



## Chlorine Exposure to a Utilities Operator

### Purpose

To share “lessons learned” gained from incident investigations through a small group discussion method format.

To understand “lessons learned” through a Systems of Safety viewpoint.



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**Lessons Learned**

**Volume 08, Issue 1**

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## Background Information

Before beginning this Lessons Learned, please review this and the next page which contain information that will introduce the concepts of Lessons Learned and Systems of Safety.

Creating a safe and healthy workplace requires a never ending search for hazards that sometimes are not obvious to us. These hazards exist in every workplace and can be found by using various methods. Lessons Learned are just as the name suggests: learning from incidents to prevent the same or similar incidents from happening again.

**Systems Are Not Created Equal: Not equal in protection and not equal in prevention.**

Using our Systems Focus to uncover system flaws or root causes is only one part of controlling hazards. We also need to look at the systems involved to decide on the best way to deal with the problem. The most effective way to control a hazard is close to its source. The least effective is usually at the level of the person being exposed. The system of safety in which the flaw is identified is not necessarily the system in which you would attempt to correct the flaw.



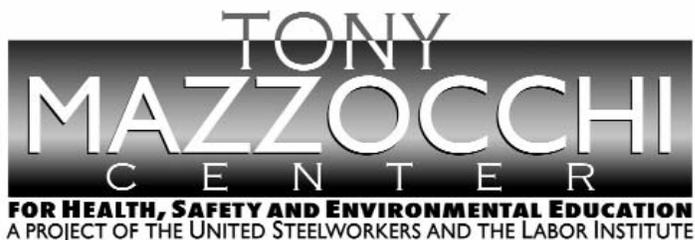
Major Safety System	Design & Engineering	Maintenance & Inspection	Mitigation Devices	Warning Devices	Training & Procedures	Personal Protective Factors
Level of Prevention	Highest—the first line of defense	Middle—the second line of defense			Lowest—the last line of defense	
Effectiveness	Most Effective	←————→			Least Effective	
Goal	To eliminate hazards	To further minimize and control hazards				To protect when higher level systems fail
<b>EXAMPLES OF SAFETY SUB-SYSTEMS**</b>	<b>Technical</b>	Inspection and Testing	Enclosures, Barriers Dikes and Containment	Monitors	Operating Manuals and Procedures	Personal Decision-making and Actions HF
	Design and Engineering of Equipment, Processes and Software	Maintenance	Relief and Check Valves	Process Alarms	Process Safety Information	Personal Protective Equipment and Devices HF
	Management of Change (MOC)**	Quality Control	Shutdown and Isolation Devices	Facility Alarms	Process, Job and Other Types of Hazard Assessment and Analysis	Stop Work Authority
	Chemical Selection and Substitution	Turnarounds and Overhauls	Fire and Chemical Suppression Devices	Community Alarms	Permit Programs	
	Safe Siting	Mechanical Integrity	Machine Guarding	Emergency Notification Systems	Emergency Preparedness and Response Training	
	Work Environment HF				Refresher Training	
	<b>Organizational (must address a root cause)</b>				Information Resources	
	Staffing HF				Communications	
	Skills and Qualifications HF				Investigations and Lessons Learned	
	Management of Personnel Change (MOPC)				Maintenance Procedures	
	Work Organization and Scheduling HF				Pre-Startup Safety Review	
	Work Load					
	Allocation of Resources					
	Buddy System					
	Codes, Standards, and Policies**					

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

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**Lessons Learned Statement:**

The absence of chlorine gas monitors and alarms in an aging water treatment facility caused a utility operator to be exposed to chlorine gas. *Systems of Safety* are utilized to provide prevention from this type of incident. The protection provided by gas monitors and alarms constitute a well-defined **Warning Devices System of Safety** approach. The practice of sending operators into an aging, poorly-ventilated water treatment facility with neither permanent nor portable detection monitors creates an extremely dangerous hazard for workers.

Despite previous requests for repairs, the problem with connections leaking chlorine solution in the facility went unaddressed. There was no action taken within the **Maintenance and Inspection System of Safety** to repair the equipment. No review was made within the **Maintenance and Inspection System of Safety** to determine if process lines were leaking excessively and could pose a threat to personnel working in the facility.

**Discussion:**

An operator entered a building and detected a chlorine odor, which is not uncommon for this water treatment facility. The operator then began descending the stairs to the basement. As he did, he began detecting a stronger concentration of chlorine vapor odor at the first landing of the stairs.

The operator began experiencing eye irritation and breathing difficulties due to the chlorine vapors. The operator covered his nose and mouth with his hand and immediately exited the building. After medical evaluation, the operator was allowed to return to work.

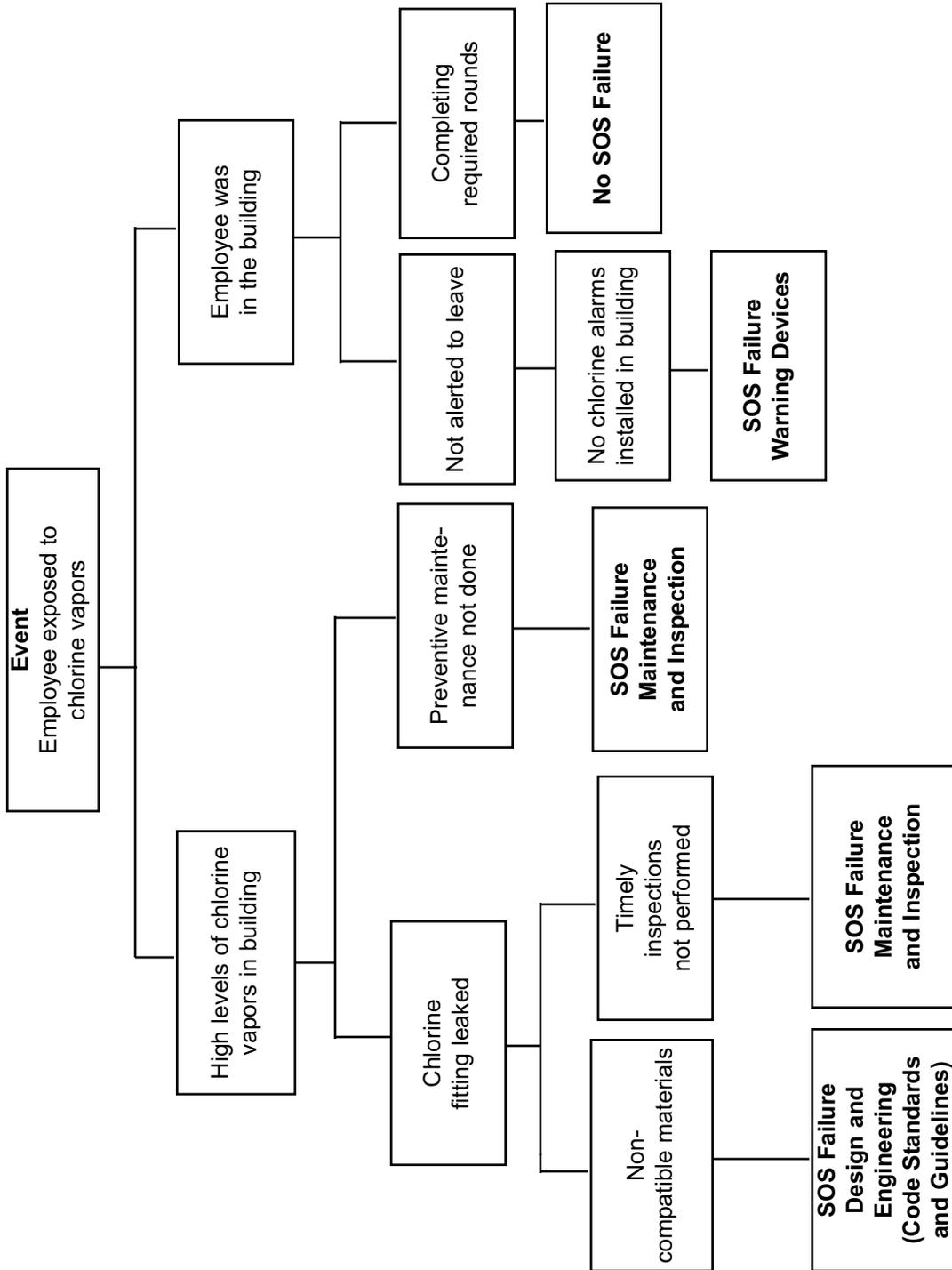
Chlorine concentrations collected by emergency response personnel after the reported incident were 25.0 ppm, initially, at the entrance door. The eight-hour Time Weighted Average (TWA) exposure limit for chlorine is 0.5 ppm.

Inspection revealed that a metal fitting connecting a one-inch diameter PVC chlorine solution supply line to the water influent line had failed. This failure has been tied to a possible component incompatibility. This failure allowed chlorine vapors to be released into the building. The chlorine solution line that failed was one of three lines that at one time were used for water treatment and this particular line had not been used for approximately four to five years.

The line that failed had recently been put into service in order to isolate the two other solution lines which were suspected of leaking underground. The chlorine solution lines were installed in 1995 and there have been numerous work requests submitted since then to repair system fittings.

**Analysis**

The Logic Tree is a pictorial representation of a logical process that maps an incident from its occurrence, “the event,” to facts of the incident and the incident’s root causes.



### Recommended Actions

1. Evaluate compatibility of connections in respect to higher percentages of chlorine solution.
2. Evaluate whether the same fitting configuration exists at other injection points and establish consistency between prints, compatibility and configuration.
3. Establish chlorine monitors and warning alarms at the water treatment building.
4. Establish entry requirements (once alarms installed) consistent with similar buildings.
5. Revise emergency response plan to include contingency actions once the chlorine alarms activate (include ventilation requirements).
6. Write Lessons Learned curriculum describing the incident and corrective actions.
7. Present Lessons Learned curriculum in monthly safety meeting.
8. Require operators to wear portable chlorine sensors when entering the building until permanent monitors are installed.
9. Post warning signs until permanent chlorine sensors are installed.

### Education Exercise

Working in your groups and using the Lessons Learned Statement, Discussion, Analysis and Recommended Actions, answer the two questions below. Your facilitator will give each group an opportunity to share answers with the large group.

1. Give examples of ways to apply the Lessons Learned Statement at your workplace.

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2. Of the examples you generated from Question 1, which will you pursue in your workplace? (**Note:** When we say something you may pursue, we mean a joint labor-management activity or a union activity rather than an activity carried out by you as an individual.)

## Trainer’s Lessons Learned Success Inventory

Following a Lessons Learned (LL) session, **the trainer who led the LL** should complete this form. This information will: 1) Help you reflect on the successes and challenges of the session; 2) Help USW with new curriculum development; and 3) Help USW as a whole better understand how the LL Program is supporting their workers.

By reviewing LL from different sites or from other areas of their workplaces, workers are able to analyze the information and apply these lessons to their own workplaces in order to make their workplaces healthier and safer.

1. Site name (if there are participants from more than one site, please list all).

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2. Date of LL training \_\_\_\_\_
3. LL number used in today’s Training \_\_\_\_\_
4. Your name \_\_\_\_\_
5. **Summary of Education Question 1:** Please summarize participants’ examples of ways to apply this LL Statement to their workplace.

**Please continue on reverse side.**

- 6. Summary of Education Question 2:** Please summarize actions or recommendations participants discussed pursuing at their workplace(s).

**Thank you for completing this form.**

# EVALUATION

## Lessons Learned: Chlorine Exposure to a Utilities Operator

Please answer the two questions below:

1. How important is this lessons learned to you and your workplace? (Circle one.) Rate on a scale of 1 to 5, with 5 being the most important.

1	2	3	4	5
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2. What suggestions would you make to improve this Lessons Learned?

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**End of Training Trainer's Instructions**

Please complete the information below.

Trainer's Name \_\_\_\_\_  
(Please Print)

Date of training: \_\_\_\_\_

No. of Participants: Total \_\_\_\_\_ Hourly \_\_\_\_\_ Management \_\_\_\_\_

Location of Training: \_\_\_\_\_

USW Local # \_\_\_\_\_

Send:

1. This page;
2. The Education Exercise (page 8);
3. The Trainer's LL Success Inventory form (pages 9 and 10);
4. The evaluation for each participant (page 11); and
5. The Sign-in sheet (page 13) to:

<b>If you are a TOP Site (excluding DOE TOP Sites)</b>	<b>Send to: Steve Cable 2915 Gradient Drive St. Louis, MO 63125</b>
<b>All other sites (including DOE TOP Sites)</b>	<b>Send to: Doug Stephens United Steelworkers 3340 Perimeter Hill Drive Nashville, TN 37211</b>

Thank you for facilitating the sharing of this  
Lesson Learned with your coworkers.



