Toxic Flammable Gas Release From Rail Car Results in 3 Fatalities

Lessons Learned

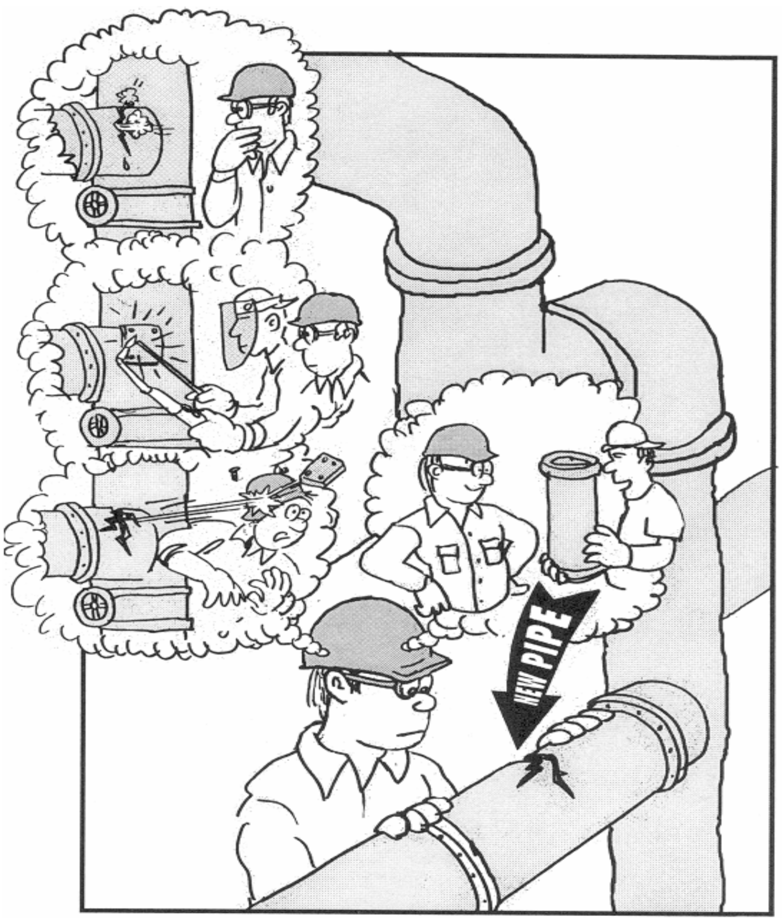
Volume 03   Issue 23

Toxic Flammable Gas Release From Rail Car Results in 3 Fatalities

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

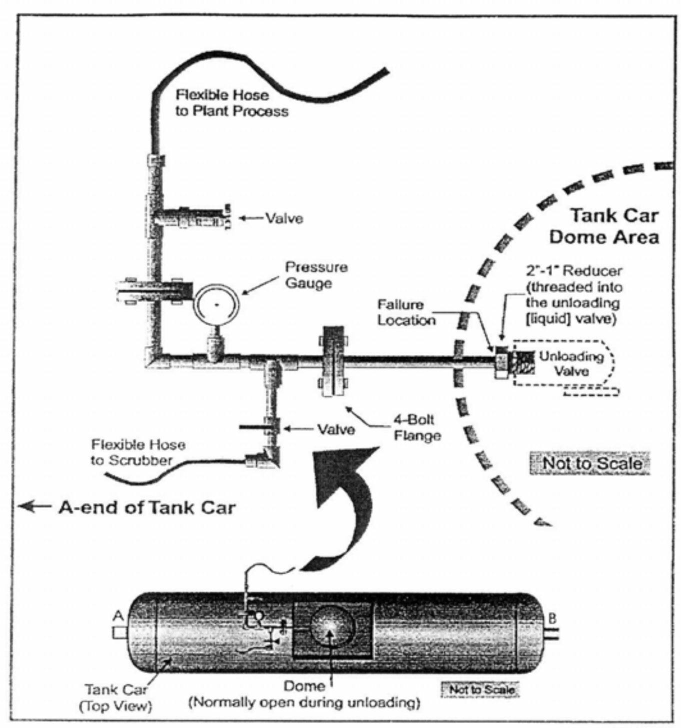
Please read the following scenario:

In the early morning hours, an operator had completed hooking up a railcar containing a flammable and toxic liquefied gas for later transfer. The operator was in the process of leak checking the connection apparatus which included a threaded connection to a two inch to one inch reducer attached to the railcar unloading valve. The procedure did not require the operator to conduct this check with an inert material and the check was being conducted with the toxic and flammable material present in the rail car. During the leak check, the pipe fractured and separated, causing a catastrophic release of the material. The excess flow valve on the railcar did not activate. Three employees died from exposure to the material.

The unloading procedures for the railcar did not require the operator to wear supplied air while performing this activity. The plant relied upon the excess flow valve on the railcar as the primary layer of protection against blowouts.

Various railcars delivered to the plant have different unloading configurations, requiring the use of differing connecting equipment. Suppliers were not required to provide a uniform and specific type of unloading connection.

The connection apparatus, which weighed in excess of fifty pounds, was only supported by the connections to the railcar and the plant hard piping. During the leak check process, additional stress could be placed on the apparatus. The same connection apparatus was used for an extended period of time, but due to the relatively few number of cars requiring a threaded connection, the threaded connection assembly was used infrequently. It was stored uncovered on the unloading platform during all weather conditions. The connection apparatus had experienced internal erosion/corrosion. Maintenance & Inspection procedures of the connection apparatus were ineffective in monitoring the extent of this erosion/corrosion.



Overhead view of unloading apparatus. (For clarity, the pressure gauge, valves, and scrubber line have been rotated into the horizontal plane.)

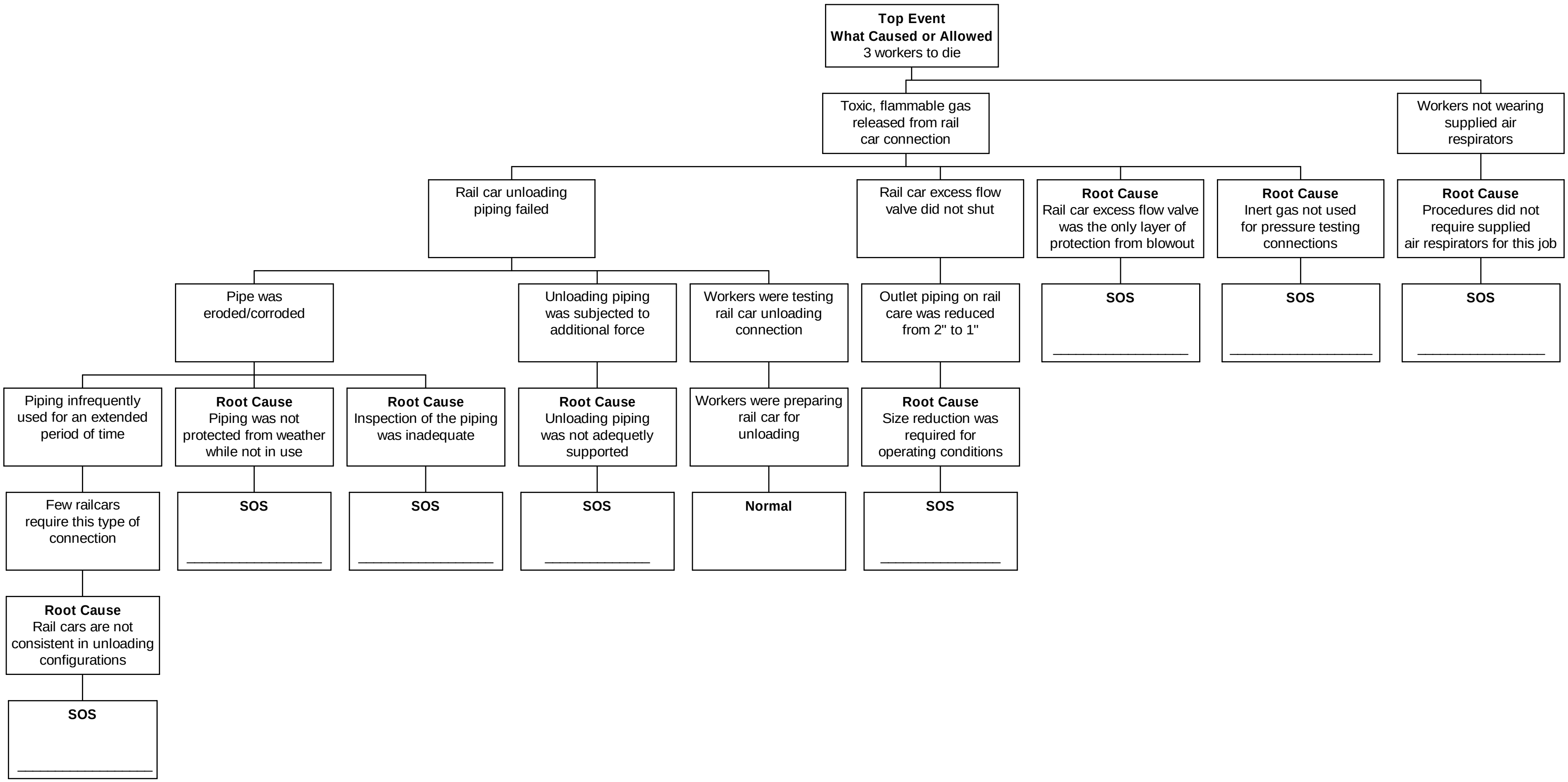
Task 1 *(continued)*

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. Procedures did not require supplied air respirators for this job	1. During hook-up of any toxic flammable material require observation of hook-up by at least one other person. Observer should be in safe location during hook-up. 2. Train the observer in proper observation techniques and what to do if something occurs during hook-up.
________	B. Inert gas not used for pressure testing connections	3. After hook-up to any toxic flammable material, for loading or unloading, hoses should be checked for leaks with an inert material.
________	C. Rail car excess flow valve was the only layer of protection from blowout	4. All rail cars and tank trailers of a specific substance, provided by suppliers, should be required to have the same loading and unloading configuration equipment. 5. Train all loaders and unloaders to recognize problems with improper unloading configuration and alert supervisor when noticed.
________	D. Size reduction was required for operating conditions	6. All loading and unloading equipment needs to be protected from weather either in its own storage box or inside a building.
________	E. Unloading piping was not adequately supported	7. Require visual inspection of all loading and unloading equipment prior to hook-up.
________	F. Inspection of the piping was inadequate	8. Plants should include all critical equipment associated with loading and unloading of rail cars and tank trailers in their Maintenance & Inspection Program.
________	G. Piping was not protected from weather while not in use	9. Plants should evaluate the design of all loading and unloading of rail cars and tank trailers for proper support of connecting apparatus.
________	H. Rail cars are not consistent in unloading configurations	10. Plant personnel should be retrained in the hazards associated with all toxic flammable materials; i.e., especially during connecting and disconnecting. 11. Plant personnel that load or unload toxic flammable materials should notify surrounding operations of their intent to connect/disconnect to/from tank trailer or rail car. 12. Plant personnel required to load or unload any toxic flammable material should be trained and required to wear supplied air during hook-up and disconnect and initial opening of any associated equipment. 13. Redesign all equipment associated with rail car and tank trailer loading or unloading to incorporate remote operated valves in proper locations. Do not use excess flow valve as layer of protection. 14. Train all plant personnel in the locations and operation of remote operated valves used in loading and unloading equipment. 15. Railcar excess flow valves cannot be relied upon to stop leaks that could occur during loading/unloading operations, and industry should identify and implement alternate layers of protection against such circumstances.

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

- Railcar and truck loading/unloading adapters should be included in inspection programs to ensure they are in good condition.
- Inert substances should always be used to leak test connections. If the substance is toxic or hazardous, there should be no chance of leakage before it is introduced into the piping.
- Redundant protection against blowouts should be a standard practice when designing loading/unloading stations.
- When adapters are being constructed, it is easy to overlook proper support for heavy parts.
- Management of Change should be utilized when designing unloading adapters.
- Unloading adapters should utilize engineering resources to actually design the system. Reducing the piping size can render blowout protection unusable as well as exposing the plant to other unforeseen hazards.

Systems of Safety
And
Subsystems

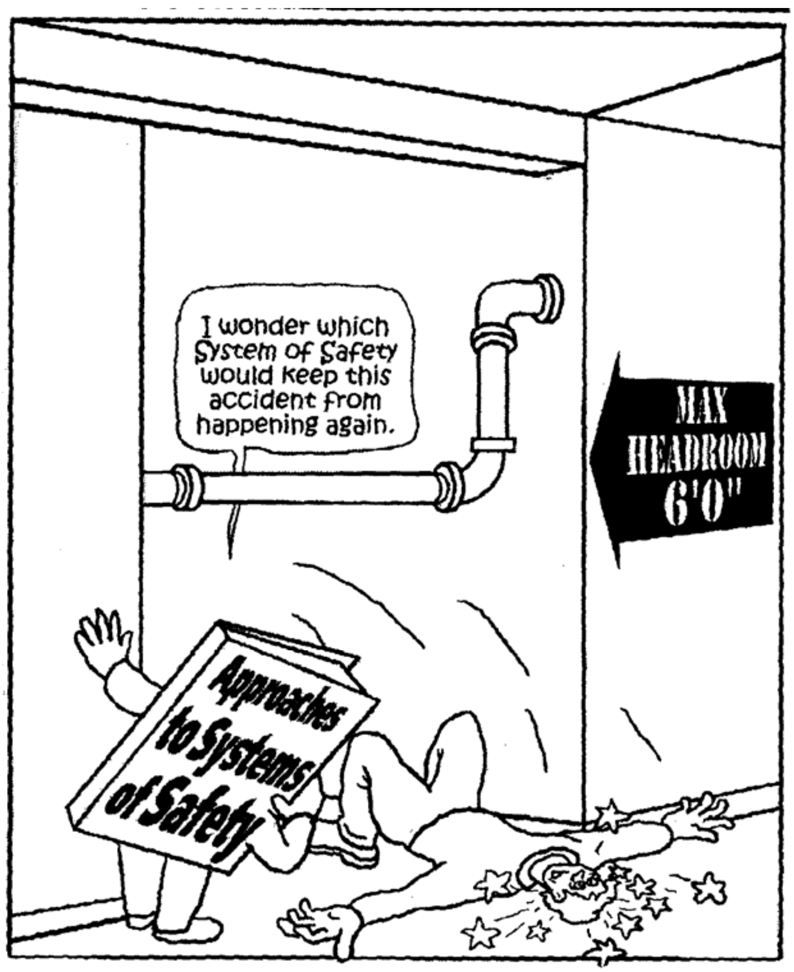
Major Safety Systems	**Design & Engineering**	**Maintenance & Inspection**	**Mitigation Devices**	**Warning Devices**	**Training & Procedures**	**Personal Protective Factors**
Level of Prevention	**Highest—the first line of defense**	**Middle—the second line of defense**				**Lowest—the last line of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

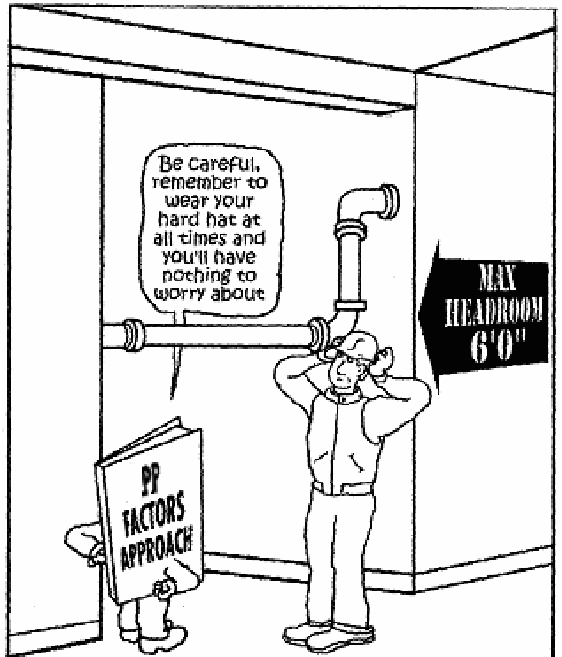
All Systems of Safety Are Not Created Equal!



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

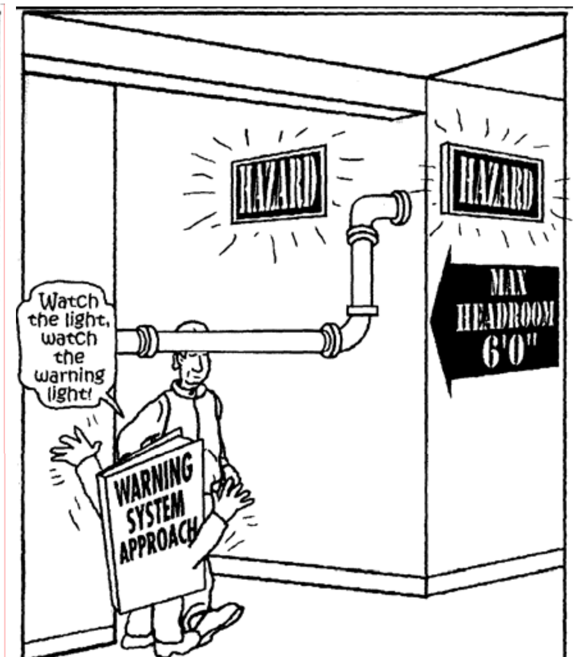
Sub-systems that include a broad range of working conditions and situations that affect workers.

- 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

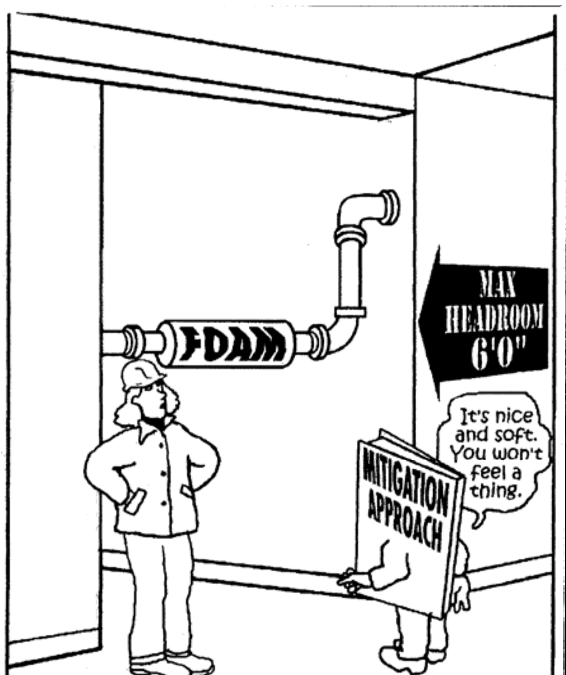
- Easier to affect groups of workers.
- Dependent on individuals' memories and lack of distraction



The Warning System

Devices that warn of a dangerous or potentially dangerous situation.

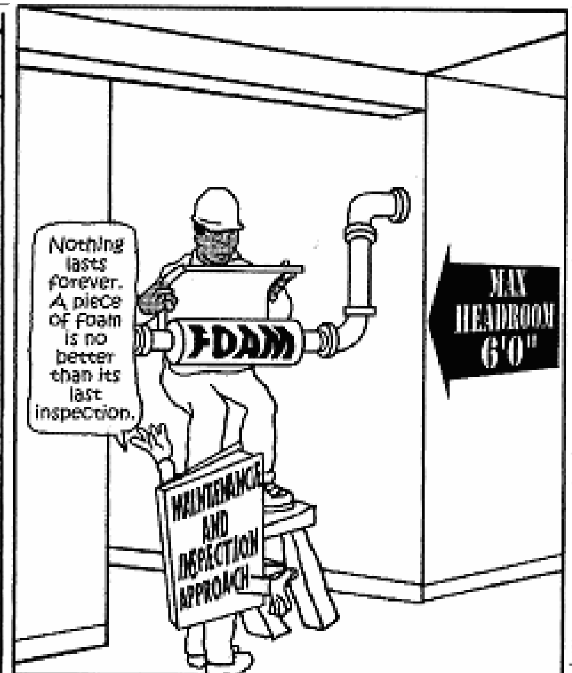
- Draws attention
- May be missed or ignored



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**