MAINTENANCE MECHANIC SPRAYED WITH HF ACID

Lessons Learned

Volume 04 Issue 45

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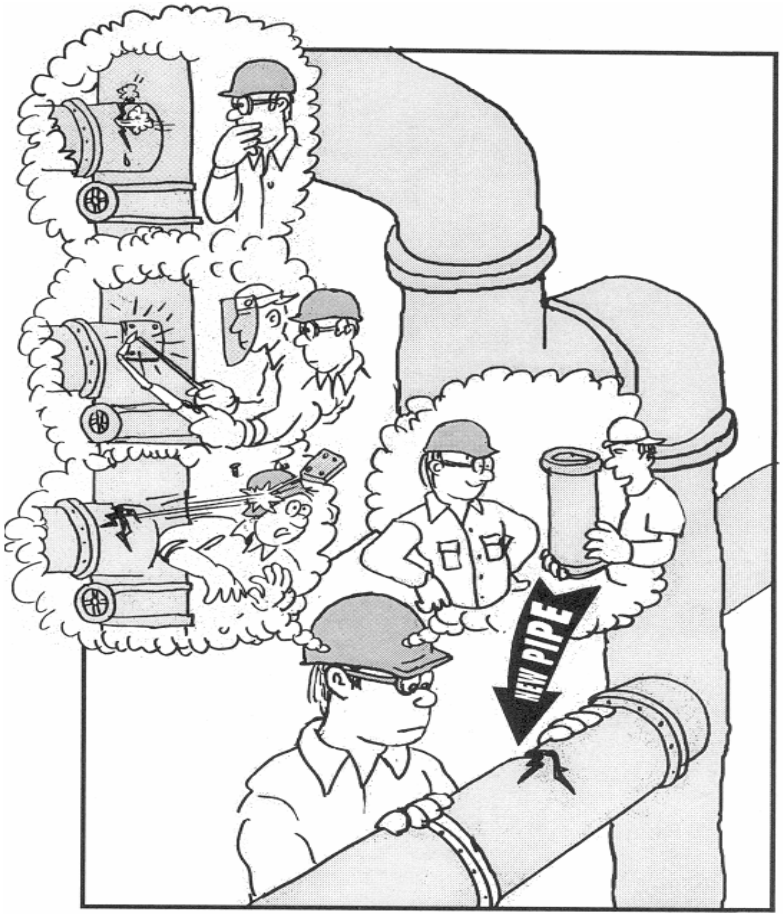
Purpose

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:

Note: HF acid is Anhydrous Hydrofluoric Acid

Two Maintenance/Mechanics were replacing the dip/tube on the SGF2 Plant HF vaporizer. They were replacing the dip/tube because of line modifications and the old dip/tube was not compatible to the new piping. They started the removal of the old dip/tube at 13:30 with the assistance of a crane. The removal was completed without incident or any smoke from the HF vaporizer. The replacement of the dip/tube was started at approximately 13:40. A decision had been made by the mechanics and the maintenance foreman to replace the dip/tube by hand without the assistance of the crane because the removal was completed without incident. During reinsertion of the dip/tube, with approximately a foot remaining to be inserted, HF was instantaneously released up through the dip/tube. The Maintenance/Mechanic reinserting the dip/tube had HF sprayed up under his face shield and onto his face. This incident happened at approximately 13:45. Water was immediately put on his face and held there by the standby safety/man. At approximately 13:47 a Code One was announced over the PA system. The Emergency Response Team and the Emergency Medical Personnel arrived at approximately 13:50-13:55 and started administering first aid to his burns. An ambulance arrived on the scene at approximately 14:15 and at 14:25 left for the hospital. Everyone involved in the dip/tube removal and insertion had all safety PPE on as required by the Special Work Permit.

The subsequent investigation found the following:

A determination was previously made that there was not a dip/tube in the SGF2 HF vaporizer. This vaporizer had a better in service record than either A&B or D&E HF Vaporizer. It was known that the other two vaporizers had dip/tubes but no one could find a record of a dip/tube in theSGF2 HF vaporizer. A determination was made to remove the dip/tubes from A&B and D&E HF vaporizers so they would perform better. After the removal of the dip/tubes from A&B and D&E HF vaporizers, it was found that there was a dip/tube in the SGF2 HF vaporizer. This was the action that started the removal and reinsertion of a new dip/tube into the SGF2 HF Vaporizer. (Assuming that the lack of a dip/tube in the SGF2 HF vaporizer allowed the vaporizer to perform better).

- A decision was made to leave liquid HF in the vaporizer.
- There was a previous good example of opening a HF tank at the tank farm (The storage unit for HF).
- There was no procedure to prevent the opening of the HF vaporizer.
- Necessary work required the vaporizer to be opened.
- The hazards associated with opening the HF vessel was not recognized by the decision/makers, planners, supervisors, or workers.
- The dip/tube was lowered into 64.4 degree F. liquid HF. The dip/tube was at ambient temperature of at least 85 degrees F. because it lay in the sun for 10 to15 minutes. The boiling point of HF is 67 degree F.
- There was not a specific work permit authorizing work on the SGF2 HF vaporizer.
- An acid hood was not worn because it was not required on the work permit they assumed they were working with.
- The original scope of work did not include the dip/tube on the SGF2 HF vaporizer.
- Other Significant Findings:
- There is not a uniform work permit system within the plant.
- A special work permit was issued for too large an area of the plant. The HF system covers a large segment of the plant.

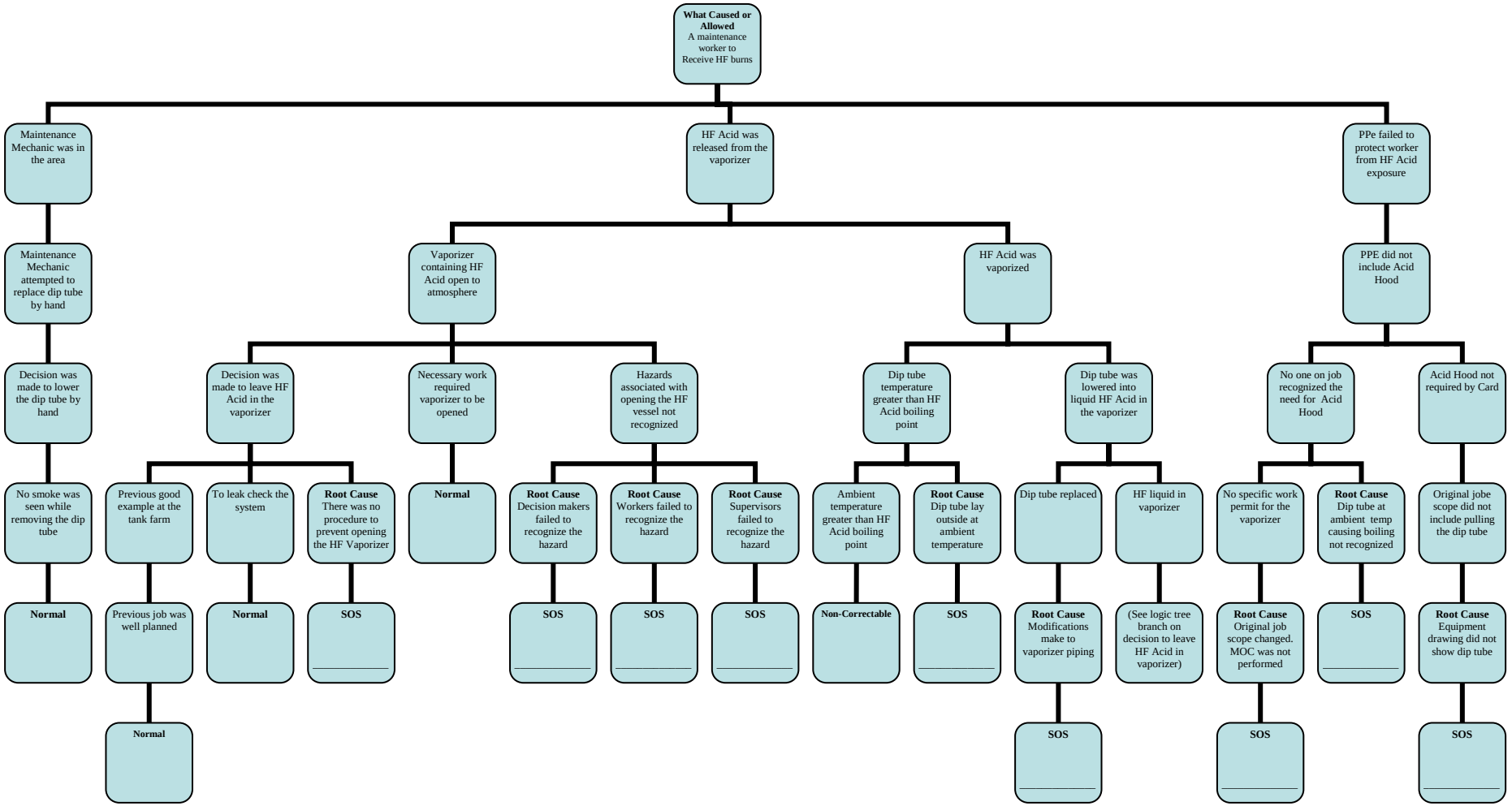
Task 1 *(continued)*

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. There was no smoke while removing the dip/tube from the HF vaporizer.	1. A work permit should be issued for each individual task performed, including those that are covered under a total system lockout card.
	B. The previous removal of a dip/tube from a tank containing liquid HF was well planned, giving a good experience with dip/tube removal.	2. Implement a uniform work permit system throughout the plant.
	C. There was no procedure to prevent opening the HF vaporizer.	3. Reduce the workload on supervisors to allow work to be planned and completed safely.
	D. Decision/Makers, Planners, Supervisors, and Workers failed to recognize the hazards.	4. Have the foreman review the Safety Handbook each time a work permit is issued, then make the appropriate PPE recommendations on the work permit.
	E. The dip/tube lay outside at ambient temperature for ten to fifteen minutes.	5. Always allow enough time to ensure jobs are completed safely.
	F. Modifications were made to the HF vaporizer piping.	6. Whenever a potentially dangerous condition is discovered during a job, stop the work, think, and re-evaluate before continuing the job.
	G. Liquid HF was in the vaporizer.	7. Never install or remove dip/tubes or any other piping connected to vessels containing any hazardous materials without proper planning and a management of change.
	H. No specific work Permit for the SGF2 vaporizer. Original job scope changed-MOC not performed.	8. No work will be performed on any vessel containing Liquid HF or any other hazardous material under standard operating procedures.
	I. Dip/Tube at ambient temperature causing HF to vaporize not recognized.	9. No HF or Sulfuric Acid bearing lines or vessels will be broken or entered into without personnel wearing a minimum of all PPE plus the acid hood per Employee Safety Handbook
	J. Equipment drawing, being used for the work, did not show a dip/tube.	10. Order more acid hoods.

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

- An individual work permit should be issued for each job performed.
- A uniform work permit system needs to be implemented throughout the plant.
- Supervisor's workloads have to be reduced to allow for planning and completing work safely.
- Always consult the Safety Handbook as required.
- We can always step back from a dangerous work situation and completely re-evaluate the situation with safety foremost in our minds.
- Work performed on vessels containing liquid HF or other hazardous material should not be worked using standard operating procedures.
- A worker can never have on too much safety PPE when HF or Sulfuric Acid bearing lines or vessels are broken or entered into.
- Have enough PPE on hand to complete all work safely.

Systems of Safety
And
Subsystems

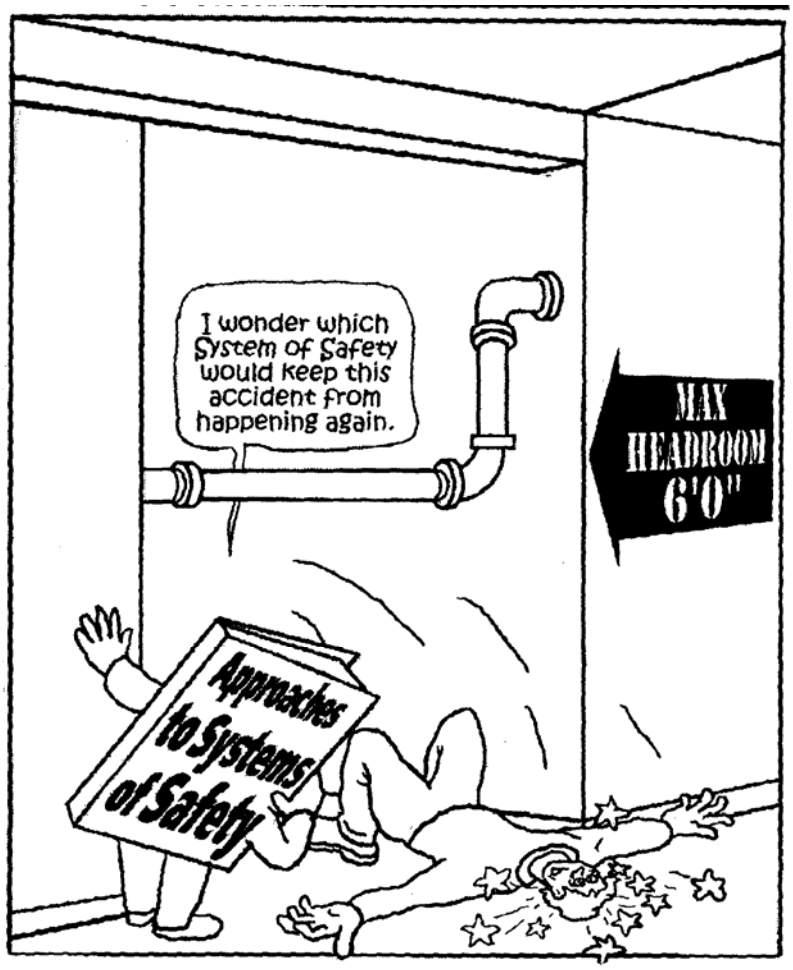
Major Safety Systems	Design & Engineering	Maintenance & Inspection	Mitigation Devices	Warning Devices	Training & Procedures	Personal Protective Factors
Level of Prevention	**Highest—the first line of defense**	**Middle—the second line of defense**				**Lowest—the last line of defense**
Effectiveness	**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.

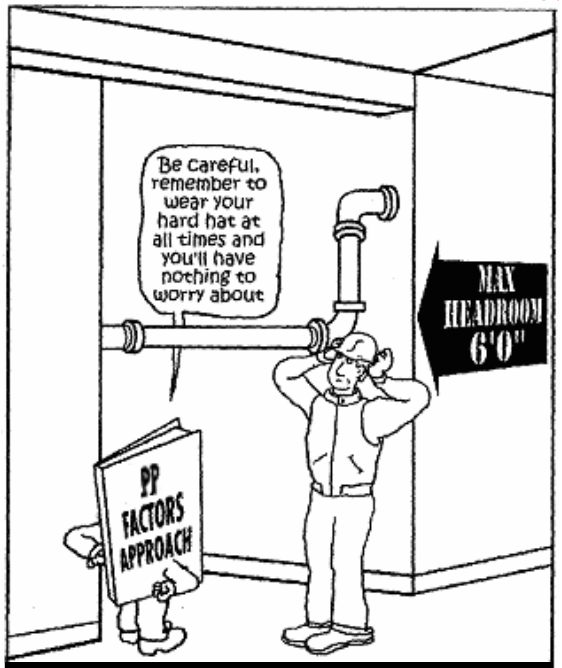
All Systems of Safety Are Not Created Equal!



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

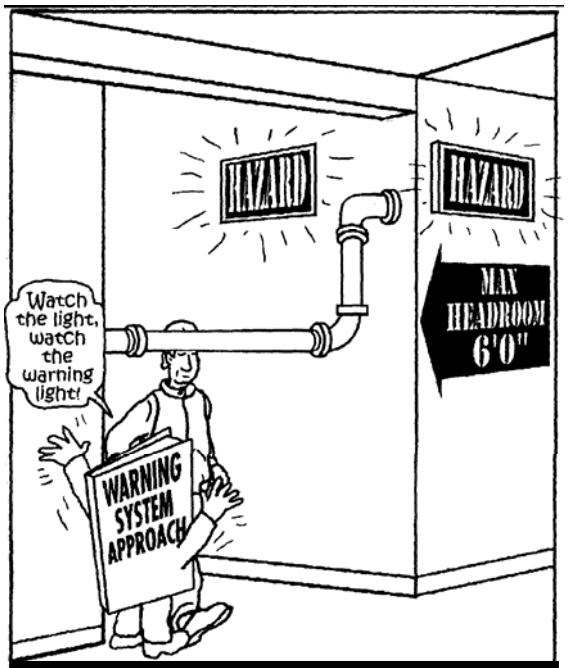
Sub-systems that include a broad range of working conditions and situations that affect workers.

- 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

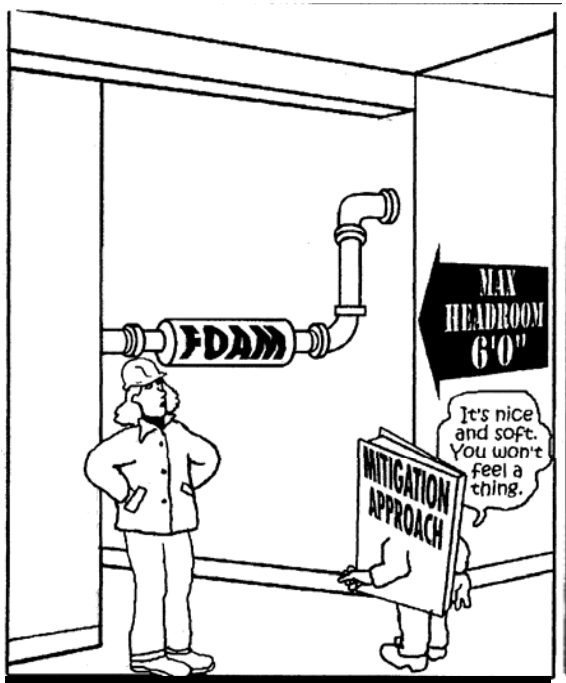
- Easier to affect groups of workers.
- Dependent on individuals' memories and lack of distraction



The Warning System

Devices that warn of a dangerous or potentially dangerous situation.

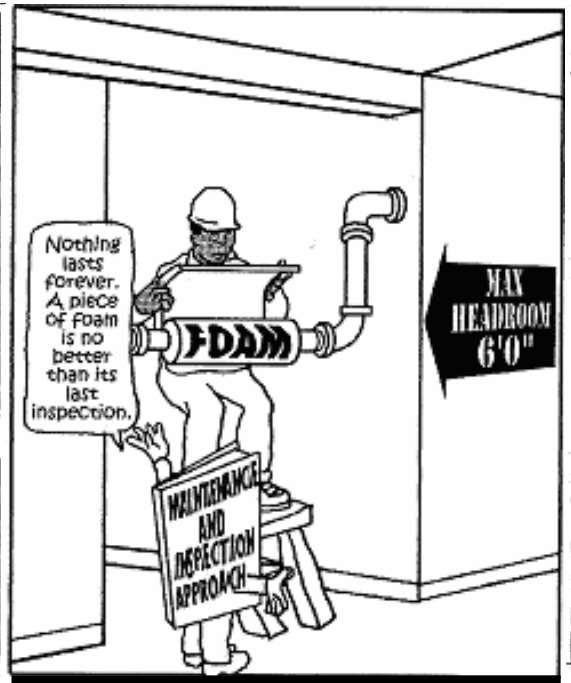
- Draws attention
- May be missed or ignored



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**