed with a crane. The piping would be unbolted at the crude tower outlet valve and cut 8 feet below the outlet. The operator objected, saying the pipe should be drained first. The maintenance supervisor proceeded with his plan anyway.

The upper flange was opened and the cut was made. A blind flange was installed on the tower outlet valve. The cut end of the pipe pointed directly at the operating crude tower. The maintenance supervisor then directed his workers to make a second cut 26 feet below the first cut. As this cut was being made, naphtha started seeping from the new cut. The worker stopped cutting and the maintenance supervisor decided to drain the line again using the open flange/half barrel/vacuum truck method. When a volume of naphtha had been drained from the vertical run of the piping, the head pressure was also reduced. This allowed enough pressure from the running process unit to leak through the defective bypass valve to allow a sudden release of naphtha through the open end of the cut pipe.

The released naphtha shot from the cut end of the pipe, engulfing the tower structure and soaking personnel working on the job with naphtha. The tower was operating above the autoignition temperature of the naphtha and so provided the ignition source for the very large fire that resulted. As a result of the fire, one worker was pronounced dead at the scene and the other three victims died at the hospital. The fifth worker jumped away from the flames at an elevated location and although he survived, he sustained serious injuries.

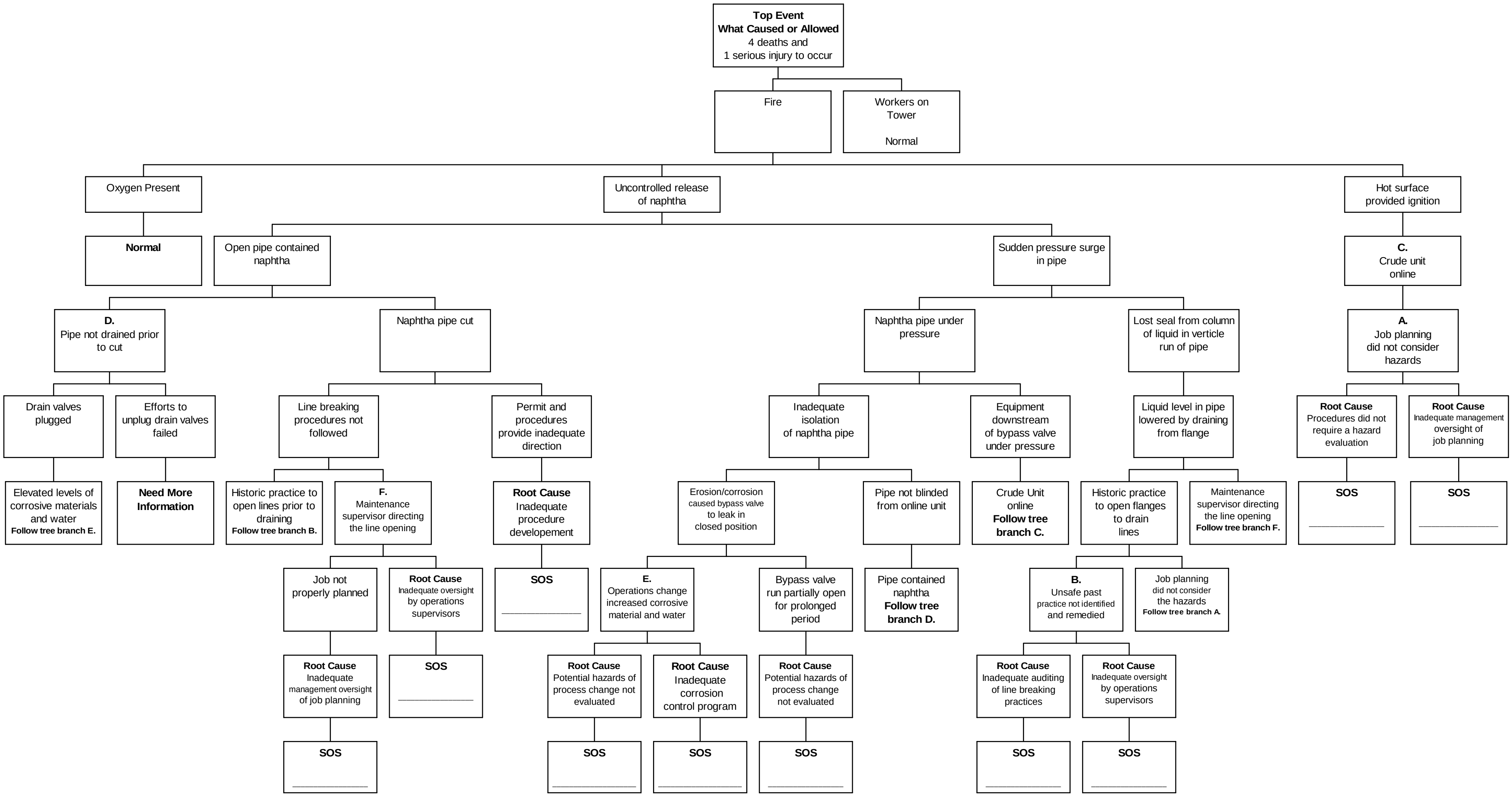
Task 1 *(continued)*

On the next page you will find a logic tree that shows how the investigators at this site linked the incident that occurred (the top event) to the facts described in the scenario and the incident's root causes. Below each root cause in the logic tree you will find a block with the title "SOS" (System of Safety).

Find the boxes marked SOS. Directly above those boxes will be a root cause of the incident. Your task is to complete the logic tree by identifying the *major* system of safety affected where the root cause failure occurred and list it in the box. These "systems" are listed in a chart on page 9. *Note: some of the SOS boxes may already be completed for you.*

Please select someone in your group to act as scribe to report back your answers.

A **Logic Tree** is a pictorial representation of a logical process that maps an incident from its occurrence to the root causes of the incident.



Task 2

A. Below you will find two lists. On the left are the root causes from the logic tree on the previous page. On the right are recommendations made by the team that investigated this incident. On the chart below identify which of the "recommendations" would eliminate or reduce each "root cause" by placing the number of the recommendation(s) on the line provided. More than one recommendation can apply to a root cause.

	Root Causes	Recommendations
______	A. Inadequate procedure development.	1. Conduct audits that assess: • Safe conduct of hazardous non-routine maintenance • Management oversight and accountability for safety • Management of change program • Corrosion control system
______	B. Inadequate oversight by operations supervisors	2. Implement a program to ensure the safe conduct of hazardous non-routine maintenance.
______	C. Inadequate management oversight of job planning.	3. Ensure that MOC reviews are conducted for changes in operating conditions, such as altering feedstock composition, increasing process unit throughput, or prolonged diversion of process flow through manual bypass valves.
______	D. Potential hazards of process change not evaluated.	4. Ensure that a corrosion management program effectively controls corrosion rates prior to the loss of containment or plugging of process equipment
______	E. Inadequate corrosion control program.	
______	F. Inadequate auditing of line breaking practices.	
______	G. Procedures did not require a hazard evaluation.	

B. Use the concepts found on the factsheets on pages 9 through 12 and evaluate the recommendations from Question A. How would you strengthen or add to the list?

Task 3

Discuss ways in which the "Lessons Learned"(listed below) from this incident can be applied at your workplace. Please explain.

Lessons Learned

- Process changes must be evaluated to comply with Management of Change.
- Changes in feedstock constitute a process change and should be treated in the same manner a change in equipment. Management of Change must be performed.
- Supervisors must oversee all aspects of hazardous work from planning to execution as they are accountable for the results.
- A corrosion control program is essential to ensure that the Maintenance & Inspection of equipment in not compromised.
- Inadequate procedures are sometimes as hazardous as no procedures. Poor procedures can lead to a false sense of security.
- If isolation of operating equipment is questionable, conducting work that precludes any possibility of securing that equipment should be avoided at all costs.
- Operating equipment in excess of its rated capacity can result in any number of unexpected hazards.
- Control valves should not be operated for extended periods of time with their bypass valves open. If the valves are too small, engineer a proper sized valve for the job.

Systems of Safety
And
Subsystems

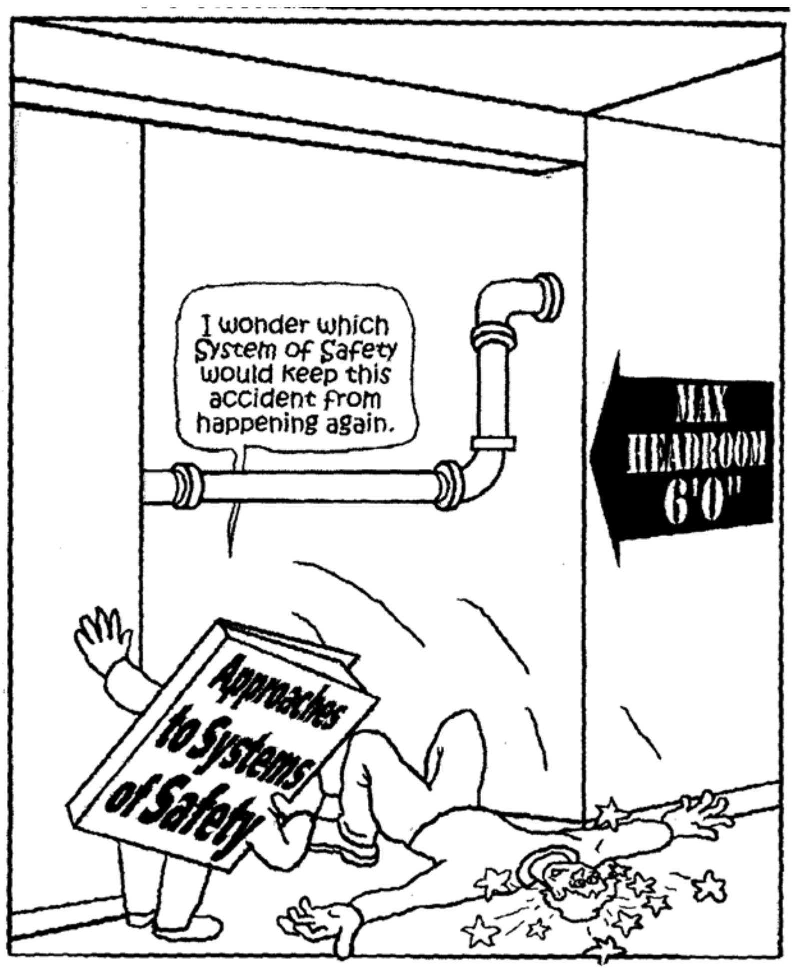
Major Safety Systems	**Design & Engineering**	**Maintenance & Inspection**	**Mitigation Devices**	**Warning Devices**	**Training & Procedures**	**Personal Protective Factors**
Level of Prevention	**Highest—the first line of defense**	**Middle—the second line of defense**				**Lowest—the last line of 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** Staffing $_{HF}$ Skills and Qualifications $_{HF}$ Management of Personnel Change (MOPC) Work Organization and Scheduling $_{HF}$ Allocation of Resources Codes, Standards and Policies**	Inspection and Testing Maintenance Quality Control Turnarounds and Overhauls Mechanical Integrity	Enclosures, Barriers and Containment Relief and Check Valves Shutdown and Isolation Devices Fire and Chemical Suppression Devices	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 Information Resources Communications Investigations and Lessons Learned	Personal Decision-making and Actions $_{HF}$ Personal Protective Equipment and Devices $_{HF}$ Stop Work Authority

HF – Indicates that this sub-system 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 sub-systems listed here are related to Design and Engineering. These subsystems may also be relevant to other systems, for example, Mitigation Devices. When these sub-systems relate to systems other than Design and Engineering they should be considered as part of those other systems, not Design and Engineering.

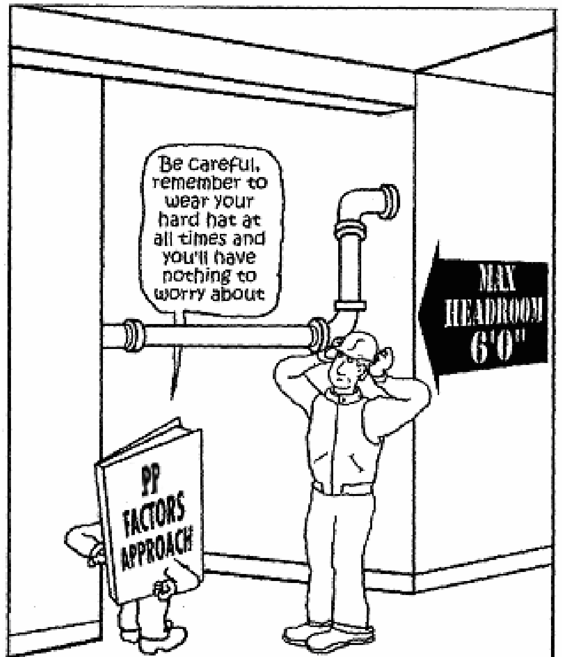
All Systems of Safety Are Not Created Equal!



Surprisingly, the same hazard can often be addressed in more than one system. Take the low pipe in the doorway above, on the next two pages you'll see how this same problem could be handled by each of the major Systems of Safety.

Which is the best approach? Well, if you look at the Systems of Safety Chart on the previous page, you will find the SOS's arranged in order of strength: the most powerful – Design – on down to the least powerful – Personal Protective Factors.

A good investigation team will consider the full range of recommendations for each root cause.



Personal Protective Factors

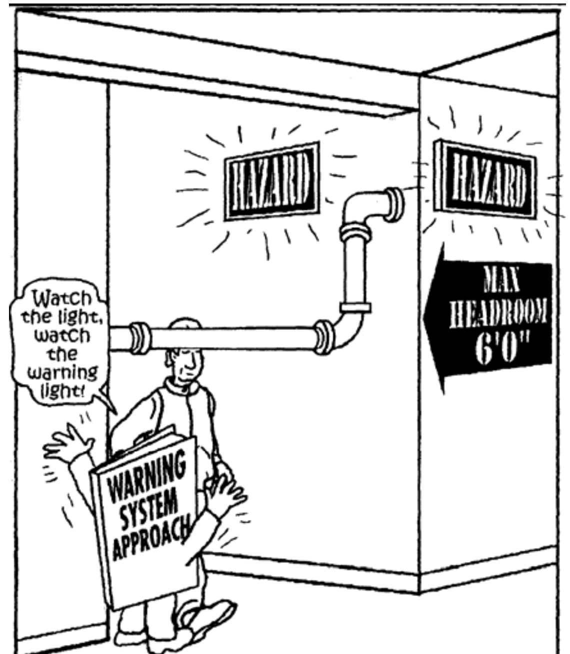
Sub-systems that include a broad range of working conditions and situations that affect workers.

- Weakest system
- Controls the hazard directly at the individual's level

Procedures and Training

The instructions and knowledge necessary to maintain and operate equipment or processes

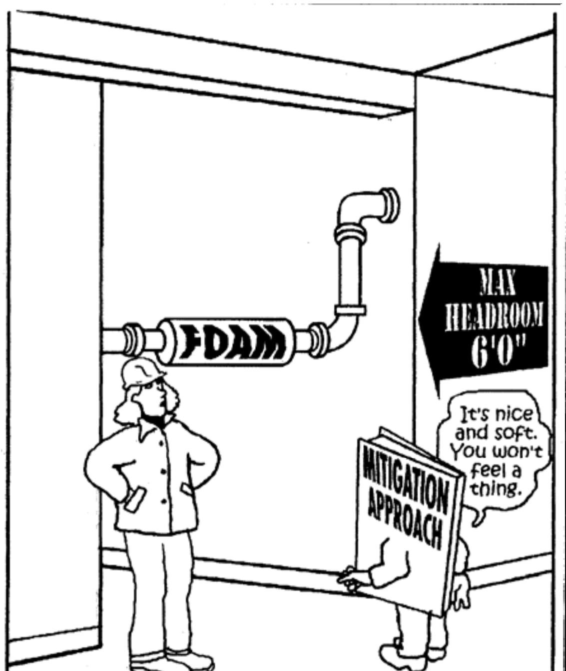
- Easier to affect groups of workers.
- Dependent on individuals' memories and lack of distraction



The Warning System

Devices that warn of a dangerous or potentially dangerous situation.

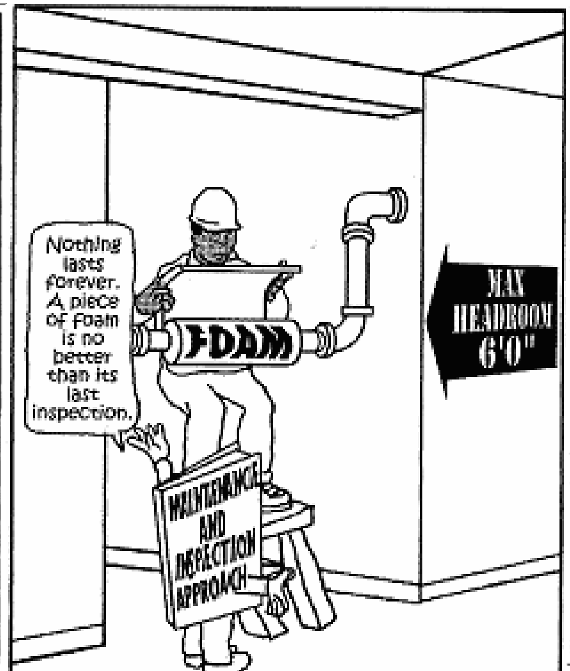
- Draws attention
- May be missed or ignored



The Mitigation System

Sub-systems that automatically act to control or reduce the effect of hazards.

- Workers protected automatically



Maintenance & Inspection

The system responsible for maintaining, repairing and inspecting equipment and processes.

- Vital to make sure even the best designed system continues to function safely

Design and Engineering

The primary (highest level) system that designs the hazard out of the process.

- Strongest system
- Hazard eliminated

Summary: Lessons Learned

1. The objective of "lessons learned" is to prevent accidents through identifying and correcting underlying defects in systems of safety. To achieve maximum prevention, all recommended changes should be made.

2. Corrective action resulting from lessons learned is one of the best methods for achieving proactive health and safety. Maximum prevention is achieved by correcting the conditions that led to the incident at other sites in the plant and at other sites.

3. Systems of safety-based analysis help identify the underlying causes of incidents and are valuable for determining what corrective measures should be taken as a result of the lessons learned.

4. Many times the result of an incident investigation is that worker error is identified as the main contributing factor. When a systems of safety-based analysis is used, multiple root causes are usually uncovered.

5. The most effective controls of health and safety hazards are those which are integrated or designed into the process, such as engineering controls. The least effective controls involve personal protective equipment and procedures that merely acknowledge the hazard and do nothing to eliminate it.

6. All work-related hazards must be evaluated before work begins to eliminate or reduce worker exposure to hazards and to prevent injuries.

Glossary of Terms (Appendix)

Several unique terms are used while doing the "Lessons Learned" exercises. Their definitions are listed below.

Contributing Factor—something that actively contributes to the production of a result, an ingredient.

Fact—a piece of information presented as having objective reality, an actual occurrence or event.

Hierarchy of Systems of Safety—the ranking of systems of safety as to their relative effectiveness in providing accident prevention. This hierarchy is represented by the "Fulcrum" with the most effective system of safety residing on the left side of the lever. Less effective systems reside further to the right on the lever.

Lessons Learned—A summation of an investigation that describes safety hazards or conditions with general educational recommendations to identify and correct similar conditions. These differ from investigation recommendations as illustrated below:

> ***Investigation recommendation:*** Replace the carbon steel gate valve on the vacuum tower bottoms line with a chrome valve. The valve failed due to corrosion.
>
> ***Lessons Learned:*** Verify that carbon steel valves and piping are not used in vacuum tower bottoms service because corrosion can cause them to fail.

Logic Tree—a pictorial representation of a logical process that maps an incident from its occurrence to the root causes of the incident.

Recommendations—calls for specific changes that address each root cause of an incident or accident to prevent its reoccurrence.

Root Cause—basic cause of an accident found in management safety systems.

Glossary of Terms *(continued)*

Supports and Barriers—"supports" are conditions that promote or render assistance to implementing recommendations while "barriers" are conditions that obstruct the implementation of recommendations.

Systems of Safety—management systems that actively seek to identify and control hazards before they result in an incident or injury.

- Design and Engineering
- Maintenance & Inspection
- Mitigation Devices
- Warning Systems
- Procedures and Training
- Personal Protective Factors

Conducting a "Lessons Learned" Activity

Circle the number that best shows your response to each of the following questions.

1. How easy was it for you to understand the "systems of safety" approach presented in this activity?

4	3	2	1
Very easy	**Somewhat easy**	**Somewhat hard**	**Very hard**

2. How useful do you think this "systems of safety" way of thinking could be for tackling safety and health problems at your workplace?

4	3	2	1
Very useful	**Somewhat useful**	**Not very useful**	**Of no use**

3. How much do you agree or disagree with the following statement:

   The logic tree diagram approach can be helpful for analyzing the root causes of safety and health incidents.

4	3	2	1
Strongly agree	**Agree**	**Disagree**	**Strongly disagree**

4. Overall, how useful was this "lessons learned activity" for considering safety and health problems at your workplace?

4	3	2	1
Very useful	**Somewhat useful**	**Not very useful**	**Of no use**