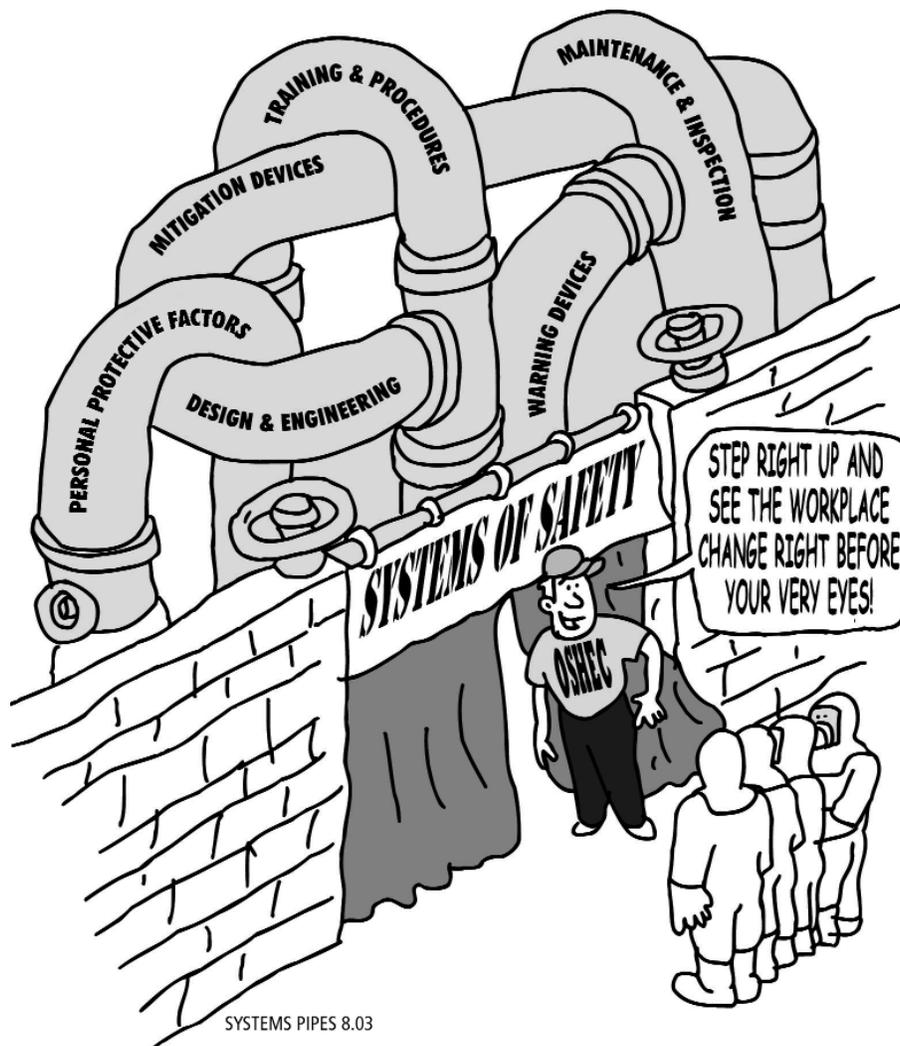# Activity 1: Systems of Safety in Incident Investigation

## Purpose

To introduce the concept of Systems of Safety.

To introduce the concept of a systems-based investigation.

This Activity has four tasks.



SYSTEMS PIPES 8.03

## 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:

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 take ownership and responsibility 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 1 to 4.  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, the person to their left will be responsible for Factsheets 2, etc.  The numbers that you have assigned yourself correspond to Factsheets 1 through 4 on the following pages.

Once everyone has read their factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in order as they were assigned (1 through 4).  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.

# 1. The "Blame Game"

**Blame is the easy way out.**

Finding and addressing root causes can be hard work.  It's much easier to pursue an investigation just to the point where someone or something can be blamed—the bad worker, the bad boss, the broken widget—instead of continuing on to find the flawed system(s) involved.

A Systems Thinking approach teaches us that everyone shares responsibility for a problem generated within a system, so there is no value in placing blame.  It also encourages everyone to work together to bring change.

When a person is blamed instead of a root cause being corrected in a flawed system, his or her replacement walks into the same trap.  The hazards still wait, like a time bomb, to injure their next victim.  Fixing flawed systems fosters a positive team approach.

By demonstrating a real concern for each worker, leadership (both management and union) help to establish a mutual respect between all parties involved.  Respect leads to trust; and soon a foundation is laid for a solid safety effort.

## 2. Finding the Root Cause

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."

The reasons for apparent mistakes, accidents and equipment failure may be hidden from 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.

# 3.  What Are Root Causes?

Root causes are sometimes referred to as "basic" causes.  There are almost always several root causes involved in an incident, accident or near-miss.

**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*, 1992, pp. 129-131.

# 4.  Shifting Gears

USW and the Labor Institute believe that Systems Thinking is the foundation of a powerful health and safety culture.  What do you believe?

We realize that we can't really make people change how they think.
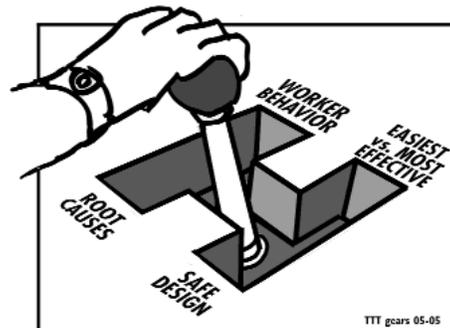
We can only "invite" them to consider a new point of view.  We are doing that within the USW and the Labor Institute with our Systems of Safety approach to health and safety.

Have you begun to shift gears in analyzing problems by:

1.  Moving from a focus on worker behavior to one that considers systems and how they work?

2.  Digging for the root causes of incidents by going beyond blame to real solutions?

3.  Applying the most effective recommendations possible (even when they are not the quickest and easiest)?

4.  Focusing on safe design before moving to other systems when considering recommendations?

If you answered "yes" to these questions, congratulations!  You are either a systems thinker or well on your way to becoming one.

If you answered "no"—well, we just ask you to keep an open mind, your eyes on the road and your hand on the gearshift. (You may want to shift at any time.)

Source:  Barnett, Ralph L and Poczynok, Peter J., "Safety Rules of Thumb," Safety Bulletin, Vol. 2, No. 4, February 1996.

## Task 1 *(continued)*

**Purposes Restated:**

To introduce the concept of Systems of Safety.

To introduce the concept of a systems based investigation.

**Using your experience, your group's discussion of the four factsheets and the scenario below, answer the questions on the next page.**

**Scenario:**

William, a supervisor, was walking back from a staff meeting to his office as he did every day prior to the beginning of the first shift. He was walking at the rear of a group of 10 employees going to their work stations. A third shift forklift operator, Hal, after proper disposal of a drum of used oil, was delivering an empty oil drum to the site. This was his last assignment before the end of his shift. After he had made his delivery he stopped to talk with Mary, another forklift operator. William saw Hal stop to talk with Mary and assumed that the operator saw him also and so he proceeded to walk behind the forklift.

Hal, the forklift operator finished talking with Mary and looked behind him. He saw the large group of people who had walked past him, but he didn't see anyone behind him. He put the forklift in reverse and backed up. He had gone just a couple of feet when he heard screaming. That is when he realized that someone had been behind him. He stopped and pulled the forklift forward and parked it.

William, his supervisor, received a bruised foot and a laceration on his leg.

Within an hour, Hal was called to the Human Resource Manager's office and terminated pending a hearing. Hal was a 25 year employee with no discipline on his record. Both he and Mary had made suggestions to make forklift operation in this area safer; but neither of these factors was considered in the decision for termination.

## Task 1 *(continued)*

**1.  List reasons you think the decision to fire Hal was an unfair one.**

_____

_____

_____

_____

_____

**2.  List possible reasons the employer may have had for firing Hal.**

_____

_____

_____

_____

_____

**3.  List reasons why you think many employers play "the blame game" following an incident or accident.**

_____

_____

_____

_____

_____

## 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:

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 take ownership and responsibility 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 5 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 5 and 9, the person to their left will be responsible for Factsheets 6 and 10, etc.  The numbers that you have assigned yourself correspond to Factsheets 6 through 12 on the following pages.

Once everyone has read their factsheets, your scribe will go around the table and ask each of you to explain to the rest of your group what you have learned. The factsheets should be explained in order as they were assigned (5 through 12).  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.

## 5. What Are Systems of Safety?

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



Let's look at an incident where a worker bumped his head on a low pipe. How could this hazard be addressed by each of our Systems of Safety? (See the next six Factsheets.)

## 6.  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 systems 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.

# 7. The Procedures and Training 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 Procedures and Training.

## 8.  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.
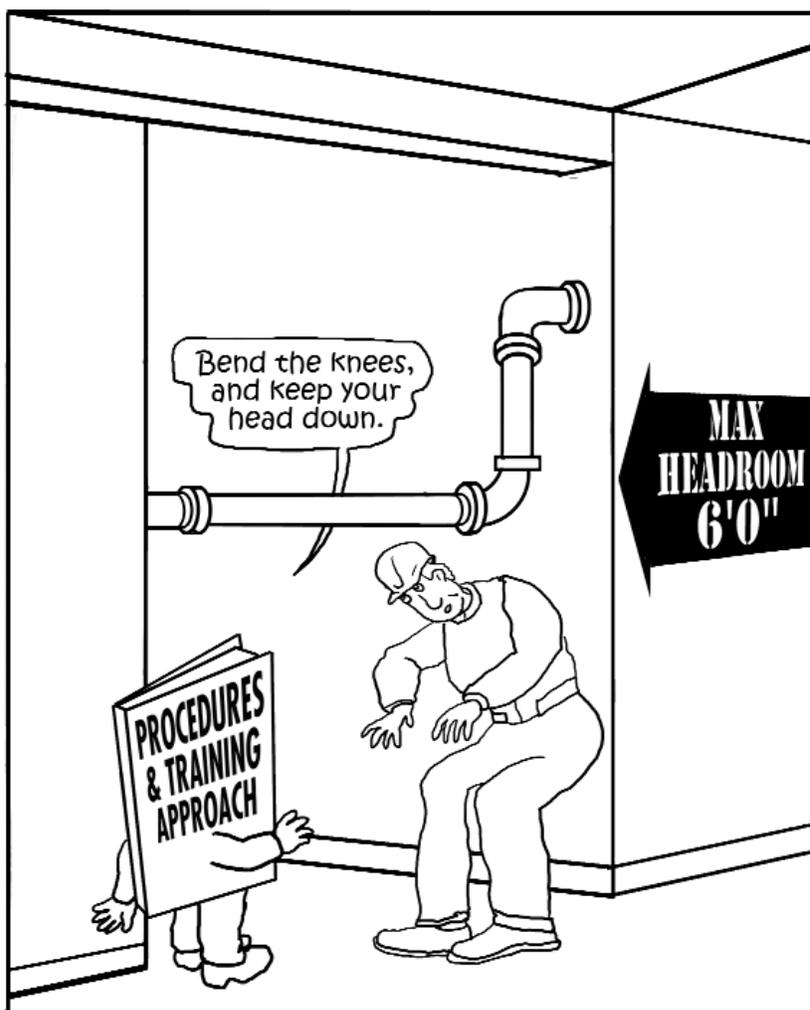
# 9.  The Mitigation System

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.
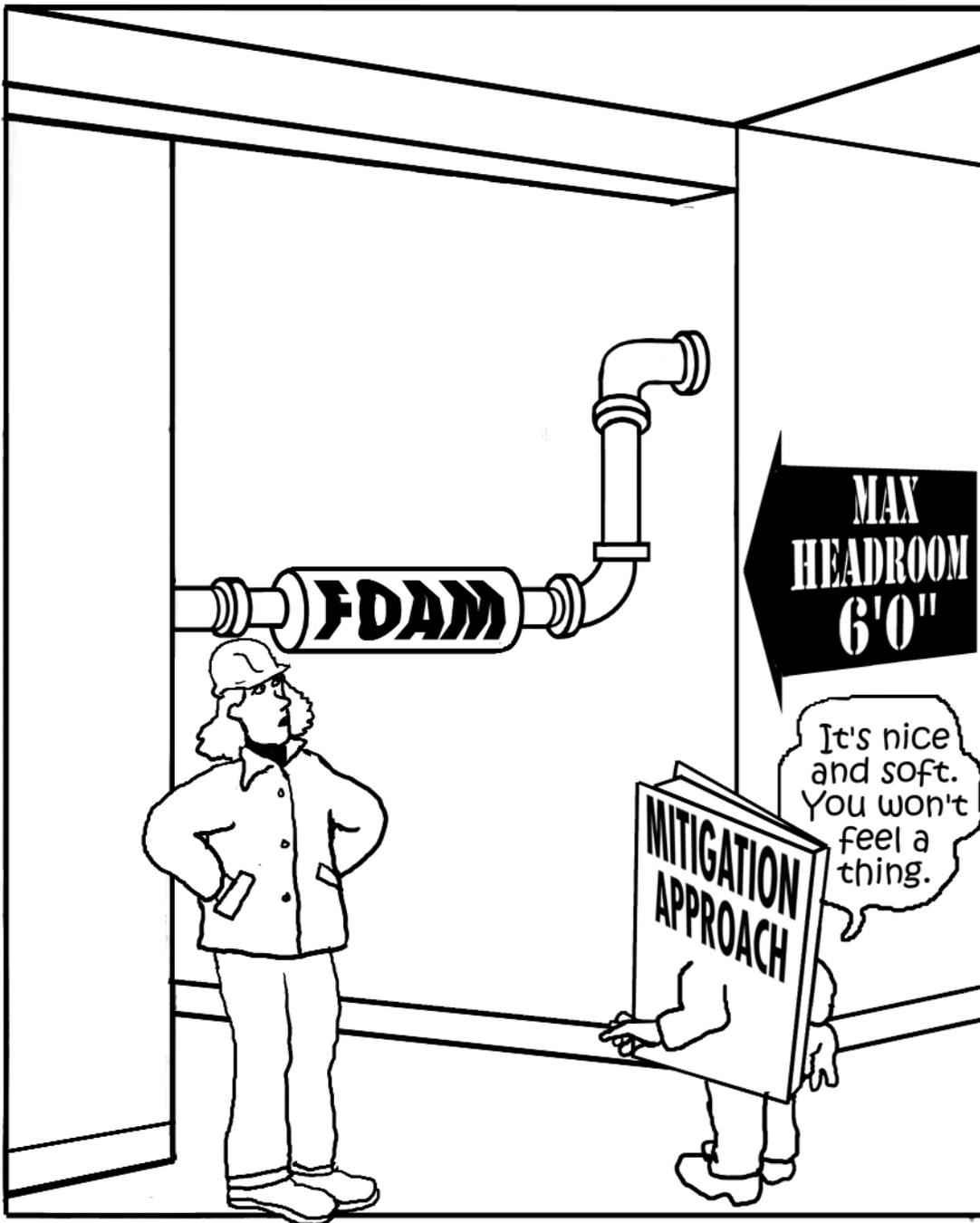
## 10.  The Maintenance and Inspection System

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 plant, the Maintenance and Inspection System is a failure.  If you don't use preventive maintenance, then you end up doing breakdown maintenance.
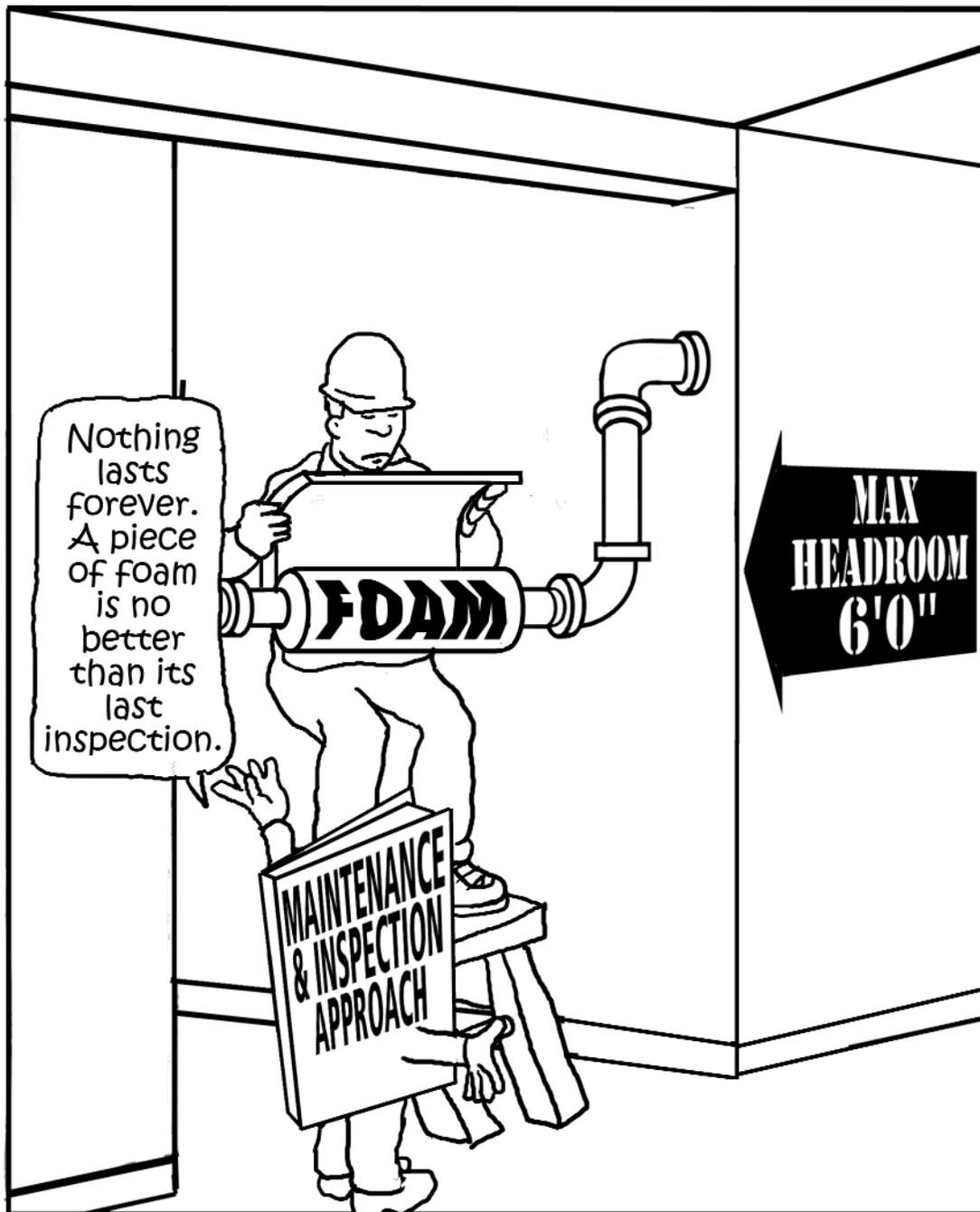
## 11.  Design and Engineering System of Safety

**Technical:**  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.

**Organizational:**  Positive changes in organization of resources and how work is structured.

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.

## 12.  Systems and Sub-systems (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**<br><br>Design and Engineering of Equipment, Processes and Software<br><br>Management of Change (MOC)**<br><br>Chemical Selection and Substitution<br><br>Safe Siting<br><br>Work Environment HF<br><br>**Organizational (must address a root cause)**<br><br>Staffing HF<br><br>Skills and Qualifications HF<br><br>Management of Personnel Change (MOPC)<br><br>Work Organization and Scheduling HF<br>Work Load<br><br>Allocation of Resources<br><br>Buddy System<br><br>Codes, Standards, and Policies** | Inspection and Testing<br><br>Maintenance<br><br>Quality Control<br><br>Turnarounds and Overhauls<br><br>Mechanical Integrity | Enclosures, Barriers Dikes and Containment<br><br>Relief and Check Valves<br><br>Shutdown and Isolation Devices<br><br>Fire and Chemical Suppression Devices<br><br>Machine Guarding | Monitors<br><br>Process Alarms<br><br>Facility Alarms<br><br>Community Alarms<br><br>Emergency Notification Systems | Operating Manuals and Procedures<br><br>Process Safety Information<br><br>Process, Job and Other Types of Hazard Assessment and Analysis<br><br>Permit Programs<br><br>Emergency Preparedness and Response Training<br><br>Refresher Training<br><br>Information Resources<br><br>Communications<br><br>Investigations and Lessons Learned<br><br>Maintenance Procedures<br><br>Pre-Startup Safety Review | Personal Decision-making and Actions HF<br><br>Personal Protective Equipment and Devices HF<br><br>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 sybsystem 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 system, not Design and Engineering.

**Revised October 2006**

## Task 2 *(continued)*

**Purposes Restated:**

To introduce the concept of Systems of Safety.

To introduce the concept of a systems based investigation.

**Task:**

After a thorough investigation the team of workers was able to identify the facts of the incident. Many were obvious; but others were not. The facts as determined by the team are listed below:

1. William received a bruise and laceration.
2. The forklift struck William.
3. William didn't move quickly enough.
4. William was walking directly behind the forklift.
5. Hal continued to backup the forklift.
6. William didn't see the forklift in time.
7. There was no warning that the forklift was backing up.
8. Walking employees and forklifts use the same aisle.
9. William thought the driver saw him.
10. William was walking in the aisle at the same time that the barrel was being moved.
11. Driver didn't see anyone behind him.
12. Propane tank placement partially blocked the driver's view.
13. Design of the roll cage partially blocked the driver's view.

The workers then used the facts on page 26 to develop the logic tree shown on the next page.

**As a group, review and discusss the logic tree on the next page and using your experience and intuition, answer the questions below.**

**1.  What is the goal in developing each leg of the logic tree?**

**2.  Where do we want the branches of the tree to lead?**

**3.  At what location in the logic tree are the root causes always located?**

William didn't move quickly enough

William didn't see forklift in time

There was no warning that forklift was backing up (Root Cause)

**SOS Warning Devices**

Walking employees and forklift use same aisle (Root Cause)

**SOS Design and Engineering Organizational (Traffic flow patterns)**

William was walking directly behind forklift

William thought driver saw him (Root Cause)

**SOS NO SOS Failure**

William was walking in the aisle at the same time as the barrel was being moved (Root Cause)

**SOS Design and Engineering Organizational (Timing of Work Activities)**

Forklift struck William

**William received trauma to legs and feet**

Driver continued to back up forklift

Driver didn't see anyone behind him

Propane tank placement partially blocked his view (Root Cause)

**SOS Design and Engineering**

Design of the roll cage partially blocked his view (Root Cause)

**SOS Design and Engineering**

## Task 3

Let's now review the recommended fixes as determined by the team of workers.  Select a scribe to report your answers back to the class.

**1.  Analyze the actions taken (listed in first column of the chart below) to attempt to eliminate the hazard of a pedestrian being struck by a forklift.  More than one Systems of Safety are listed for each action.  Your group should choose the System of Safety (SOS) in which each action was taken to attempt to eliminate the hazard.  Be ready to give reasons for your choices.  You should circle the selected SOS to indicate your group's answer.**

**(Note:  The logic tree identified the failed Systems of Safety.  This is not necessarily the system that the fix would be made in.)**

| Recommendations | In which SOS was the recommendation made? (One for each action) |
|---|---|
| 1.  Install backup alarm on all forklifts. | A. Warning Devices<br>B. Mitigation Devices |
| 2.  Designate aisle between finishing room and number one machine room for forklift traffic only. | A.  Design and Engineering<br>B.  Training and Procedures |
| 3.  Contact forklift manufacturer to redesign propane tank and roll cage to increase visibility in the rear. | A.  Training and Procedures<br>B.  Design and Engineering |
| 4.  Eliminate forklift use for last 20 and first 20 minutes of shift. | A.  Mitigation Devices<br>B.  Training and Procedures<br>C.  Design and Engineering |
| 5.  Include in training the importance of communications between a forklift driver and pedestrians. | A.  Warning Devices<br>B.  Training and Procedures |
| 6.  Install convex mirrors on forklift to make full rear area visible to driver. | A.  Mitigation Devices<br>B.  Warning Devices |
| 7.  Change procedure for forklift operation to include sounding horn before beginning to back up. | A.  Training and Procedures<br>B.  Personal Protective Factors |
| 8.  Install automated material handling system to eliminate need for forklift as much as possible. | A.  Mitigation Devices<br>B.  Design and Engineering<br>C.  Design and Engineering |

## Task 4

With six root causes, eight recommendations and a logic tree to show where they came from, the workers felt well prepared to defend Hal in the upcoming hearing. And one important thing that they thought would go a long way in strengthening their case was that none of the root causes or recommendations blamed anyone, not the worker or the supervisor. It was all about identifying root causes and failed Systems of Safety and making recommendations in the most effective Systems of Safety.

**In your groups think about your workplace and answer the questions below.**

**1. How important would it be for workers, at your workplace, to have the ability to do Systems-Based Incident Investigations?**

**2. List ways in which workers could use this tool.**

# Summary:  Systems of Safety in Incident Investigation

1. Identifying the facts is the first step in a Systems of Safety Investigation.

2. The logic tree is a powerful tool in organizing investigation facts to identify root causes and failed Systems of Safety.

3. Systems of Safety are the key to making recommendations to fix root causes.

4. Major Systems of Safety (in order of effectiveness):

    • Design and Engineering;

    • Maintenance and Inspection;

    • Mitigation Devices;

    • Warning Devices;

    • Training and Procedures; and

    • Personal Protective Factors.

5. The Design and Engineering System is the system workers should first look to in addressing hazards.

# *Tony Mazzocchi Center Proficiency Assessment*

## Activity 1:  Systems of Safety in Incident Investigation

**Learning Objectives:**

1. **To introduce the concept of Systems of Safety.**  How much do you agree or disagree that the **training met this learning objective**?

    O                          O                          O                          O                          O
    Strongly agree        Agree        Neither agree        Disagree        Strongly
                                         nor disagree                                disagree

2. **To introduce the concept of a systems-based investigation.**  How much do you agree or disagree that the **training met this learning objective**?

    O                          O                          O                          O                          O
    Strongly agree        Agree        Neither agree        Disagree        Strongly
                                         nor disagree                                disagree

3. **Identifying the facts is the first step in a Systems of Safety Investigation.**  How much do you agree or disagree with the following statement?  Understanding and applying this learning objective **will assist me in improving health and safety at my workplace.**

    O                          O                          O                          O                          O
    Strongly agree        Agree        Neither agree        Disagree        Strongly
                                         nor disagree                                disagree

4. **The logic tree is a powerful tool in organizing investigation facts to identify root causes and failed Systems of Safety.**  How much do you agree or disagree with the following statement?  Understanding and applying this learning objective **will assist me in improving health and safety at my workplace.**

    O                          O                          O                          O                          O
    Strongly agree        Agree        Neither agree        Disagree        Strongly
                                         nor disagree                                disagree

33

5.  **The major Systems of Safety (in order of effectiveness) are:  Design and Engineering; Maintenance and Inspection; Mitigation Devices; Warning Devices; Training and Procedures; and Personal Protective Factors.**  How much do you agree or disagree with the following statement?  Understanding and applying this learning objective **will assist me in improving health and safety at my workplace.**

    O          O          O          O          O

Strongly agree     Agree     Neither agree nor disagree     Disagree     Strongly disagree