Vessel Overflow Burns Operator

Lessons Learned

Volume 05 Issue 06

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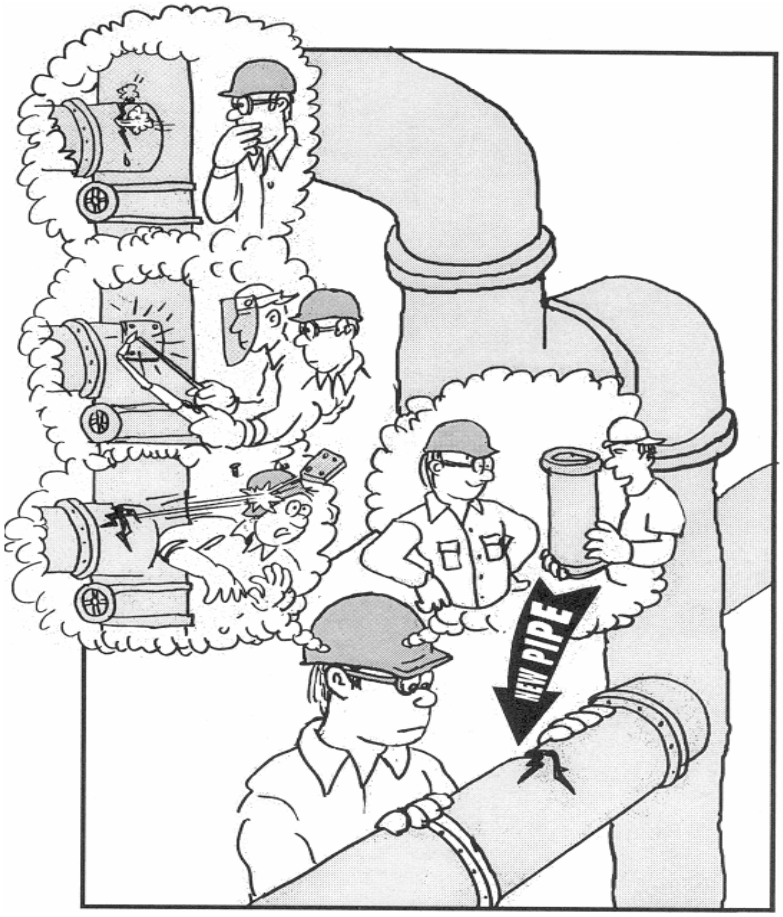
Purpose

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 Chemical Operator was conducting a Pot Nitrate production run. The steps of this operation are as follows:

1. The Chemical make-up is performed in Vessel V-1
    a. Steam is not applied at this step, but the reaction from combining/blending the chemicals raises the temperature.
2. After the make-up, the product is transferred to Vessel V-2 for the boil-down operation.
    a. During this transfer, the agitator of V-2 is activated,
    b. Steam is applied to the vessel.
3. The product from the boil-down is sent to Vessel V-3 for recycle and then through a centrifuge and a dryer. The product is then packed out from the dryer.
4. The packing out consists of weighing the correct amount of product into fiber drums.
    a. During this packaging (which the operator also does) the operator starts the process again by filling and blending a new batch in V-1.

The incident occurred after the operator had completed step 2 (a & b) above. The operator was beginning a new make-up in V-1 and not monitoring the temperature in V-2 when another worker reported there was an overflow of the boil-down vessel (V-2). The operator left the control room to check on this report. V-2 is approximately 30 feet from the control station, but is out of sight of the operator. When the operator arrived at V-2, the floor and sides of the vessels had chemical on them, but the overflow had stopped. The operator opened the manway to visually check the process. At this time, he was engulfed in a cloud of steam and chemicals.

Another (more experienced) operator in the vicinity, had yelled "No!", but the warning was too late. This operator extracted the injured employee and proceeded to the nearest safety shower where emergency procedures were carried out. (It is generally agreed, that the response of this employee prevented much more serious injury from occurring). The injured operator was transported to the company Health Center. The local EMT Squad was requested to respond, and at their discretion, the employee was air evacuated to the burn center of a nearby hospital.

The investigation revealed the following facts:

1. This operator was somewhat new to this procedure (this was his second time) and therefore he was inexperienced on how to handle an anomaly.
2. The operator was "multi-tasking" during the entire process.
3. Some of the language in the operating procedure is vague: i.e.,
    a. "because excess foaming may occur, monitor solution level to prevent overflow."
    b. And, "boil as hard as possible."
    c. Procedures do not specify corrective actions to prevent overflows
4. They only way to monitor the solution was by peeking into the vessel through the open manway. This was the standard method of monitoring this process as there are no sight glasses on this vessel and level indicators are not reliable on this process due to agitation.
5. There is some data indicating steam was applied prior to the agitator being activated, possibly allowing rapid area heating and thermal expansion of the chemical.
6. This has been the standard method of operating this procedure, since its implementation.
7. The procedures for this process require the operator to multi-task, with one of his duties on a lower floor level without any control of the equipment in case of emergency.
8. Operator's training did not include what actions to take if an overflow event occurred.
9. The operator was not wearing additional PPE nor do procedures require any additional PPE to perform these tasks.

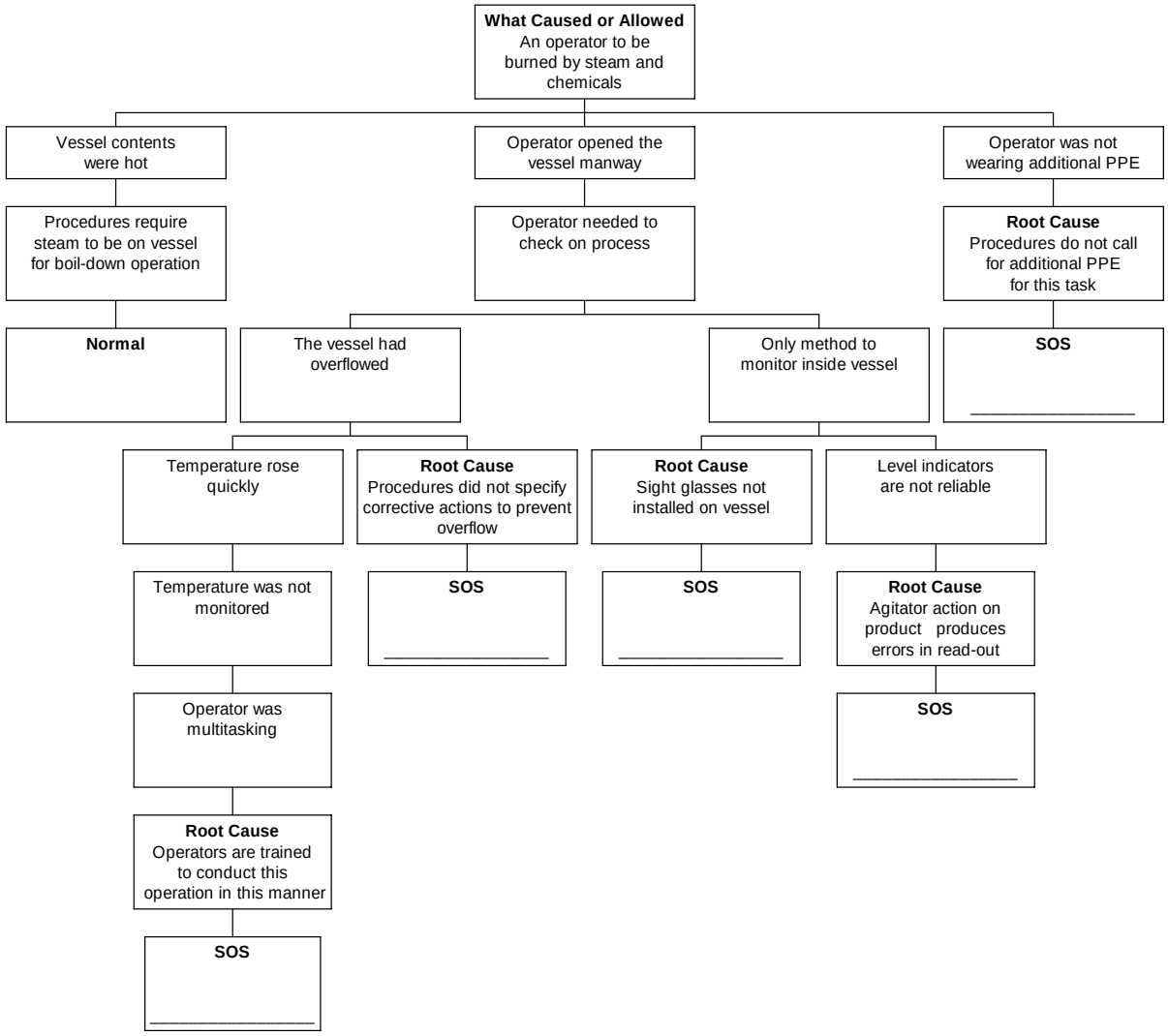
Task 1 *(continued)*

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
_____ _____ _____ _____ _____ _____ _____	1. Sight glasses not installed in vessel 2. Agitator action on product produces an error in the level read-out. 3. Operator was trained to multi-task. 4. Procedures mention the possibility of an overflow, but do not include corrective measures to prevent this overflow from occurring 5. Employee was not required to wear any PPE other than the normal work uniform.	a. Review with all operators the new PPE requirement. b. Remove all vague and contradictory language from procedures. c. Evaluate the need for this type of equipment for all similar processes in the plant. d. Evaluate the additional PPE that may be required when opening any manway, hatch or other access device during a production run. e. Add any additional PPE requirements to procedures. f. Train all operators on the revised procedure. g. Install equipment that can calibrate the high and low level of contents, to produce a realistic read-out of vessel content levels. h. Use this recommendation in all the business units. i. Standard Practice must be addressed to allow operators to maintain monitoring and control over all processes until the operation is stabilized. j. Revise procedures to include actions to prevent overflows. k. Design and install a method (other than opening the manway) to visually check the contents of the vessel. l. Use this set of recommendations throughout the plant.

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

- Operators training needs to include what steps to take in the event of an anomaly during a production run.
- Procedures need to be reviewed for vague, confusing, and/or contradictory language.
- NORMAL actions are not necessarily the safest or most efficient method for operations. NORMAL (*this is the way it's always been done*) needs to be questioned and reviewed.
- Overflows have occurred prior to this event, but were not reported or documented. They were accepted as an occasional part of the job. A thorough plant review would most likely discover other processes where this attitude is prevalent.
- Each business unit needs to periodically review their PPE requirements (especially for NORMAL operations).
- Operators need to be provided the time and equipment to stabilize a process before beginning another task.
- Vessels should be 'powered down' before opening any hatch, flange, or man way. (Steam, agitator, etc.)

Systems of Safety
And
Subsystems

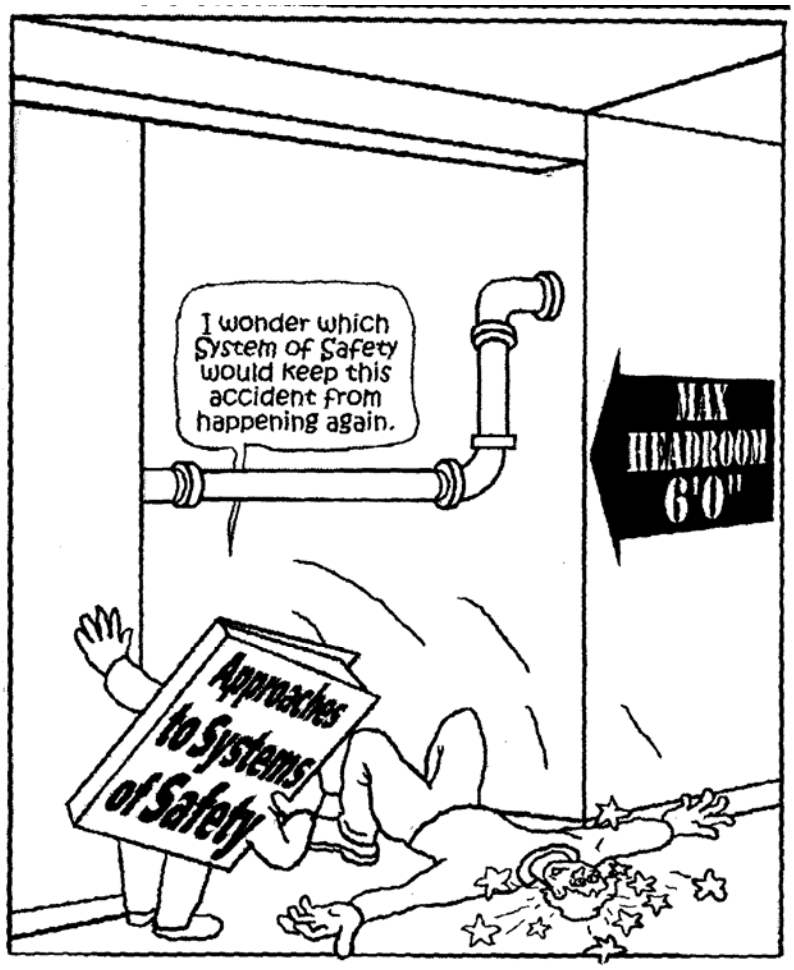
Major Safety Systems	Design & Engineering	Maintenance & Inspection	Mitigation Devices	Warning Devices	Training & Procedures	Personal Protective Factors
Level of Prevention	**Highest—the first line of defense**	**Middle—the second line of defense**				**Lowest—the last line of defense**
Effectiveness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

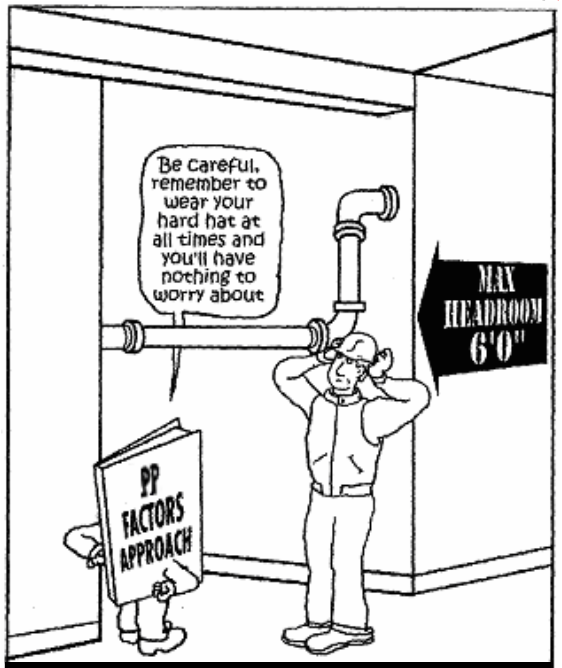
All Systems of Safety Are Not Created Equal!



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

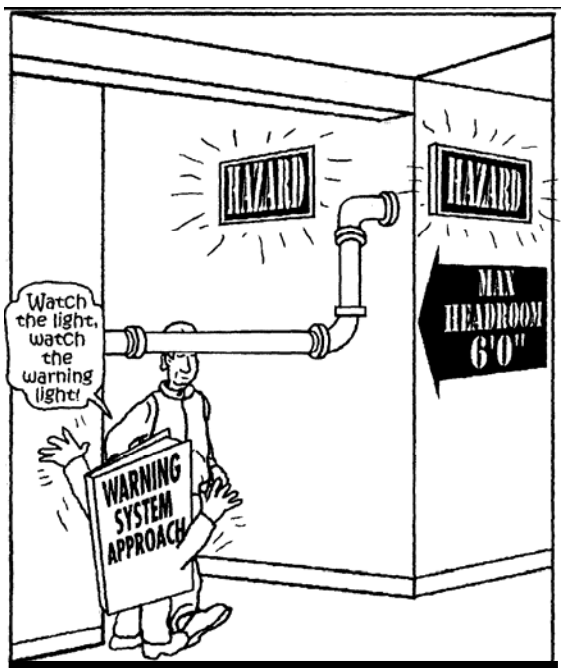
Sub-systems that include a broad range of working conditions and situations that affect workers.

- 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

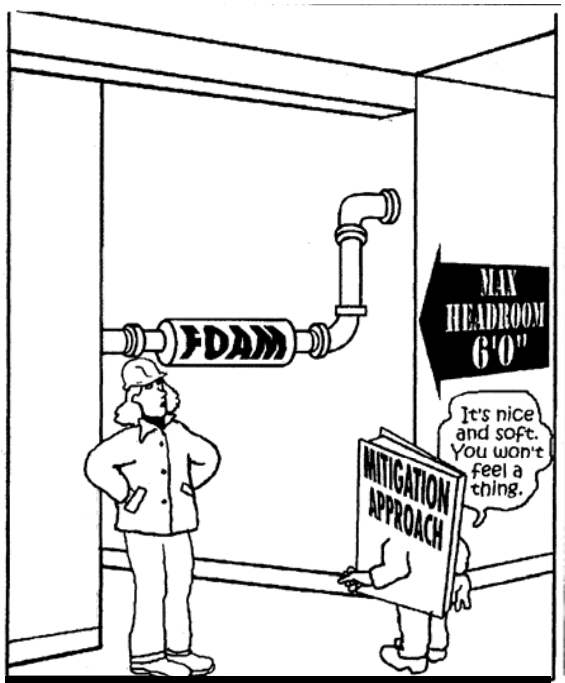
- Easier to affect groups of workers.
- Dependent on individuals' memories and lack of distraction



The Warning System

Devices that warn of a dangerous or potentially dangerous situation.

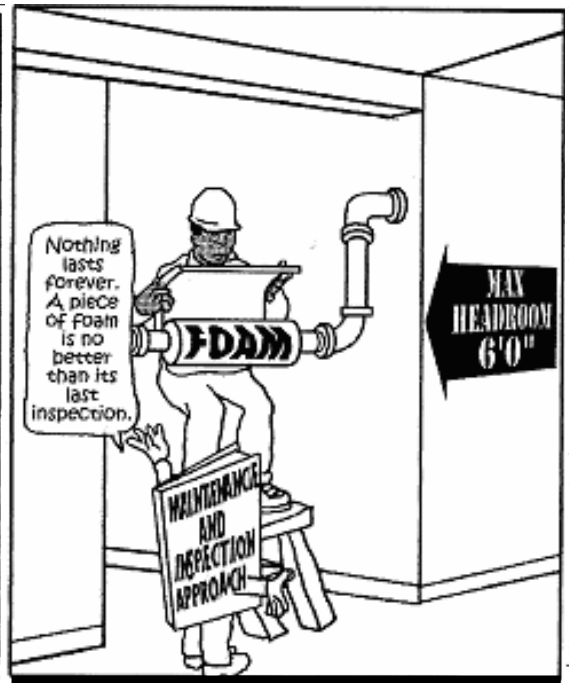
- Draws attention
- May be missed or ignored



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**