

8-Hour HAZWOPER Refresher Course



Student Manual

**Western Region Universities Consortium (WRUC)
Labor Occupational Health Program
University of California, Berkeley**



Emergency Response and Planning



Outline

1. What Are Hazardous Materials?
2. If You Don't Know...Assume It's Hazardous
3. Defining What Is an Emergency
4. Spills: Small vs. Large and Why You Need To Know
5. HAZWOPER Requires a Comprehensive Emergency Response Program
6. The Written Plan
7. Worker Training Requirements: Know Your Role
8. Assessing Your Emergency Response Plan

Objectives

Participants will be able to:

1. Define an emergency
2. Describe the Cal/OSHA criteria for a small spill
3. State the priorities in an emergency
4. List the 7 Emergency Response Actions
5. Describe the different roles in an emergency response

What Are Hazardous Materials?

The OSHA/EPA emergency response regulation defines hazardous materials as:

- chemicals that can burn or explode
- chemicals that cause cancer
- poisons
- germs
- radioactive materials
- chemicals that can cause violent chemical reactions.

“Hazardous material” is a legal term. OSHA and EPA have many definitions for hazardous materials.

Some materials are hazardous because they are on a list in the regulations. Other materials have certain properties.

If You Don't Know What Chemical Has Spilled, Assume It Is Hazardous

At any spill, you should assume a material is hazardous until you know for sure it is not. Some hazardous materials have no smell. You may not be able to see it or feel it, but the chemical could be poisoning you. For example:



- You can't smell carbon monoxide;
- You can't see methylene chloride; and
- You can't smell phosgene until there is a dangerous amount in the air.
- You may be able to smell the benzene in gasoline. But it can also soak through your skin and you can't feel it.



If You Don't Know Exactly What the Dangers Are, Don't Go Near It

Some poisons can soak through your skin and kill you. Other chemicals can creep along the ground and find a flame. Chemicals in cylinders can explode like a rocket. Chemicals can mix and start a fire or give off poisonous gases. **If you don't know exactly how the chemical will act in an emergency, assume the worst.**

By law, your employer has to keep a list of all the hazardous chemicals you work around. You have the right to get a copy of this list. It should include all the hazardous chemicals you use, all of the hazardous chemicals used by people around you (including contractors) **and** anything that is likely to spill! Your employer can get information about chemicals that are carried on trucks in your area from government agencies.

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What Is an Emergency?

In the law, a hazardous materials emergency is a spill or leak that you and your co-workers **in the area** can't handle safely on your own.

It is an emergency if:

- you need special training and equipment to protect yourself from the chemicals;
- you even **think** about calling the fire department or a Hazardous Materials (HazMat) team.

Emergencies include spilling any amount of an unknown or very irritating chemical or spilling a large amount of a chemical. "Large" is defined by EPA, not by your employer. Here are some examples of emergencies:

- A semi crashes and barrels spill out on the side of the road. No one knows what is in them.

- Two chemicals in the lab mix, forcing you and your co-workers out of the room.
- A tank of solvent in an auto shop overflows. All of the brake mechanics—in fact everyone in the shop—are pulled off of their regular jobs to clean up the spill.
- One pound of Chlordane (a very poisonous pesticide) spills in the storage room.

It is your employer's responsibility to decide **ahead of time** which spills you can handle and which ones are emergencies. The union should review the plan and make sure that it protects workers. In an emergency, only workers with special training and equipment may go near the spill. The definition of an emergency is a very important part of your employer's emergency plan.

How Small Is Small?

It depends! Workers **can** handle some spills, especially small spills of less dangerous materials. But you **always** need specially trained workers if:

- The material is very dangerous
- The spill is large (even if the material is not extremely dangerous)
- You don't know what the chemical is
- Chemicals may mix.

Workers can usually clean up:

A small spill of gasoline or diesel fuel

Unless—It has mixed with another chemical. It is on fire.

A small leak (a propane cylinder)

Unless—It is a deadly chemical (like chlorine).

A spill of less than 55 gallons (one drum)

Unless—It has mixed with another chemical. It is a deadly chemical (like styrene).



How Large Is Large?

It depends! What if your employer only wants to call it an emergency if the spill is enormous? The government has a definition of large spills. This is called the **Reportable Quantity (RQ)**. Large spills (bigger than the Reportable Quantity) have to be reported to the Coast Guard. The definition of a spill in an employer's emergency plan may not be bigger than the Reportable Quantity. Here are the Reportable Quantities for a few different materials:

Asbestos	1 pound
Chlorine	100 pounds
Sodium hydroxide (lye)	1,000 pounds

You can find reportable quantities for various chemicals in the *Driver's Guide to Hazardous Materials*. (Your instructor has a copy.)

If any gasoline or oil gets into a river or ocean, your employer must also notify the Coast Guard.

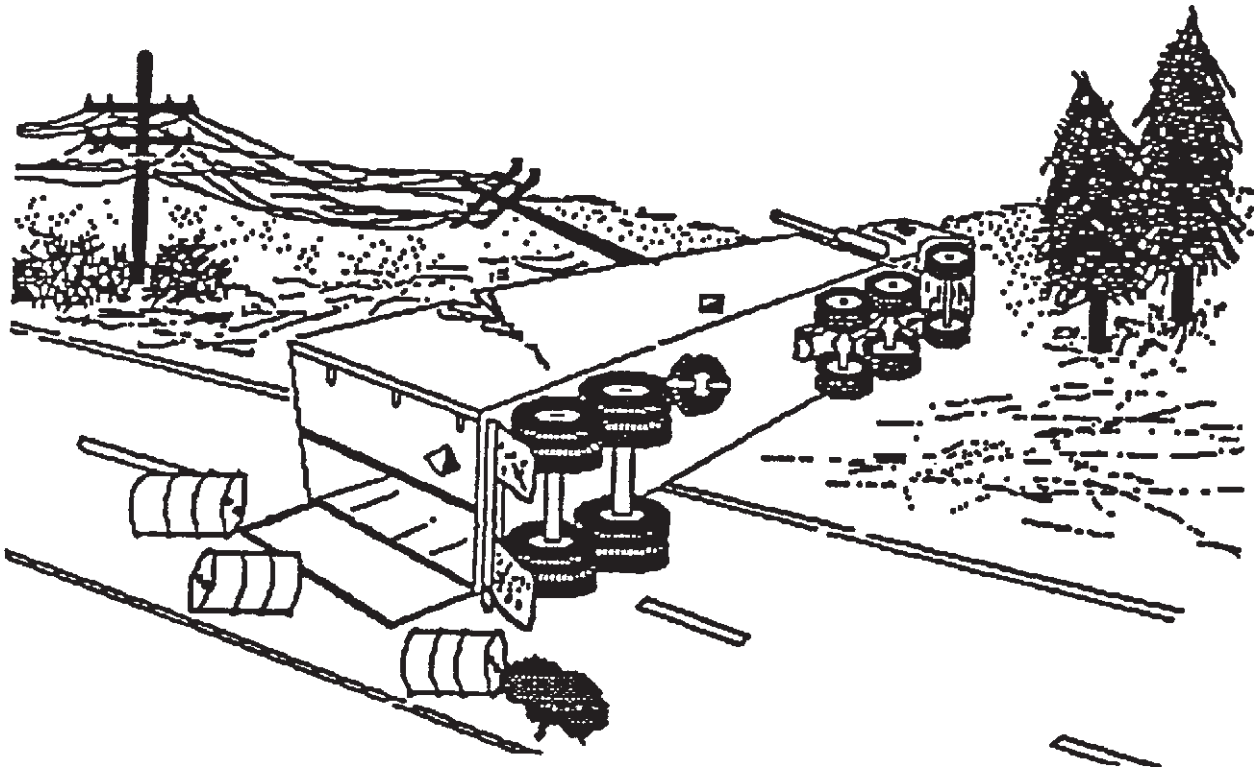


Illustration courtesy of the Midwest Consortium for Hazardous Waste Worker Training. Reproduced by permission.

Types of Emergencies at TSD Facilities

Fire and explosions are probably workers' top concern because they have the potential to escalate from small to extremely large and serious emergencies. That's why fire brigade teams are so important.

But industrial plants with TSD areas must also be prepared for other kinds of emergencies. The facility's emergency response plan should have detailed response procedures for all emergencies that the employer may reasonably expect in the workplace. Often two or more factors come together to create an emergency situation.

Below is a partial list of possible emergencies. Use your own experience and knowledge of your workplace to add to it. You can then use it as a checklist to evaluate how complete your facility's plan is:

- Fires
- Explosion
- Leak of product
- Spills
- Power failure, loss of utility
- Pressure vessel failure
- Equipment failure
- Mechanical problems
- Release of toxic vapors—vapor clouds, radioactive materials
- Reaction of incompatible chemicals
- Discovery of radioactive materials
- Natural disasters (earthquakes, floods, hurricanes, tornadoes)
- Personal Protective Equipment failure (air source failure, tearing or permeation of protective clothing, facepiece fogging)
- Chemical and radiation overexposure
- Medical problems (heat stress, heart attacks)
- Physical injury (serious accidents or falls, injury from flying objects, trenching or confined spaces hazards)
- Malfunction of alarms and monitors
- Bomb threats
- Weather changes (rain, lightning, extreme heat or cold)

Do the Right Thing: Stop and Think Before You Act

Your first instinct in an emergency is probably to jump in and help, particularly if a co-worker is in trouble. But in a hazardous materials emergency, trying to save someone's life could cost you your own. You could do more harm than good. Workers who respond to hazardous materials emergencies need special training—up to 40 hours—and special equipment.

Below are two examples of what can happen to unprepared workers during a spill:

Untrained Worker Cleans Up Styrene Spill; suffers serious injury and wins \$1 million award

Chemical worker Joe Darvis was ordered to clean up a chemical spill after a drum containing styrene was punctured by a forklift earlier in the day. The supervisor said a respirator was not needed. The drum was marked “Flammable Liquid, N.O.S. Flash Point 86 B F, UN 1993.” Worried about the risk of explosion, Darvis grabbed a shovel and spent about 40 minutes loading the chemical into four boxes, which he dumped in a nearby dumpster.

He later suffered serious health problems. A jury awarded him \$1 million because the company failed to properly label the chemical, warn Darvis of the risks, or provide proper PPE.

Power Failure Causes Runaway Chemical Reaction: Kills Poorly Trained Emergency Responder

A power failure in a chemical plant caused a chemical to rapidly decompose, releasing dangerous hydrogen sulfide and sulfur dioxide gases.

Two workers, exhausted by the emergency response efforts, removed their self-contained breathing apparatuses and inhaled high levels of toxic gases. One worker died instantly and the other was hospitalized.

The company was fined \$250,000 for failure to provide refresher training for emergency responders, and failure to train employees, contractors and outside responders on the specific health hazards in the work area. They were also fined for failure to provide a source of backup electrical power.

Source: BNA Occupational Safety & Health Reporter, 3/9/2000.

Summary:

What Are Hazardous Materials Emergencies?

1. Hazardous materials include:
 - chemicals that can burn or explode
 - chemicals that cause cancer
 - poisons
 - germs
 - radioactive materials
 - chemicals that can cause violent chemical reactions.
2. If you don't know what chemical has spilled, assume it is hazardous.
3. If you don't know exactly what the dangers are, don't go near it.
4. A hazardous materials emergency is a spill or leak that you or your co-workers **in the area** can't handle on your own.
5. It's your employer's responsibility to decide **ahead of time** which spills you can handle and which ones are emergencies. The union should review the plan and make sure it protects workers.
6. Shutting off a valve, putting dirt on spilled material, or rescuing someone could poison you, start a fire, or set off an explosion. "Doing the right thing" could be the wrong thing in a hazardous materials emergency.
7. Workers who respond to hazardous materials emergencies need special protective equipment and training. Workers who handle hazardous materials during a spill must have at least 40 hours of training.



Hazardous Waste Response Standard Requirements for Emergency Response

The Hazardous Waste Operations Standard requires all employers at hazardous waste sites and treatment, storage and disposal (TSD) facilities to develop and use **an emergency response program**. This program should include the following:

1. A **written plan** that is available for all workers and OSHA inspectors to see and copy (see the next page). This plan is a section of the overall site safety and health plan.
2. **Specific training** for the use of emergency response equipment.
3. **General training** for workers who are not directly responsible for responding to emergencies.
4. **Regular practice** of the emergency plan as a part of the overall training program for site operations.
5. **Specific steps** explaining the role of the employer during an emergency.

For more information, see CCR Title 8, GISO 5192, paragraph (1).



Your Employer's Written Emergency Plan

By law, your employer has to plan for emergencies like this one **before they happen**.

The **written** plan has to include the following information:

- The definition of an emergency
- What chemicals are used, and how they could spill
- How spills can be **prevented**
- If chemicals do spill, who is qualified to respond, and at what level
- How to contact emergency responders
- What kind of training is required for different levels of response
- How your employer will work with the fire department, HazMat teams, and other outside groups
- Who is in charge at the emergency and who reports to who
- How the spill should be cleaned up
- What protective equipment cleanup workers will need
- Whether anyone must be evacuated, and how that will be done
- Safe places to go in an emergency
- How to account for all workers in an emergency
- How to keep bystanders out of the area
- How workers will be cleaned off (decontaminated) if they accidentally get chemicals on them
- Who will give emergency medical care to chemical victims
- How the program will be evaluated for weaknesses and improvements

Worker Training Requirements: Know Your Role

TSD workers may work in situations where they are likely to be the first to spot an emergency. They are called “Awareness-level first responders.”

Sometimes we are expected to do something for which we haven’t been properly trained or equipped. If workers are expected to respond to hazardous materials emergencies, OSHA law now says that all employers must divide their workforces into five levels of emergency responders.

The five levels of responders, in order of increasing responsibility, are:

- First Responder, Awareness Level
- First Responder, Operations Level
- Hazardous Materials Technician (Hazmat)
- Hazardous Materials Specialist
- On-Scene Incident Commander (IC)

Training First

According to OSHA, you have to be properly trained and equipped **before** your employer can expect you to respond at your designated level. Contractors must be trained too.

Check Your Plan

Your employer’s emergency response plan should describe in detail in which level everyone fits. A good plan should also clearly describe contractor duties during an emergency.

First Responder Awareness Level: Call Someone and/or Sound the Alarm and Run

You need to know who to notify and where to run. This applies to most SEIU members.

First Responder Operations Level: The Defense Team

They act defensively from a safe distance. They put down sand to keep a spill from spreading. They **do not** try to stop a leak. They need special equipment to protect themselves. Your employer may choose to train a small crew for the operations level.

Hazardous Materials Technicians: The Offense Team

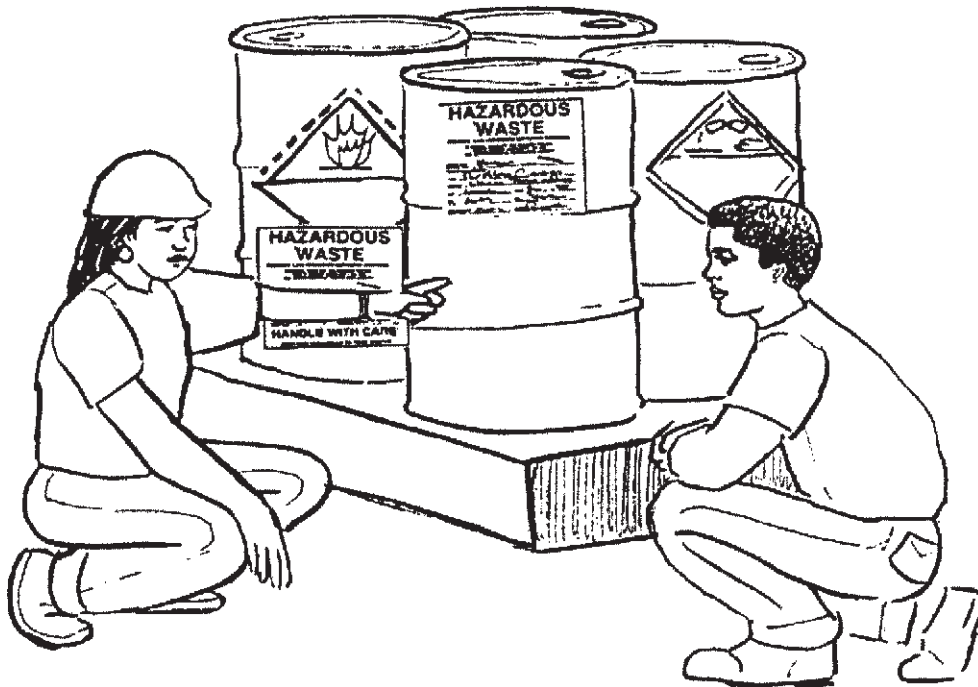
They take offensive actions to stop the release and wear specialized protective equipment. Extensive training is required, beyond fire brigade training.

Hazardous Material Specialists: The Experts

These people are special assistants to the Hazmat team.

On Scene Incident Commander: The Emergency boss

The one person authorized to make all key decisions during emergencies.



OSHA Awareness level: Call someone and/or sound the alarm

“First responders at the awareness level are individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release. They would take no further action beyond notifying authorities of the release.”

OSHA Operations level: Act defensively from a safe distance

“First responders at the operations level are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keeping it from spreading, and prevent exposure.”

OSHA Technical level (HazMat team): Offensive team, extensively trained

“Hazardous material technicians are individuals who respond to releases or potential releases for the purpose of stopping the release. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of the release in order to plug, patch or otherwise stop the release of a hazardous substance.”

OSHA Specialist level: The experts

“Hazardous Materials Specialists are individuals who respond with and provide support to hazardous material technicians. Their duties ... require a more directed or specific knowledge of the various hazardous substances they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with Federal, State, local and other governmental authorities in regards to site activities.”

OSHA Incident commanders: The emergency boss

“Incident commanders [are individuals] who will assume control of the incident scene beyond the first responder awareness level.”

Cal/OSHA Criteria for Incidental Spills

1. The spill response is addressed in the IIPP, and responding employees have been trained.
2. Someone with sufficient training has determined that it is not an “emergency.”
3. Employees have had HAZCOM Training.
4. The substance is identified.
5. Employees have been trained on the hazards of the chemical, the clean-up procedures, what precautions they need to take to protect themselves, how to detect over-exposure, etc. (hazcom).
6. Employees have been furnished with proper protective equipment, and training in the equipment.
7. The proper equipment is available to clean up the spill safely.

Assessing Your Emergency Response Plan

By law, every employer in California needs to be prepared to respond to an emergency. The California Occupational Safety and Health Administration (Cal/OSHA) requires that employers who have chemicals in the workplace train workers about the possible hazards of working with chemicals, and provide training for all employees about the difference between a hazardous materials emergency and a small spill. The Cal/OSHA standards that require this training include:

- Hazard Communication (“Right to Know” law; GISO 5194)
- Injury and Illness Response Plan (IIPP; GISO 3203)
- Hazardous Waste Operations and Emergency Response (HAZWOPER; GISO 5192)

The following two checklists are developed based on information in these standards. They are designed to help you evaluate your worksite emergency response plan and be clear on your role in an emergency or small spill.

Pre-Emergency Planning Checklist: Are We Prepared?

1. Sizing up the situation

- I've received Hazard Communication training, including information on:
 - how to protect myself from the dangers of the chemicals I work with
 - the signs of overexposure to the chemicals I work with
 - where to get additional information (labels and Material Safety Data Sheets) on the chemicals I work with
 - when to use personal protective equipment, including how to clean, store and wear it correctly.
- I know the location of the most hazardous chemicals in the building.
- I've received training on what to do in case of a chemical spill:
 - I know the person to contact who has sufficient training to determine the difference between a small spill that can be safely cleaned up vs. an emergency **and/or**
 - I have received sufficient training to be able to make a safe judgement about the difference between a small spill and an emergency.

2. Alert

- The company has an evacuation alert system that reaches all employees.
- The company has tested the evacuation alert system.
- I know how to activate the emergency evacuation system if necessary.
- I have seen and been trained on the company's emergency response/evacuation plan.
- I know who is "in charge" in an emergency.

- The company has a clear “chain of command” with back-ups (a contingency plan) if primary people are absent.
- Communication equipment is readily accessible throughout the building.
- The company has a way to alert neighboring businesses and homes of a spill.
- I know what my role is, and what to do if a spill occurs, including:
 - Where to go
 - Who to call
 - What to report (name of chemical, size of release/spill, employees affected, any additional information that could be helpful).

3. Get Out

- I know the evacuation plan.
- I know the company’s designated meeting place outside the building.
- I could easily walk out of the building even with the lights out.
- We have practiced the evacuation plan.
- Exits are clearly marked and accessible.
- The company keeps a daily list of on-duty employees that will be brought to the designated meeting place in an emergency.
- Other.

When an Incident Occurs: Checklist

1. Size-up: Is it an emergency or small spill?

You should be able to answer YES to all the following questions in order to determine if this is a small spill that you can safely clean up. If you answer NO to any of these questions, go immediately to Alert:

Yes	No	
-----	----	--

- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | I've received training on what to do in case of a chemical spill: |
| <input type="checkbox"/> | <input type="checkbox"/> | I know the person to contact who has sufficient training to determine the difference between a small spill that can be safely cleaned up vs. an emergency and/or |
| <input type="checkbox"/> | <input type="checkbox"/> | I have received sufficient training to be able to make a safe judgement about the difference between a small spill and an emergency and can answer yes to the following information: |
| <input type="checkbox"/> | <input type="checkbox"/> | I know when to notify my supervisor and/or spill response coordinator about the spill to get their input and guidance about how to respond. |
| <input type="checkbox"/> | <input type="checkbox"/> | I know what the chemical is and how hazardous it is. |
| <input type="checkbox"/> | <input type="checkbox"/> | The chemical is not mixing with other chemicals. |
| <input type="checkbox"/> | <input type="checkbox"/> | The chemical is not extremely hazardous. |
| <input type="checkbox"/> | <input type="checkbox"/> | know the signs of overexposure to the chemical. |
| <input type="checkbox"/> | <input type="checkbox"/> | Personal protective equipment is available and in usable condition. |
| <input type="checkbox"/> | <input type="checkbox"/> | I've been trained in how to safely clean up this chemical and how to use the personal protective equipment (PPE) correctly. |
| <input type="checkbox"/> | <input type="checkbox"/> | Staffing is adequate to clean up the spill. |
| <input type="checkbox"/> | <input type="checkbox"/> | Clean-up equipment is accessible and in usable condition. |

2. Alert

- Notify co-workers in immediate area.
- Leave immediate area.
- Report incident as trained:
 - What happened? (name of chemical, size of release/spill, employees affected)
 - When did it happen?
 - Where did it happen?
 - Is anyone injured, contaminated or trapped?

3. Get Out

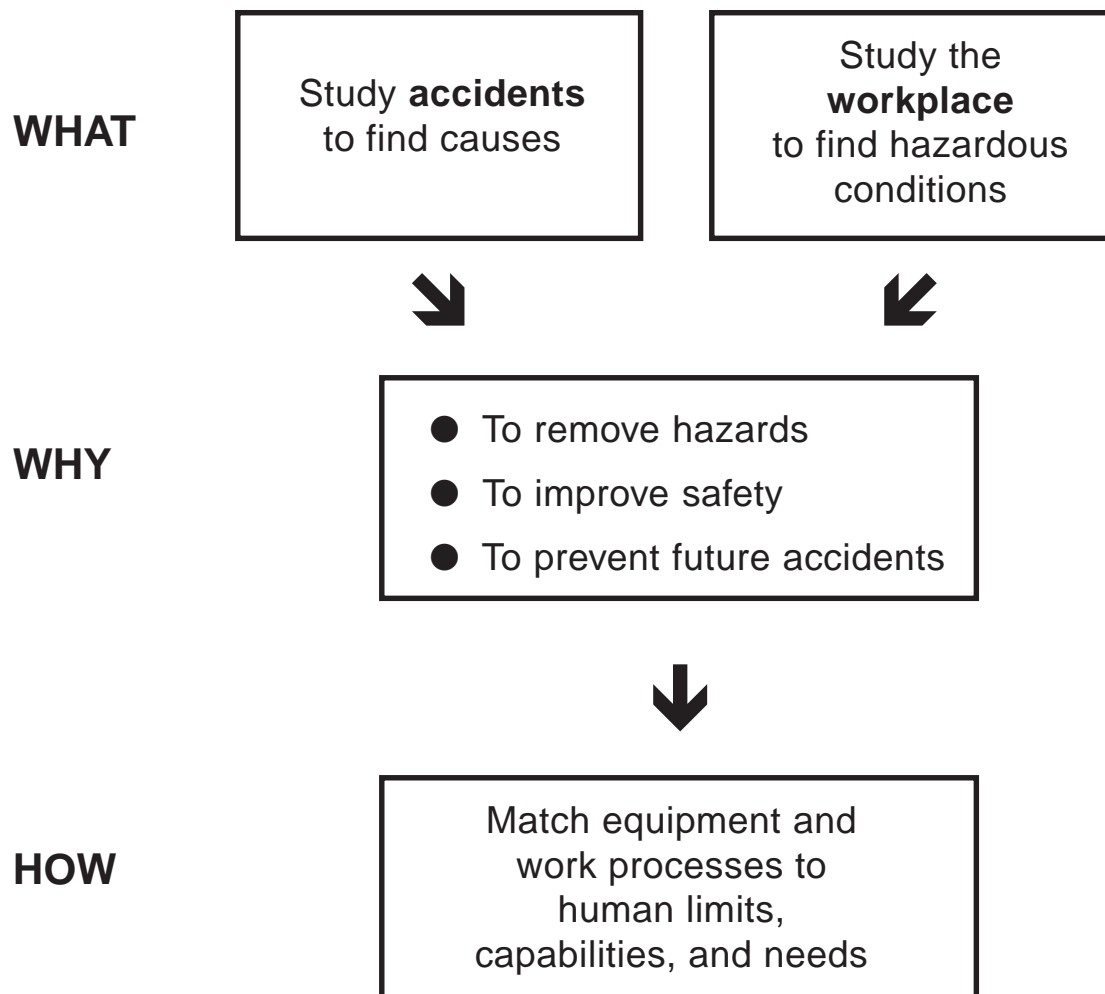
- Evacuate building as trained.
- Double check that your closest co-workers are with you; if not, notify the person in charge.
- Go to the designated meeting place outside the building.
- Check in with the supervisor of the meeting place to check off your name.



Human Factors



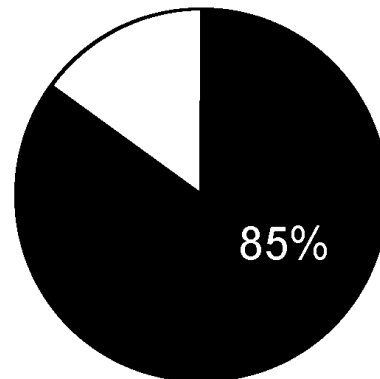
The Human Factors Method



Labor and Management Agree

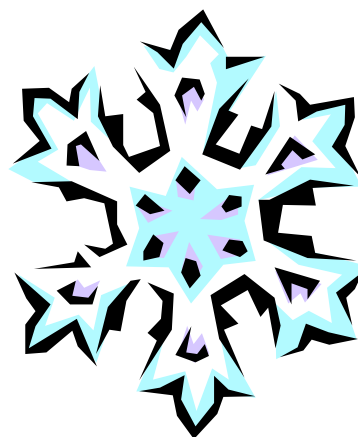
“The vast majority (80-85%) of human errors primarily result from the design of the work situation (the tasks, equipment, and environment) which managers directly control.”

—Chemical Manufacturers Association

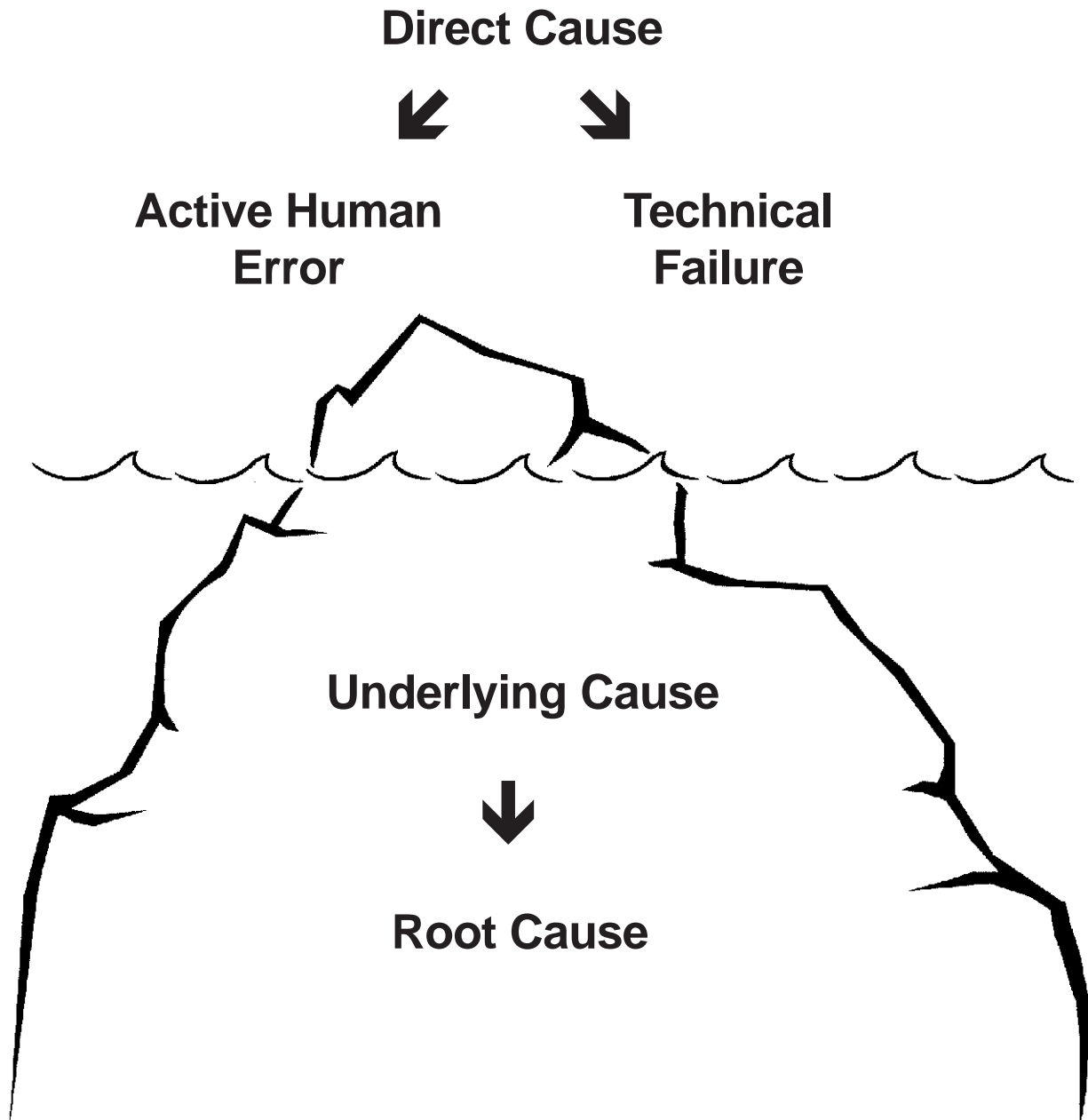


“Blaming workers for safety failures is like blaming the snowflake for the avalanche.”

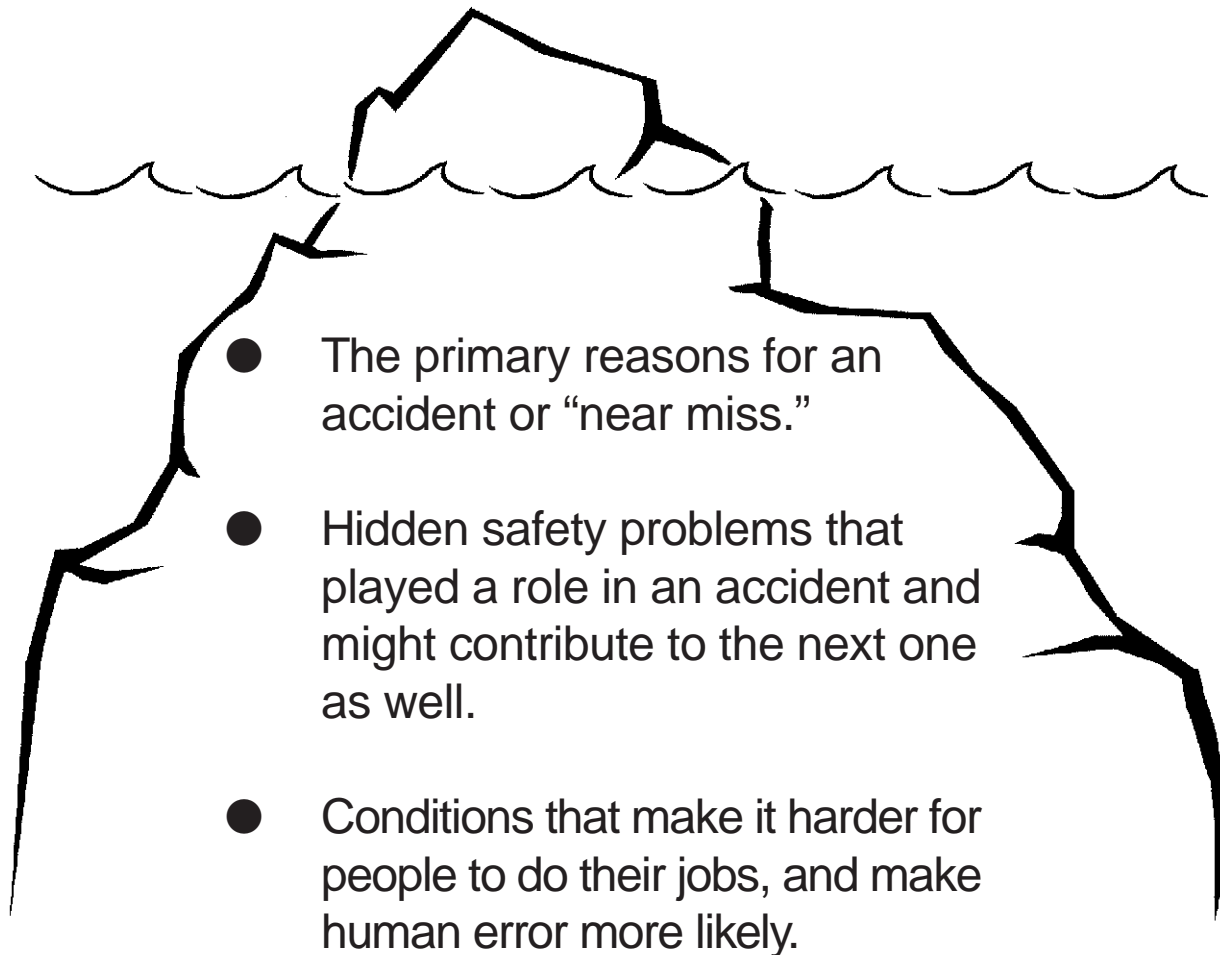
—Glenn Erwin, PACE



Human Factors Terms



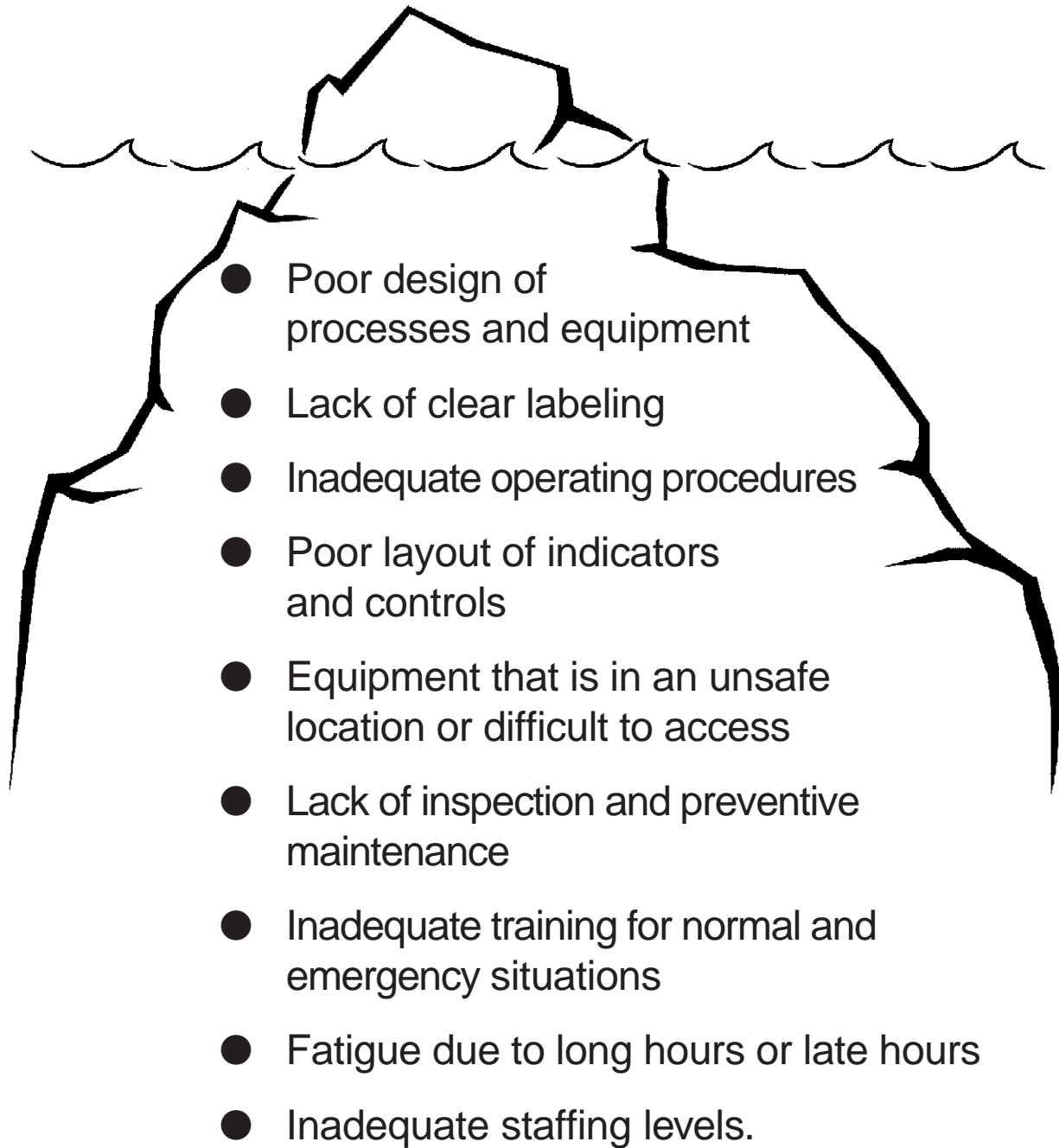
Underlying and Root Causes



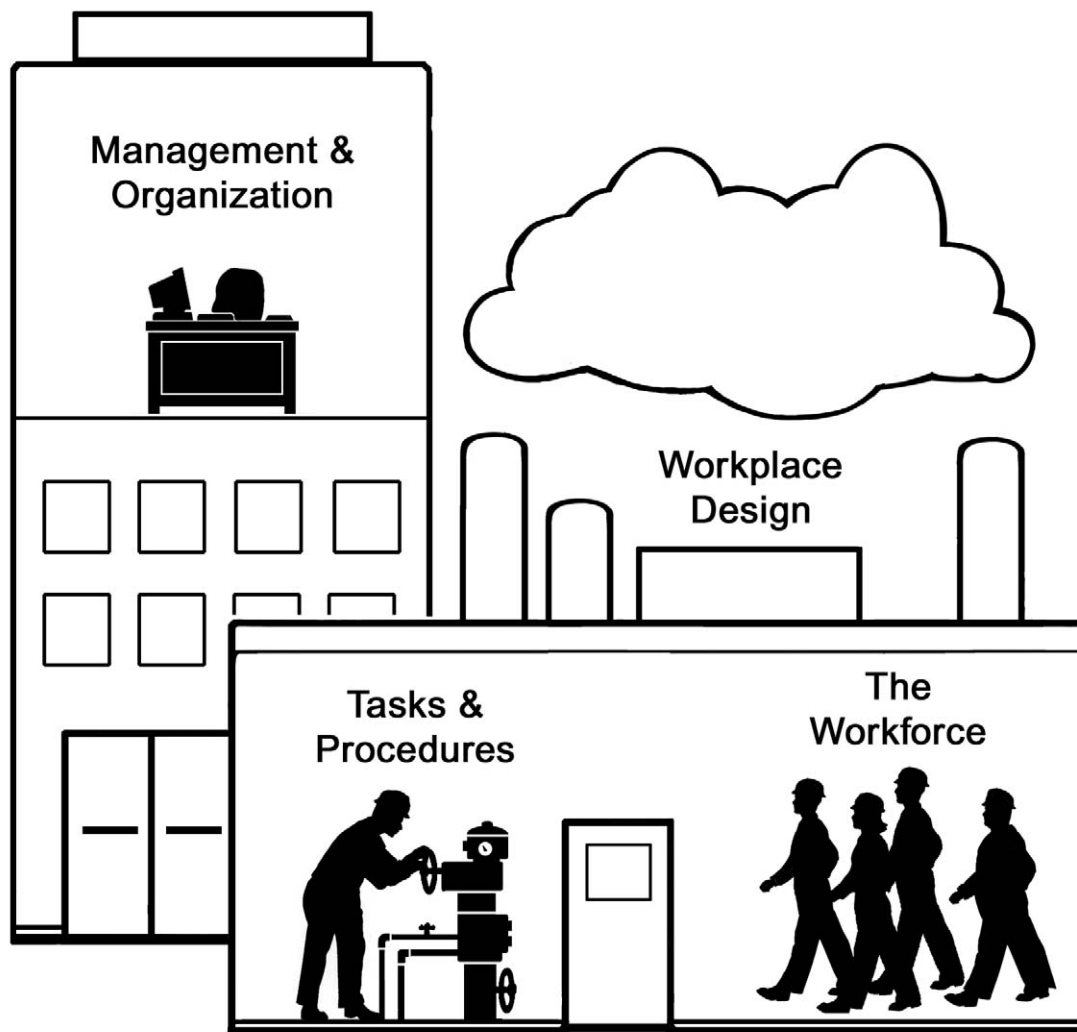
“Putting the immediate causes right will prevent only the last accident from happening again; attending to the underlying causes may prevent many similar accidents.”

—Human Factors Expert

Underlying and Root Causes— Some Examples



Four Point Approach to Safety



Human factors evaluates the whole operation:

- Management and Organization
- Tasks and Procedures
- Workplace Design
- The Workforce

Human Factors—The Four Point Approach

Here are just a few examples of the kinds of issues considered by human factors experts when they investigate accidents or design processes and equipment. These issues are often organized into four broad categories as shown below. Problems in each category can be a source of human error.

Considering the four categories together allows human factors to get a comprehensive look at the whole operation rather than focusing narrowly on its separate parts.

Management and Organization

- Safety and human factors programs
- Communications
- Safety training
- Safety culture
- Accountability
- Rewards and incentives

Tasks and Procedures

- Written procedures for each task
- Task-specific training
- Clear delegation of responsibility: who does what?

Workplace Design

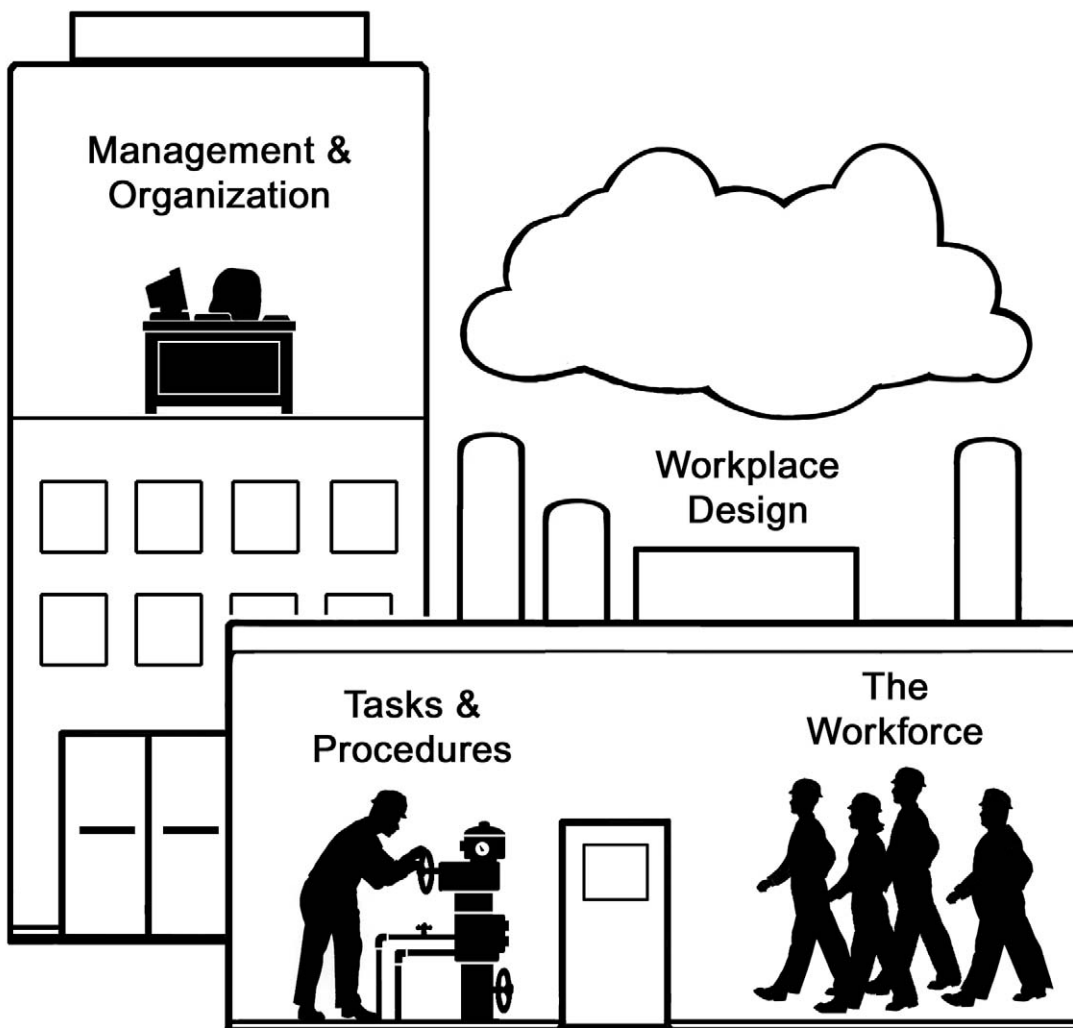
- Design of processes and equipment
- Labeling
- Design of controls, control rooms, and control panels
- Work environment (heat, noise, lighting, etc.)

(continued)

The Workforce

- Knowledge and experience
- Training
- Staffing and overtime
- Workload
- Stress and fatigue

The diagram below shows how all four categories fit together to make up the “big picture.”



Summing Up

Human factors:

- Takes a comprehensive approach to safety and examines the whole workplace.
- Looks at management and organization, tasks and procedures, workplace design, and the workforce.
- Doesn't just blame the worker and try to modify worker behavior.
- Understands that anyone in the whole system can make a human error, including designers and managers.
- Recognizes that people will make mistakes and works to eliminate "error likely" situations.
- Aims to match equipment, processes, and procedures to human capabilities and limits.
- Looks at physical, mental, and behavioral issues.

Human Factors Methods

Human factors works to improve job safety. Its approach is to eliminate situations where errors are likely to happen. It doesn't try to modify individual behavior. The aim is to "control the hazard, not the worker."

Human factors tries to:

1. Allow for differences among people.
2. Remove opportunities for error.
3. Reduce the impact of errors that do occur.
4. Design "fail-safe" systems into the operation.
5. Match the job to the worker.

Match the Job to the Worker

Human factors looks at physical, mental, and behavioral needs. It tries to match equipment and work processes to human capabilities and limits.

Physical Capabilities and Limits

Equipment should be designed so all employees are **physically** able to do the job.



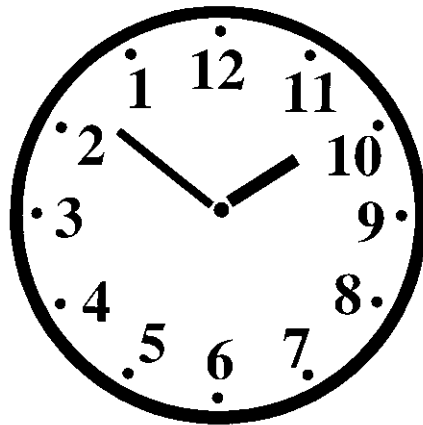
What's wrong with this picture? The valve is too high, so the worker has to stretch to reach it. It's also awkwardly placed and behind a barrier. The worker could get hurt reaching for the valve, or might have trouble reaching it quickly in an emergency. The valve also appears hard to turn, and is not clearly labeled.

(continued)

This example illustrates why good design is more important than just training workers to use proper techniques. With the operation designed like this, the worker is **forced** into an awkward position. Instead, equipment needs to be adapted to meet the **physical** capabilities of the worker.

Mental Capabilities and Limits

Equipment should be designed so all employees are **mentally** able to do the job.

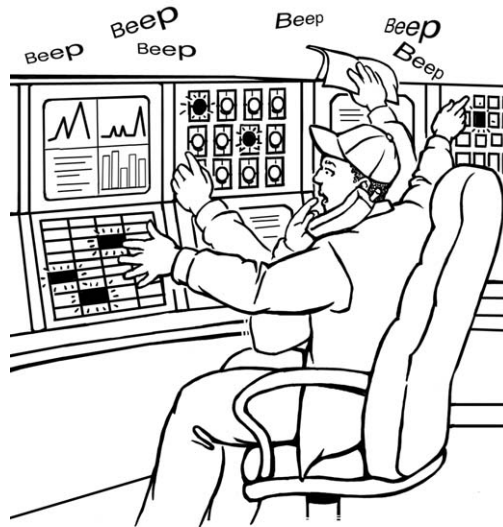


According to this clock, what time is it? The clock reads about 10:08. Notice it took longer to figure out the time because it is not a regular clock. Most people would have trouble reading this clock.

The clock illustrates a basic principle of human factors—the workplace should be designed to match our knowledge of everyday things. Equipment should work the way we expect it to.

Behavioral Issues

In addition to physical and mental capabilities, human factors looks at other issues like stress, fatigue, and motivation. These are usually grouped together as **behavioral** issues.



This is the control room at a nuclear power plant. Wouldn't you have trouble with a control panel this complicated? A worker might easily push the wrong button because:

- There are too many buttons.
- The control panel layout is poorly designed and very complicated.
- Nothing appears to be clearly labeled.
- The board seems overwhelming and could create mental overload for the operator.

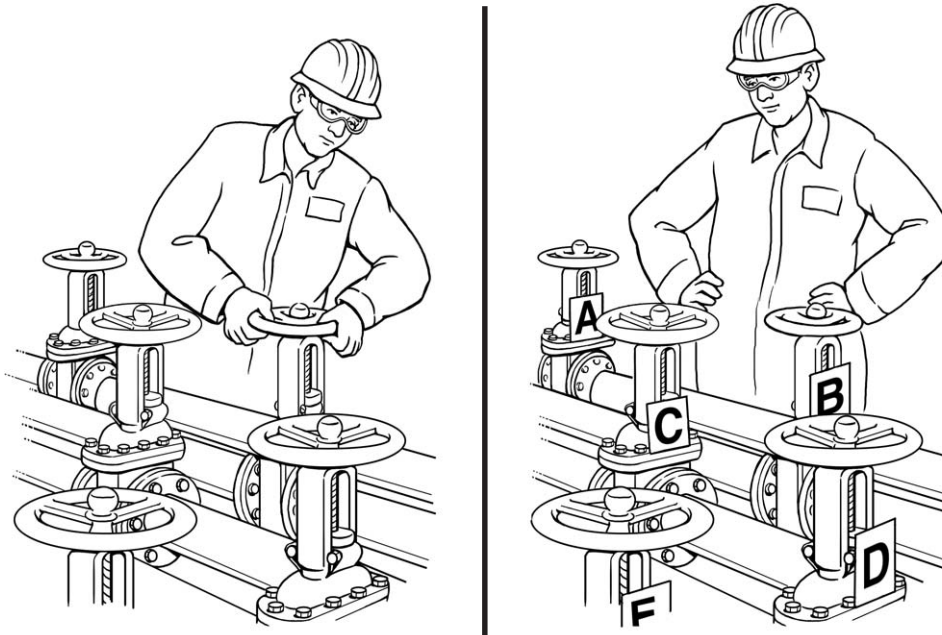
It would be easy to make a mistake, especially in an emergency situation.

Behavioral issues include factors like workload, stress, and alertness. Equipment has a breaking point—what about people? What happens when it is 3 am, a worker has worked 11 days straight and is exhausted? Suppose there were an emergency? Suddenly there are lights flashing and alarms sounding. Wouldn't this contribute to mistakes?



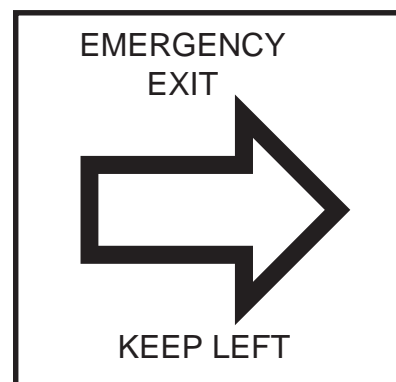
Labeling

Many accidents occur because of the lack of clear labels. There should be clear labeling of valves, service lines, equipment, instruments, and chemicals.



✓ Make labels easy to understand.

Here's an example. In case of a toxic gas release, this sign was intended to direct people down the **right-hand** corridor, but to keep them on the **left** side of it. This would give the emergency response team a clear path into the building. When an actual release occurred, several workers died trying to escape via the left-hand corridor. The sign required too much "information processing" at a time when the workers were under stress.



(continued)

✓ **Make letters and numbers easy to read.**

is clearer than

✓ **Check the labeling system periodically.**

- Designate trained operators to conduct the periodic checks.
- Adjust work loads to give operators time to complete this assignment.
- Do the periodic checks on a regular schedule.
- Have the periodic checks overseen by a supervisor.

Procedures

✓ **Make procedures specific, clear, and realistic.**

When procedures are ambiguous, impractical, or unrealistic, workers will take shortcuts. When you notice that a procedure is not being followed, it is important to find out the underlying reasons:

- Does the procedure exist in writing, and is it readily available?
- Is the procedure confusing, incomplete, or difficult to use?
- Is the procedure specific to the job?
- Is the procedure up-to-date with equipment and process changes?
- Does the procedure warn of the special hazards involved in the task?
- Has the procedure been audited by operators for workability?
- Have operators been adequately training on the use of the procedure?
- Are there production pressures that may encourage workers to take shortcuts?

—*Center for Chemical Process Safety*

Japan's Nuclear Accident



Japan's worst nuclear accident occurred in October, 1999 at a uranium processing plant. The radiation leak occurred while workers were feeding uranium into a tank. Two workers received fatal doses. The investigation found that:

- The company had distributed a secret manual instructing employees to bypass safety procedures for the sake of speed.
- Workers involved had devised further shortcuts themselves.
- Workers hadn't been trained about the volatility of enriched uranium or the amount needed to set off a chain reaction.

—*San Francisco Chronicle, October 7, 1999*

Ergonomic Analysis Form for Extending Accident Investigations to Find Root Causes

Check the appropriate findings and use ergonomic guidelines to identify areas for improvement. There should be at least one finding under each of the 4 major categories, Individual, Task, Environmental, and Organizational Factors. For each finding, identify Why ? it was present and a strategy to reduce its contribution to injury risk in the future.

A. Individual Factors

Finding	Why Was It There?	Action Taken
<input type="checkbox"/> Physical, mental, or perceptual overload	<input type="checkbox"/> Inadequate strength/endurance <input type="checkbox"/> Inadequate help available <input type="checkbox"/> Too small, short reaches <input type="checkbox"/> Too large, inadequate clearance <input type="checkbox"/> Inadequate skill <input type="checkbox"/> Inadequate training/experience <input type="checkbox"/> Worker with lower capacity	
<input type="checkbox"/> Lack of attention	<input type="checkbox"/> Monitoring multiple tasks <input type="checkbox"/> Outside of work distractions <input type="checkbox"/> History of wrong information learn to ignore it	
<input type="checkbox"/> Over-rode a safety device/policy	<input type="checkbox"/> Time pressure to work faster <input type="checkbox"/> Lack of understanding of risk <input type="checkbox"/> Safety device makes work harder	
<input type="checkbox"/> Missed signal/info	<input type="checkbox"/> Distractions in work area <input type="checkbox"/> Poor visibility/vision or hearing <input type="checkbox"/> Not paying attention	
<input type="checkbox"/> Not following SOP	<input type="checkbox"/> No SOP <input type="checkbox"/> New or inexperienced on task <input type="checkbox"/> Risk-taking behaviour	
<input type="checkbox"/> Rushing	<input type="checkbox"/> Production pressure/deadline <input type="checkbox"/> End of shift; before break/lunch <input type="checkbox"/> Overloaded—workforce too lean	
<input type="checkbox"/> Fatigued	<input type="checkbox"/> Hours of work <input type="checkbox"/> Awkward postures <input type="checkbox"/> Outside of work concerns <input type="checkbox"/> Health status <input type="checkbox"/> Sustained concentration <input type="checkbox"/> High accountability	
<input type="checkbox"/> Other:		

B. Task Factors

Finding	Why Was It There?	Action Taken
<input type="checkbox"/> Error-likely work	<input type="checkbox"/> Complexity (>1 month to train) <input type="checkbox"/> Multiple tasks simultaneously <input type="checkbox"/> Frequent changes in task demands <input type="checkbox"/> Confusing controls/displays	
<input type="checkbox"/> Sustained awkward postures	<input type="checkbox"/> Work heights below 20" and above 50" from the standing surface <input type="checkbox"/> Extended reaches more than 20" standing and 15 inches seated in front of the body <input type="checkbox"/> Poor lines of sight <input type="checkbox"/> Inadequate workspace <input type="checkbox"/> Poor body supports for work in awkward positions, e.g., steps, grasp points, platforms, etc.	
<input type="checkbox"/> Excessive forces or lifts	<input type="checkbox"/> Handling compact loads or push/pulls >50# <input type="checkbox"/> Handling lighter loads >20 inches in front of body <input type="checkbox"/> Gripping with strong wrist angles or pinch grip	
<input type="checkbox"/> External control	<input type="checkbox"/> Machine-paced, automation <input type="checkbox"/> JIT/DFT/Flow controls on pace	
<input type="checkbox"/> Repetitive work	<input type="checkbox"/> > 20 repetitions per minute for 2 hours continuously <input type="checkbox"/> High effort and repetition rate > 6/min for more than 15 minutes an hour <input type="checkbox"/> Moderately heavy effort of 6 to 20 seconds at a repetition rate >1 and < 5 per minute sustained for 2 hours <input type="checkbox"/> Muscle effort sustained for more than 30 seconds without relaxation	
<input type="checkbox"/> Fine visual work	<input type="checkbox"/> Low contrast visual task <input type="checkbox"/> Small visual targets <input type="checkbox"/> Low signal to noise ratio of target in background	
<input type="checkbox"/> Other:		

C. Environmental Factors

Finding	Why Was It There?	Action Taken
___ Lighting: glare or poor quality	___ Light location relative to work ___ Wrong type or color of light ___ Layout problem—columns, overhead conveyors, cranes, window locations ___ Not enough light fixtures or dark walls/machines ___ Competing visual tasks	
___ Noise: distraction, communication is affected, signals may be missed	___ Machine noise ___ Equipment/tool noise ___ People noise ___ > 65 dBA continuously ___ Inadequate alarm levels	
___ Temperature air flow & humidity	___ > 86 degrees F for 8 hours ___ < 60 degrees F for 8 hours ___ Low airflow (< 20 ft/min) or exchange rate ___ High air flow (> 100 ft/min) or speed of movement (mph) ___ < 25 or > 70 % RH	
___ Vibration	___ Vehicular or floor/building vibration— isolation needed ___ Power tools not maintained or wrong type ___ Maintenance needs ___ Poor work location	
___ Workplace layout	___ Poor maintenance access ___ Poor space for materials flow ___ Low flexibility for rapid changeovers working multiple parts ___ Inadequate work surface area ___ Excessive traffic, distractions ___ Housekeeping issues	
___ Other:		

D. Organizational Factors

Finding	Why Was It There?	Action Taken
___ Hours of work	___ Night shift worked/end of shift ___ Extended overtime schedule ___ End of year or before shutdown	
___ Production Schedule Pressure	___ Emergency situation—unusual ___ Inadequate staffing for task ___ Developmental task—deadline ___ Quality problem ___ Vacation coverage inadequate ___ Seasonal demand ___ Vendor or purchasing failure ___ Communication failure	
___ Training	___ Inadequate initial training ___ Inadequate follow-on training ___ Inadequate health & safety and ergonomics awareness for job ___ SOPs not clear ___ Worker’s introduction to tools and equipment not adequate ___ Worker returned after several weeks off the job (vacation, illness, or another assignment)	
___ Policies/Style, Management Issues	___ Preventive maintenance is not scheduled regularly ___ Parts quality inadequate for task ___ Inadequate tools or equipment ___ Expense budget too small ___ Investment budget too small ___ Too many responsibilities to perform all needed tasks ___ Inadequate communications between departments/cells ___ Too little time to institute new processes, products, etc. ___ Delays in communicating changes or projects to the production floor	
___ Other:		

Design of Controls

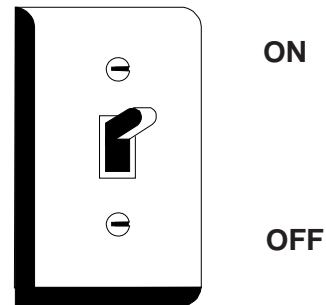
With good control design, communication between operators and equipment is more efficient and less stressful.

✓ Controls should operate as expected.

In everyday life, certain colors and positions have commonly understood meanings. For example:

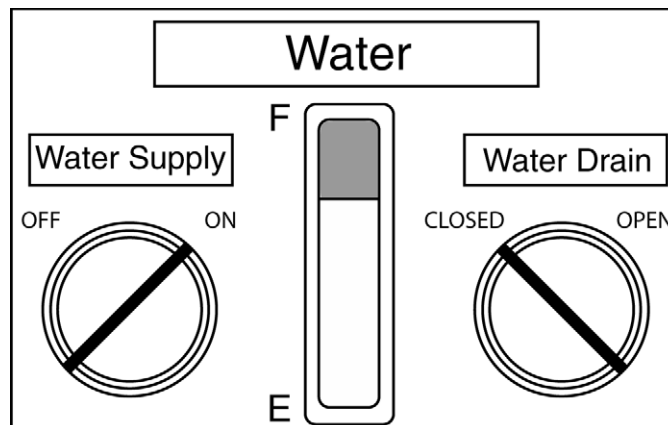
- Red usually means “stop.”
- Up usually means “on.”

Controls at a plant should match these everyday expectations. Otherwise, confusion and error can easily result.



✓ Controls for each task should be grouped together.

If the controls needed while doing a particular task are all in one place, mistakes are less likely.

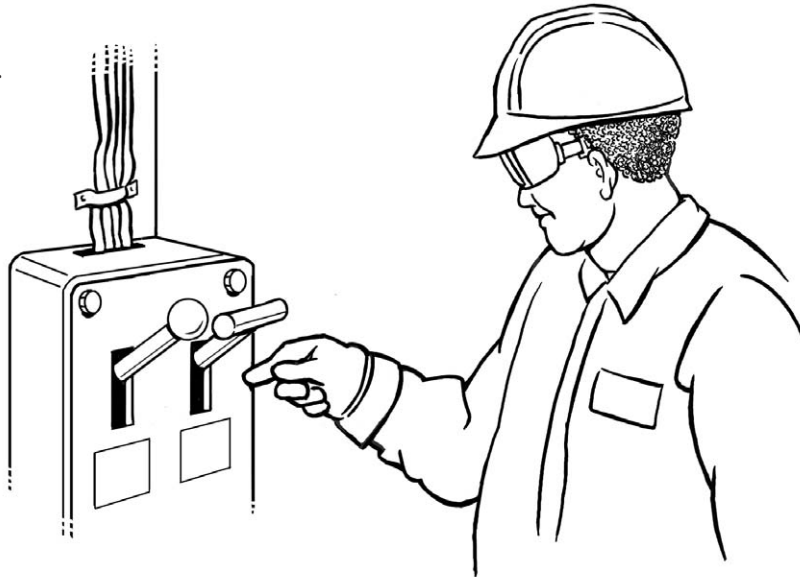


(continued)

✓ **Controls should be easy to tell apart.**

Mistakes can be avoided if different controls are easy to distinguish from each other. Give controls:

- Adequate spacing.
- Different colors.
- Distinctive shapes.



✓ **Key displays should be in the best position for the operator.**

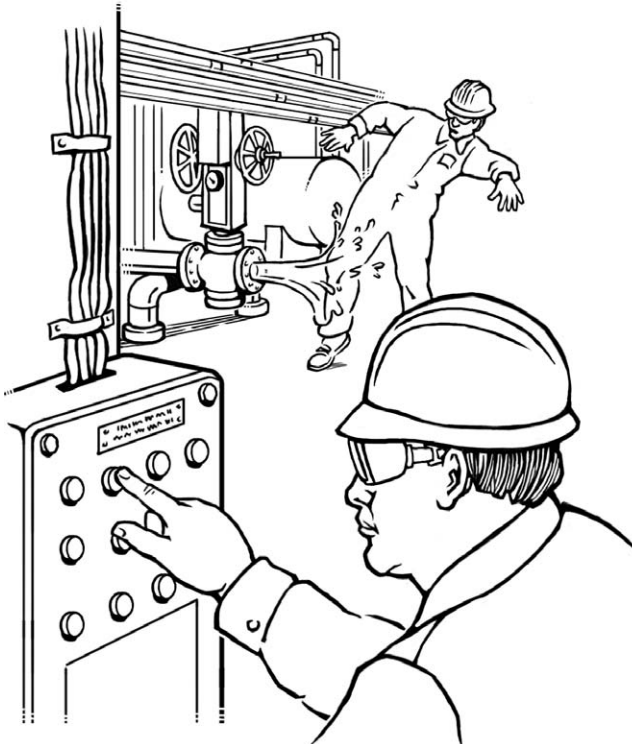
Important displays should be directly in front of the operator, and 20 to 50 degrees below a horizontal line extending from the operator's eyes. That way, the operator is looking straight ahead and slightly down.

✓ **Controls shouldn't require excessive strength.**

The force needed to move a switch, valve, or other control should not exceed the operator's strength. Ergonomic guidelines should be followed in designing them.

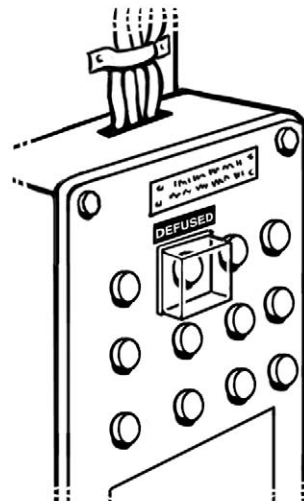
✓ **Controls should be difficult to operate by accident.**

Lock out or defuse controls that could cause serious problems if they were engaged by mistake.



**SWITCH ENGAGED
BY ACCIDENT**

**SWITCH
DEFUSED**



The Physical Work Environment

Traditional safety specialists are mainly concerned with preventing physical harm to the worker. Human factors considers both physical and mental effects.

When human factors specialists talk about exposure to noise, poor lighting, heat, or cold, they are usually considering the impact on an operator's ability to carry out a task. For example, these hazards may cause anxiety or fatigue, thus reducing performance.

✓ Consider OSHA standards as only minimum requirements.

Federal and state OSHA set standards regulating some hazards in the physical work environment (including noise and lighting). However, human factors may be concerned about these hazards even when levels meet OSHA requirements. OSHA standards are designed to protect workers from physical harm, but human factors has a broader concern for **all** conditions that may lead to human error. For example, workplace noise may be within OSHA limits but still distract workers enough that they make mistakes.

NOISE

Sometimes it's so noisy that "you can't hear yourself think." Noise can increase human error. It may:

- Mask warning sounds like alarms and shouts.
- Increase fatigue.
- Make it harder to mentally "process" complex information.
- Distract workers so they don't pay attention to other things that are happening.
- Make it harder to monitor and interpret events.



(continued)

LIGHTING AND GLARE

Poor lighting and glare can make it hard to see what you are doing. Workers may not be able to read valve labels or displays on the control panel. In the field at night, poor lighting may make it nearly impossible to read instruments.

HEAT AND COLD

Extreme heat and cold can cause workers to experience fatigue and loss of concentration. They may miss a step in a procedure, especially if they rush to complete tasks.

Cold can also affect muscle control, reducing dexterity and strength.

When working in extreme heat, workers should first be **acclimated** (given enough time to get used to working in heat). Otherwise they are affected more adversely by the heat.

—*Center for Chemical Process Safety*

Management Commitment

✓ **Make sure management does its job.**

According to the Center for Chemical Process Safety (CCPS), one of management's top priorities should be reducing human error and maintaining a safe environment. The following management attitudes, policies, and practices are crucial parts of this effort. Management should:

- **Demonstrate a commitment to safety.** This should start at the very top of the organization.
- **Establish a blame-free atmosphere.** This will encourage employees to report problems and give other feedback that may be essential for identifying and reducing risks.
- **Provide resources.** Human factors experts should be used to guide efforts to improve process design, operation, and maintenance. The necessary funds and personnel should be made available.
- **Promote understanding of human factors principles.** Employees throughout the organization should understand the basics of human factors so they can help apply these ideas.
- **Eliminate situations where errors are likely.** Use human factors techniques and expertise to identify and eliminate high-risk conditions.

Training

✓ Train operators to exercise judgment.

As plants become more automated and complex, it is not possible to write detailed procedures for every possible situation. Good training not only gives operators the skills and knowledge they need, but also allows them to exercise judgment and discretion.

Today's operators should be trained to:

- Understand the **intent** of rules and procedures.
- Understand the scientific basis of processes and of potential problems. For example, they need to understand the relationship between temperature and pressure, the power of gases and liquids under pressure, and metal fatigue.
- Diagnose problems thoroughly. With good diagnostic skills, there's less chance of developing a "mind set" that locks them into considering only one possible explanation.
- Understand the scope of their authority. For example, can operators initiate a shutdown or take other action to avert a problem?

✓ Give operators "refresher" training periodically.

Operator training should be repeated on a regular schedule. Training should also be updated whenever processes, equipment, or jobs change.



Stress & Fatigue

Human factors examines work hours and schedules to find out how they affect job performance and error rates. While more research is needed, here are some findings.

✓ **Avoid a long workday.**

Studies have shown that exceeding the 8-hour workday can lead to lower productivity, higher accident rates, and higher absenteeism.

One study of control room operators who switched from an 8-hour shift to a 12-hour shift found decreases on tests of performance and alertness.

Fatigued workers are more likely to experience “tunnel vision.” They are able to focus only on a few instruments rather than a whole display panel. A tired worker tends to perform very much like an unskilled worker.

✓ **Limit shift rotation and night work.**

Shift work and night work can affect people’s natural body rhythms (called “circadian” rhythms). Constant readjustment of sleep schedules seems to produce acute feelings of fatigue and disorientation. Experts recommend either making shifts permanent or reducing the frequency of shift rotation.

✓ **Minimize high hazard graveyard tasks.**

Where possible, it’s best to avoid scheduling certain types of high hazard work on the graveyard shift. Examples include start-up of process equipment and removal of equipment from service. These are tasks that require maximum alertness. Plants should set guidelines to minimize such tasks at night. If they must be done, special precautions should be taken.

Other potentially risky tasks to avoid on the graveyard shift should also be identified.

(continued)

In the News

Europe Limits Work Hours

The European Union issued a directive in 1993 which set the following limits on work hours:



- 48-hour average maximum work week
- 8-hour limit on night work in each 24-hour period
- 11 consecutive rest hours in each 24-hour period
- 24-hour rest period in each calendar week
- 4 weeks annual leave.

—*Irish LP Gas Association, Working Time Directive Report*

Staffing & Safety

Pipes have a breaking point—what about people? Refinery engineers set maximum process limits at which equipment can be safely operated. But no such limits are set for humans!

✓ Provide adequate staffing.

Few refineries use human factors specialists to systematically evaluate operator workload in terms of human limits, especially during emergencies. Most workload analysis still uses traditional techniques. It studies how operators respond to single, narrowly defined incidents—not complex incidents where many things go wrong simultaneously.

Understaffing can create a variety of unsafe working conditions. When plants are short staffed, long hours and high levels of stress can increase fatigue, increasing the chance of worker error.

At a minimum, every refinery must have enough operators to deal with plant upsets and emergencies on all shifts, without calling in people from off-site. Adequate staffing is a management responsibility—an important part of the management safety system.

✓ Watch for these symptoms of understaffing.

- There is a backlog of maintenance work orders.
- There is a backlog of routine inspections.
- It is hard to schedule team meetings given people's work schedules.
- Workers complain about attending training classes during time off because they are already working so much overtime.
- Procedures are not kept up to date due to other work demands.
- Emergency drills indicate there are not enough people to cover all the bases during upset conditions.
- Work done by permit and by contractors is not adequately supervised due to competing duties of the operators.
- There is no management system to ensure that staffing levels are safe.

Buddy System

✓ Use “buddies” on high hazard jobs.

It is common practice in the oil and chemical industries to have at least two people work together on potentially risky jobs. If one worker gets in trouble, a partner is there to help.

Each plant should create a list of high hazard jobs which require a “buddy.” Examples include:

- Doing any work that requires the use of a permit—hot work permit, confined space entry permit, etc.
- Opening process lines or other equipment that might contain hazardous materials or flammables.
- Using a supplied air respirator.
- Working on high pressure or high energy equipment.
- Working on electrical equipment that could cause a paralyzing shock.
- Working in extremely hot or cold environments.
- Lifting equipment over process lines.
- Capping over ended valves.



Recommending and Implementing Solutions

- Focus on underlying policies, procedures, and practices.
- Aim to fix programs or systems that allowed unsafe conditions to exist. Don't simply correct particular problems.
- Determine which major programs are most in need of improvement. Set priorities.
- Involve operators and maintenance staff in developing recommendations.
- Look for multiple recommendations. Just as a problem can have many causes, it may also have many possible solutions.
- Have a tracking system to make sure recommendations get implemented.
- Inform all employees of steps that have been taken to fix the problems.



Air Monitoring



Objectives

In this chapter participants will learn the health and safety issues surrounding a variety of air monitoring techniques for measuring contamination in air. They will also be introduced to a number of monitoring instruments and their use and operation. Participants will also be made aware of the limitations of monitoring techniques and equipment.

The goals of this chapter are to ensure that participants understand:

- The reasons for doing air monitoring at hazardous waste sites;
- The importance of having an air monitoring plan;
- The various types of air-monitoring equipment available;
- The use and limitations of air monitoring equipment;
- The need for proper training in selection, use, and care of air monitoring equipment.

On completion of this chapter, participants will be able to:

- List two reasons for doing air monitoring on a hazardous waste site;
- List three things that should be considered in an air monitoring plan;
- List three instruments used for measuring air concentrations;
- Identify two instruments commonly used for detecting organic vapors on hazardous waste sites;
- Identify whether or not an instrument is “intrinsically safe;”
- State the EPA action levels for combustible and oxygen-deficient atmospheres;
- List two common units used to measure air concentrations.

Air Monitoring

Introduction

One of the most common ways to be exposed to chemicals is by breathing them in. Wherever there are large amounts of chemical contamination, vapors, gases, dusts, or mists are likely to be present in the air. In order to protect your health it is important to locate, identify, and quantify the air borne chemicals on a site. Section (h) of 29 CFR 1910.120 states that:

“Air monitoring shall be used to identify and quantify airborne levels of hazardous substances in order to determine the appropriate level of employee protection needed on site.”

Air monitoring is particularly difficult at hazardous waste sites. Unlike industrial settings, the chemicals and chemical mixtures at a hazardous waste site usually are unknown. Airborne contaminants are also free to move throughout the site. Constantly changing site activities and weather conditions can cause large fluctuations in the concentrations of airborne contaminants. In order to locate, identify and quantify airborne contaminants under these conditions an air-monitoring plan must be developed.

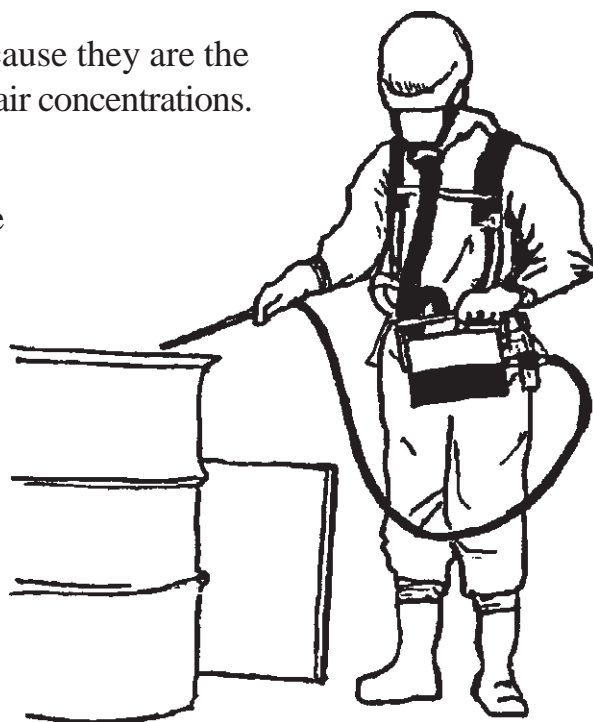
Measuring Air Concentrations

The units below are important to understand because they are the common units of measurement used to describe air concentrations.

Parts Per Million (ppm) is a measure of the volume of gas or vapor contaminant in a volume of air. The concentration “50 ppm xylene” means that there are 50 molecules of xylene for every one million molecules of air.

Percent is the same concept as parts per million only it means parts per hundred. A concentration of “5% xylene” means that there are 5 molecules of xylene for every one hundred molecules of air.

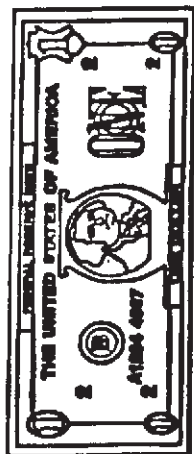
1 percent = 10,000 parts per million



Milligrams per cubic meter (mg/m^3) is a measure of the weight of a contaminant in a volume of air. The concentration of “ $0.05 \text{ mg}/\text{m}^3$ of lead” means that there is .05 mg of lead for every cubic meter of air. It’s commonly used for solids and particulates, but can be used for gases and vapors.

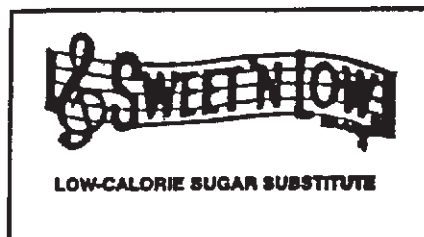
Measuring Weight

1 gram (g) =



weight of a
dollar bill

or

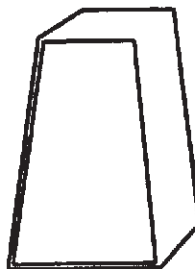


weight of 1 packet of
Sweet 'N Low

1 thousand milligrams (mg) = 1 gram

1 million micrograms (μg) = 1 gram

456 grams =



1 pound

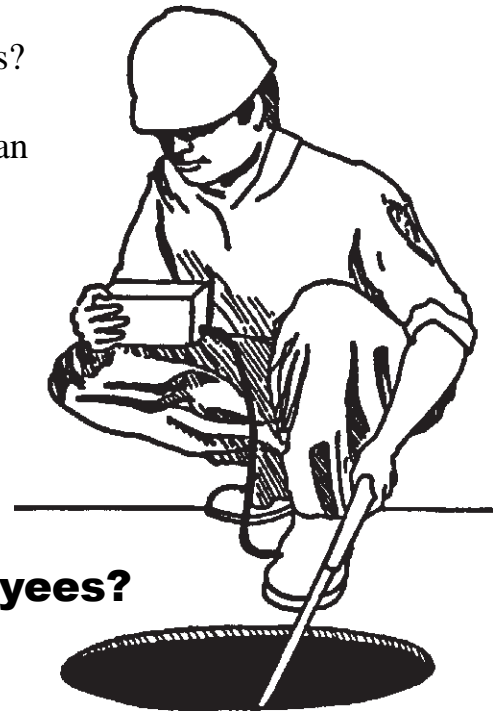
The Air Monitoring Plan

In order to monitor variable conditions, an air monitoring plan should be developed by an occupational health and safety professional. The air monitoring plan should be part of the HASP. Before an air monitoring plan can be developed you must decide what you want to learn from the monitoring you will do. There are three basic things you can determine from these measurements:

- Is there an immediate danger to employees at the site?
- Are workers being exposed over published exposure limits?
- Are contaminants moving into uncontaminated areas?

Once you have determined what you are looking for you can start answering more specific questions about the plan, such as:

- What instruments are appropriate?
- When and where should I monitor?
- How do I evaluate the results?



Is There an Immediate Danger to Employees?

Your first concern when conducting air monitoring is to make sure that no one is working in an atmosphere which presents an immediate danger to life or health. These situations include:

- explosive atmospheres;
- oxygen deficient atmospheres;
- high concentrations that are immediately toxic.

These conditions may be found in any poorly ventilated area. Look for any natural or artificial ‘walls’, such as hills, tall buildings, or tanks, where the air might be still, allowing chemicals to build up. Examine any confined spaces, such as pits, shafts, silos, storage tanks, box cars, buildings, bulk tanks, and sumps where conditions could make you very sick. Low-lying areas, such as hollows and

trenches, should be watched carefully. These areas should be checked for dangerous conditions before working in them.

Toxic vapors and gases tend to spread out in the air whenever they can. The above listed conditions are not likely to be present in open spaces for a long period of time. However, they may develop around any large liquid spill, an open lagoon, or large areas of heavily contaminated soil.

Air monitoring in confined spaces presents conditions which should be considered in the air-monitoring plan. Remote sampling is often required in order to avoid entering potentially dangerous atmospheres in spaces such as vaults or tanks. In remote sampling, a hose is attached to the instrument and air is drawn in by means of a pump. This will increase the response time of the instrument, thus requiring more time to monitor. Some passive instruments require a separate pump to be attached for remote sampling. The ability to draw a remote sample varies with different pumps.

These spaces are so poorly ventilated that layering of gases and vapors may occur. When this happens chemicals with a higher vapor density will tend to sink toward the bottom. You will need to monitor at different levels to evaluate the conditions in the space.

Always monitor these spaces before entering them. If work must be done, frequent or continuous monitoring should be performed unless the space is ventilated.

Combustible Gas Indicators

Combustible gas indicators (CGIs), or explosimeters, are used to detect flammable atmospheres. They will detect any flammable substance and give a reading in percent of the LEL. (Some units will give the value in parts per million.) When concentrations are between the LEL and the UEL, the meter will indicate greater than 100%. When the concentration is above the UEL the instrument will either lock at the maximum value or quickly return to zero. Most CGIs have audio and/or visual alarms that can be set by the operator. You should not work in areas where flammable vapors may ignite or explode. To avoid this, the action level is set well below the LEL.

CGI's have the following advantages and disadvantages:

Advantages:

- General purpose detector for most combustible hydrocarbons
- Accurate over most of its range
- Indicates total combustibles present
- Relatively unaffected by temperature and humidity changes.

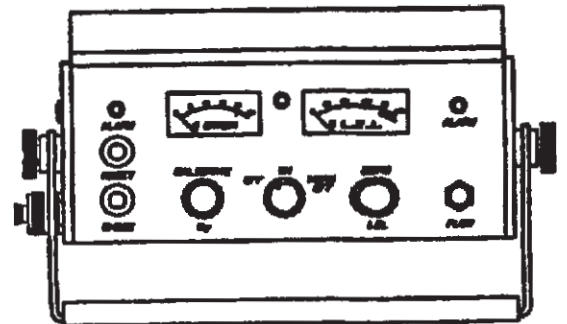
Disadvantages:

- Nonspecific
- Requires oxygen for (air) for operation
- Not recommended for chlorinated hydrocarbons or tetraethyl lead containing compounds.

When a CGI reads more than 10 percent of the LEL, an extremely hazardous condition may exist. When flammable vapors make up more than 10 percent of the LEL, concentrations may be increasing rapidly. They could be much higher in nearby areas where the gases and vapors tend to collect due to poor ventilation. Moreover, the CGI responds differently to different flammable gases. As a result, the actual percent of the LEL may be more than two times higher than the reading obtained.

Field conditions, such as temperature, can also reduce the accuracy of the CGI. In addition, some CGIs have errors as large as 15 percent even when operated correctly. Finally, the meter may not be properly maintained or calibrated. This could introduce more error.

It is important that the evacuation action guideline be strictly adhered to. A CGI reading below 10 percent of the LEL requires caution while monitoring; because a flammable atmosphere may be nearby.



Measuring Oxygen Levels

An **oxygen meter** is used to measure the concentration of oxygen in the atmosphere. This instrument usually gives the concentration in percent. The range is from 1-25%. Oxygen meters are often combined with a CGI in a single instrument. This allows the user to determine if there is enough oxygen for the CGI to operate.

Oxygen meters are affected by temperature and pressure. Oxidizers can cause high readings. Carbon dioxide can reduce instrument sensitivity.

Detecting Atmospheres Which Are Immediately Dangerous to Life and Health (IDLH)

Occasionally concentrations of hazardous chemicals will build to such a level that they will cause immediate harm upon exposure (IDLH conditions). These conditions would only be expected under special circumstances. If you do have poorly ventilated areas or large areas of extremely contaminated material you may have to monitor to determine if an IDLH atmosphere is present. Colorimetric tubes could be used for these samples. Gas monitors can be used for known chemicals. These are instruments, similar to the oxygen meter, which are designed to detect specific chemicals.

What Instruments Should I Use?

Because of the variability in airborne concentrations at hazardous waste sites direct reading instruments are required. Direct reading instruments give information at the time of sampling. Many direct reading instruments will not give you the actual concentration of specific chemicals. In such cases the instrument only indicates the presence of a contaminant, not its concentration. This information is still important because it can be used to develop a more detailed air monitoring strategy.

There are direct reading instruments available which can measure the concentrations of specific gases, such as oxygen, carbon monoxide, and hydrogen sulfide. However, direct reading instruments cannot determine the concentration of most gases and vapors. So, most air monitoring plans will require the use of additional air monitoring equipment.

Some direct reading instruments can take and store periodic readings over an extended period of time. The unit can then display individual readings, averages

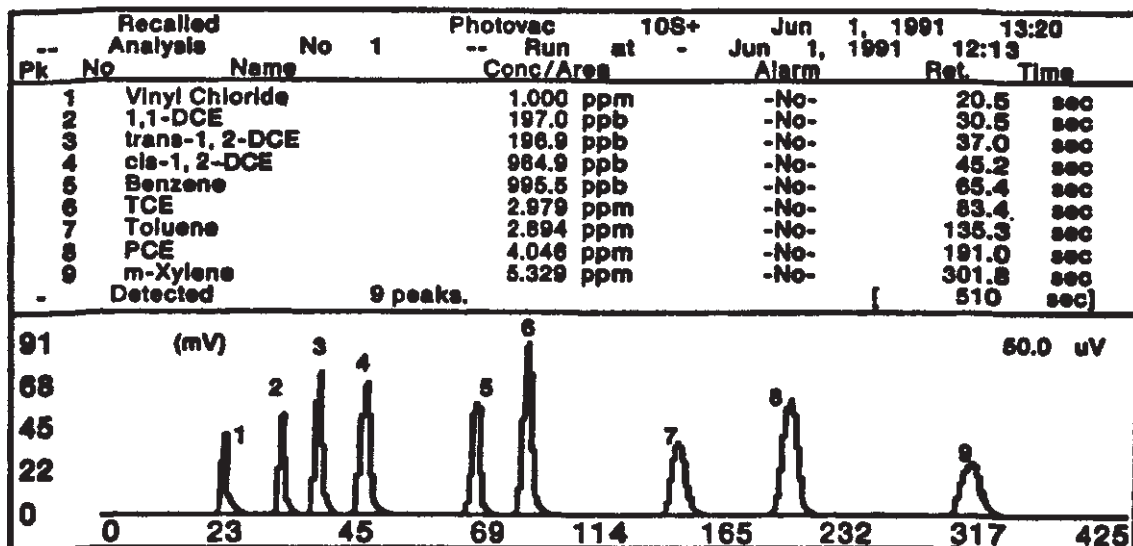
and/or high and low readings. This stored information can also be put into a computer so that a visual display of the data can be produced.

The most common direct reading instruments used on hazardous waste sites are combustible gas indicators, oxygen meters, gas monitors, photoionization detectors, flame ionization detectors, dust monitors and radiation survey monitors.

Colorimetric tubes are used to determine approximate concentrations of known air contaminants, verify the presence of a specific chemical and to establish personal protective equipment and other control measures. With this device a color change in the detector tube is caused by a reaction between the sampled chemical and a special chemical in the tube. The length of the stain can be used to get a concentration by comparing it to a scale which is etched on the tube. Other chemicals may cause positive or negative interferences when using colorimetric tubes.

A fairly recent development in air monitoring equipment is the **portable gas chromatograph**. Like the detector tubes this instrument can give concentrations of specific chemicals very quickly. The portable GC has the advantage that it can be used to determine the identity and concentrations of many chemicals at once. A sample containing the chemical is fed into the instrument. Each chemical passes through the instrument at a different speed so that they all reach the detector at a different time. The instrument produces a print out which can be used to determine what chemicals are present and their concentrations. This instrument is more accurate than the colorimetric tubes but requires more specialized training to interpret the results. Traditional GCs are large and require that the sample be brought for laboratory analysis.

Typical Chromatogram for Solvent Vapors Using CP-Sil 19 CB



Most of the instruments mentioned so far are only useful for determining concentrations at a specific time and place. In order to determine exposure levels over an extended period of time personal sampling must be conducted. Sampling is the collection of a contaminant on an adsorbent or filter. These collection media usually require a pump to draw the sample. Passive samplers have been developed for some chemicals. These samplers do not require a pump. The adsorbent or filter is then sent to a lab for analysis. Sampling is the most accurate method to determine the concentrations of airborne chemicals. Personal sampling is the collecting of the sample at the breathing zone of the worker. Sampling devices also may be placed at certain locations to perform area sampling.

When and Where Should I Monitor?

HAZWOPER sections (c) and (h) require that air monitoring be conducted:

- Upon initial site entry;
- When work begins on a different part of the site;
- When you start handling chemicals that weren't found before;
- At the start of a different operation, such as opening drums instead of well drilling; and
- When you are handling leaking drums or working with liquid contamination, such as a spill or a lagoon.

The complexity of the air monitoring schedule will depend upon the chemicals and conditions at the site.

How Do I Evaluate the Results?

The air monitoring plan should designate action levels based upon air monitoring results. An action level specifies the action to be taken at a specific concentration. Actions that may be required are:

- Continued air monitoring;
- A change in personal protective equipment;
- Initiate engineering controls such as dust suppression, vapor suppression;
- Immediate evacuation;

- Immediately dangerous to life or health concentrations (IDLH).

Any atmosphere with oxygen levels below 19.5 percent should be considered oxygen deficient. Your oxygen meter should be set to alarm at this value. If you must work in such an area you will need an atmosphere supplying respirator.

An oxygen-enriched atmosphere creates an increased flammability hazard. If you are working in such an atmosphere, the excess oxygen tends to cling to your hair and clothing. If a fire occurs your hair and clothing will burn violently.

Your oxygen meter should be set to alarm at a concentration of 19.5% and 25.5% oxygen. When an alarm sounds leave the work area immediately.

Surveying for Gases and Vapors

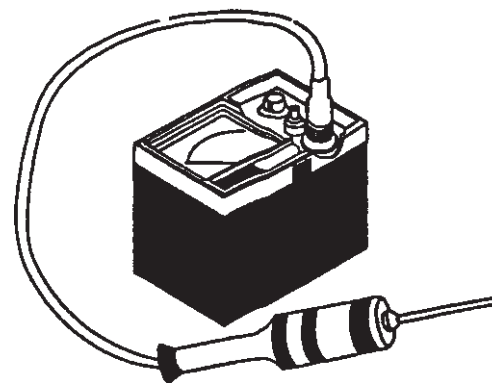
Photoionization detectors (PID) are commonly used on hazardous waste sites to survey for gases and vapors. This instrument uses an ultraviolet light to ionize samples. The PID can be used to determine the total concentration of detectable contaminants. It will detect any chemical that has an ionization potential less than the energy produced by the instrument. This information will help determine appropriate controls and action levels. The PID will detect many, but not all gases and vapors. The meter usually reads in the 0-2,000 ppm range, but some models will saturate at about 500 ppm.

Advantages of Photoionization Detectors:

- Good general purpose detector;
- Durable and reliable;
- Wide common use;
- Common contaminant ionization potentials (IP) are readily available in the NIOSH Guide to Hazardous Chemicals.

Disadvantages of Photoionization Detectors:

- Nonspecific;
- Response varies with contaminant;
- Affected by humidity;
- Does not detect methane.



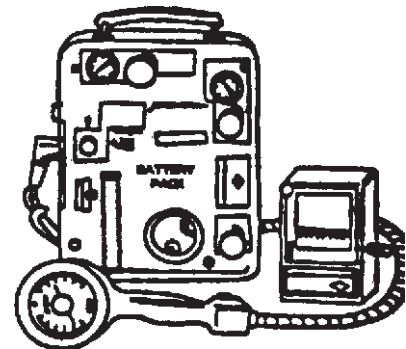
The **flame ionization detector (FID)** can also be used for surveying purposes. This instrument uses a hydrogen flame to ionize the sample. It will detect any flammable organic compound. The FID has a similar range as the PID but will not detect any inorganic gases or vapors. The FID will detect most hydrocarbons such as methane that a PID will not.

Advantages of Flame Ionization Detectors:

- General purpose detector for most combustible hydrocarbons;
- Accurate over entire range;
- Indicates total combustibles present;
- Relatively unaffected by temperature and humidity.

Disadvantages of Flame Ionization Detectors:

- Nonspecific;
- Requires oxygen for operation;
- Not recommended for chlorinated solvents.

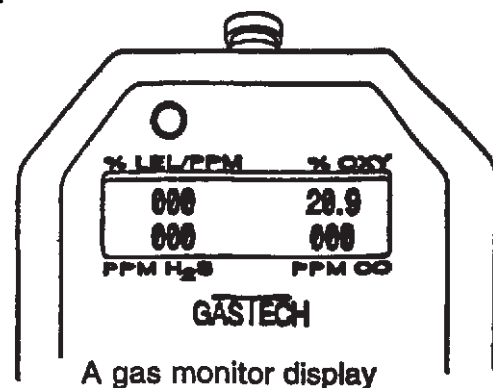


Multiple Gas/Vapor Detectors

Multiple gas detectors usually detect three or more gases, two of which are % O₂ and % LEL. The other sensors detect gas you are primarily concerned with such as Chlorine, Sulfur Dioxide, Nitrogen Dioxide, Nitric Dioxide, Hydrogen Sulfuric, Carbon Monoxide, Ammonia, Methane and Pentane.

Advantages of the Multiple Gas Detector are:

- Detect more than one chemical;
- Direct reading;
- Can be downloaded to a computer to get a time/exposure record;
- Alarms can be set for low level and high level i.e. PEL and IDLH.



Disadvantages:

- Must know the gas/vapor trying to detect;
- If trying to detect more gases/vapors than sensors the instrument can house, then more than one instrument will be needed.

Personal Sampling

When remediation begins, air monitoring must be used to determine the actual exposures that workers are receiving to hazardous chemicals.

HAZWOPER requires that personal sampling be performed during all phases of remediation except initial site characterization. The usual procedure is to sample workers who are most likely to have high exposures. If these workers are below exposure limits other workers are not likely to be over exposed.

Look for monitoring requirements for chemicals with specific OSHA standards such as asbestos, arsenic, and lead. These standards may require additional monitoring.

Personal sampling gives only average exposures. Direct reading instruments need to be used to detect sudden changes in concentrations which may require additional controls.

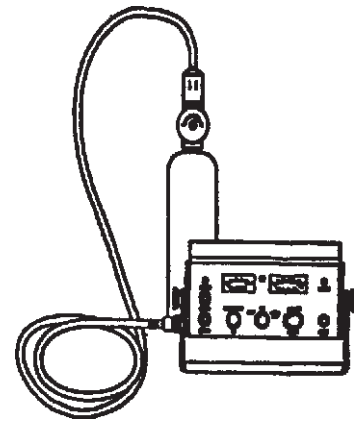


Other Concerns

The sampling plan should also have standard operating procedures for using the various instruments. This includes provisions for instrument calibrations and maintenance. It should require that all instruments be certified for use in flammable atmospheres.

Calibration

Direct reading instruments and sampling pumps need to be calibrated before and after each use. Records should be maintained and included in the HASP. Although it will give you readings, an uncalibrated instrument gives meaningless information. If sampling pumps are not calibrated properly the measured exposure level will be incorrect.



Colorimetric Detector Tubes (Dräger, MSA)

Use:

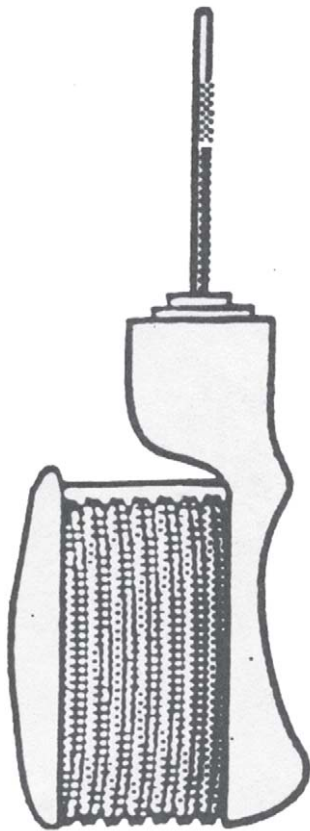
- To samples gas or vapor concentration in any workspace.

Read-out:

- Percent concentration is indicated by color change or length of color stain.

Precautions:

- Not very accurate—within 25% of the real value at best.
- Pump must be checked for leaks and calibrated.
- Tubes have a limited lifetime, so the expiration date on the container should be checked before use.
- Results are affected by temperature and humidity.
- User must be trained in reading the scales on the tubes used.
- User must follow specific pump stroke requirements.

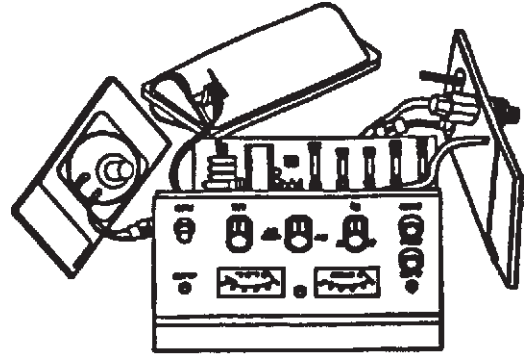


A colorimetric detector tube is a glass tube filled with a solid material gel that has been impregnated with an indicator chemical. When the detector tube is used the ends are broken off and the tube is inserted into a bellows or piston pump. An

arrow on the tube indicates which end of the tube to insert into the pump orifice. A predetermined volume of air is pulled through the pump. The contaminant of interest reacts with the chemical in the tube. This reaction produces a stain in the tube with a length proportional to the concentration of the contaminant.

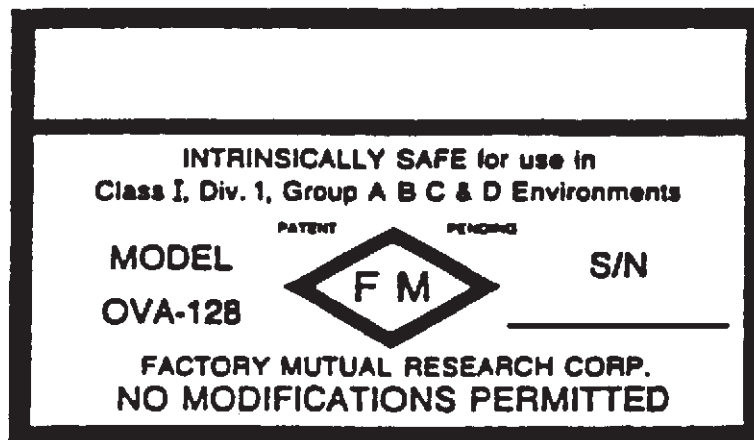
Maintenance

Instruments also need to be carefully maintained. This includes recharging and replacing batteries, cleaning lamps and detection surfaces, and replacing sensors. Maintenance records must be kept on file. Some maintenance can be done by the user's tech and other maintenance can only be done by the manufacturer.



Intrinsic Safety

When working in areas which may contain a flammable atmosphere, you do not want your instrument to become an ignition source. To insure that this does not happen, you should use instruments which have been certified to be intrinsically safe by an OSHA approved testing laboratory such as Factory Mutual Research Corp. (FM) or Underwriters Laboratory Inc. (UL). An intrinsically safe instrument is one that will not serve as an ignition source when used in a flammable atmosphere. Certification should appear somewhere on the instrument. You are looking for certification for Class I, Division 1, Groups A, B, C, and D Environments. In addition to intrinsic safety testing, certified instruments also undergo some performance testing. Most CGIs will be safe, but meters such as PIDs and FIDs may or may not be certified.



Atmospheric Hazard Action Guides

Monitoring Equipment	Atmospheric Hazard	Level	Action
Combustible Gas Indicator	Explosive	<10% LEL	Continue monitor with caution
		>10% LEL	Explosion Hazard. Withdraw from area immediately.
Oxygen Level	Low or High Oxygen	<19%	Use remote sampling or wear SCBA. NOTE: Combustible gas readings not valid in atmospheres with less than 15% Oxygen.
		19.5%-23.5%	Acceptable levels.
		>23.5%	Evacuate. Fire potential. Consult specialist.
Radiation Survey Instrument	Alpha, Beta, Gamma Radiation	background(<1 mR/hr)	Continue monitoring.
		>1 mR/hr	Consult Health Physicist. Withdraw. Continue monitoring only upon advice of a Health Physicist.
Colorimetric Tubes	Organic & Inorganic Vapors/Gases	Depends on Chemical	Consult reference manuals for air concentration vs. PEL and IDLH.
Photoionization Detector	Organic Vapors/Gases	Depends on Chemical	Consult reference manuals for air concentration vs. PEL and IDLH.
Flame Ionization Detector	Organic Vapors/Gases	Depends on Chemical	Consult reference manuals for air concentration vs. PEL and IDLH.

Summary

- An air-monitoring plan should be part of every HASP.
- CGI – Used in situations where there may be flammable vapors in the air. Reads out in %LEL. Remember if the instrument reads over the UEL, this does not mean it is safe to enter the environment.
- O₂ meter – If you are using this meter to check an unknown atmosphere, you should be wearing an air-supplying respirator.
- PID – Used for the detection of organic and inorganic compounds. Whether a compound is detected depends only on the Ionization Potential of that compound.
- FID – Used only for the detection of combustible organic compounds. Like the PID it does not read accurately unless you calibrate the instrument to the contaminant that you have on site. Used as a screening device on an unknown site.
- Draeger tubes – Used for the detection of one specific chemical. Interference can occur if you have more than one contaminant in the air. Poor accuracy, but a good screening device to verify the presence of known or suspected contaminants.
- Inherently safe certification on equipment in flammable/explosive atmospheres.
- Personal Sampling should be used to determine exposures.



Recognizing Hazardous Materials



Objectives

Trainees will be able to:

1. Define what is a “Permissible Exposure Limit” or “PEL.”
2. Define what is a “Threshold Limit Value” or “TLV.”
3. Recognize and prioritize three approaches to controlling exposures:
 - a. Engineering Controls
 - b. Administrative Controls
 - c. Personal Protective Equipment (PPE)
4. Identify four types of monitoring equipment, and describe situations in which to use each one.
 - a. Detector tubes
 - b. Continuous instruments
 - c. Direct reading instruments
 - d. Integrated air monitors
5. Name at least two sources of information that can help workers learn about the hazards of chemicals they work with.
6. Use the different resources to find answers to their questions about health and safety on their job.

Recognizing Chemical Hazards

How can you find out if chemicals are a hazard to your health and safety?

Here are some ways to get the facts about the chemicals you work with:

- Read labels on containers.
- Read Material Safety Data Sheets (MSDSs). These give important information about ingredients and hazards of chemical products.
- Pay attention to posted warning signs.
- Be observant. Notice which chemicals are around, how they're used, and when they're used.
- Get the air tested. Have a trained person use instruments to find out which chemicals are there, and where the highest chemical exposure is.
- Get information and help from your union, OSHA, schools libraries, and community groups.
- Use your right to know. OSHA requires your employer to give you information and training about chemicals.

Steps for Identification and Hazard Assessment

There are 6 key steps involved in assessing and identifying a chemical hazard:

1. Attempt to identify material(s) involved
2. Assess all hazards common to material
3. Determine the physical and chemical properties
4. Determine variables and modifiers

5. Assess outcomes

- What will substance do?
- Who can be harmed?
- Can substance move?

6. Check several sources of information

- Labels
- Materials Safety Data Sheet (MSDS)
- National Fire Protection Association (NFPA) Label
- (NIOSH) National Institute of Occupational Safety and Health Pocket Guide
- Other Chemical Resource Books

Don't Rely on Your Senses

Never Rely On Your Sense of Smell to Tell You If Chemicals Are Present

Just because you don't notice a chemical smell, doesn't mean that everything is OK.

Many hazardous chemicals have no odor, taste, or color.

You can smell some chemicals only after they've reached a dangerous level.

Also, certain chemicals can deaden your sense of smell. After awhile you may no longer be able to smell chemicals like chlorine and ammonia. Sometimes it takes just a few minutes to stop smelling a chemical. But they still can be dangerous.

Some people have a better sense of smell than others. And colds, allergies, or other illnesses can weaken anyone's sense of smell.

—Never touch or taste something to figure out what it is—

The Material Safety Data Sheet (MSDS)

The Material Safety Data Sheet (MSDS) can tell you a lot about the hazards of a chemical. It may be the only source of information available in your plant.

Every manufacturer must fill out an MSDS for each chemical product. The manufacturer must send the MSDS to your employer along with the product. The law requires employers to keep all MSDSs on file. You have a right to see the MSDS for any chemical product you work with. MSDSs must be readily available to workers on all shifts.

MSDSs are required by law to include certain kinds of information. But many MSDSs are incomplete or inaccurate. Others are long, technical, and hard to understand. Some MSDS are out of date.

The MSDS May Not Have All the Answers

A recent study of 476 MSDSs found:

- Only 3 out of 100 had all the information required by law.
- Only 11 out of 100 stated whether or not the substance caused cancer.
- Only 10 out of 100 listed the OSHA PEL (Permissible Exposure Limit).
- 3 out of 10 had information which contradicted itself.

Source: Survey conducted by the Seattle Area Hospital Council. *Industrial Hygiene News Report*, Vol. 29, November 1986.

Reading an MSDS

An MSDS can help you figure out the hazards of a particular chemical or chemical product. You can plan the best course of action to protect yourself when you know how the chemical will behave.

First, you need to know how to read the MSDS. OSHA has its own MSDS form (shown on page 10), but there is no single standard MSDS form. An MSDS may

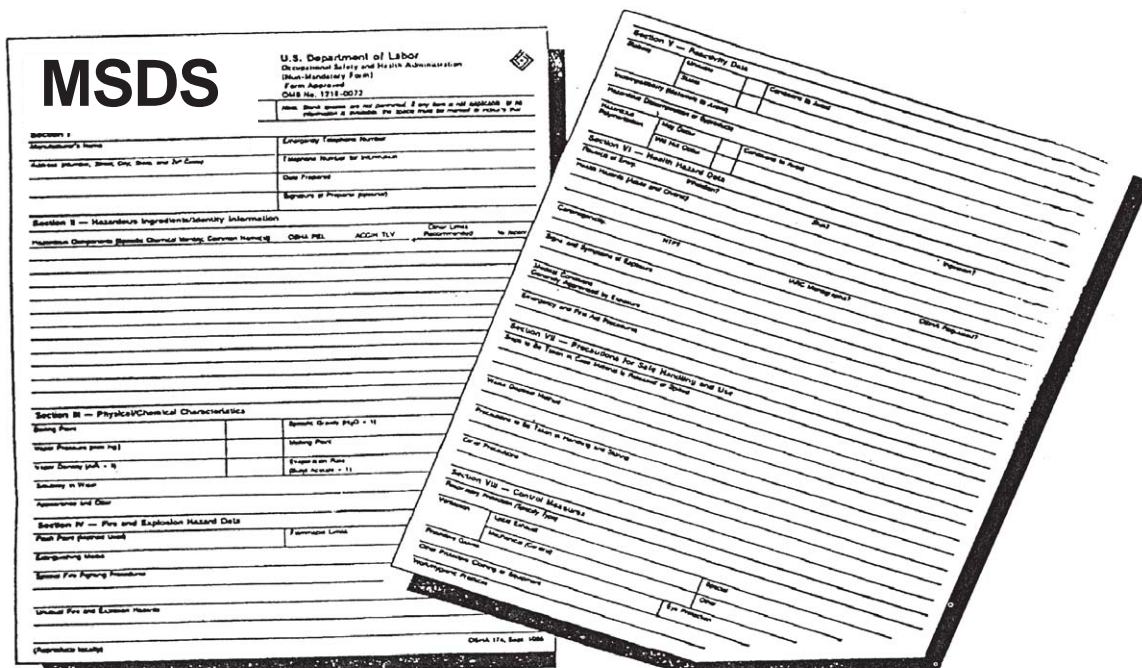
have one page or ten pages. Companies may use their own MSDS formats, but every MSDS must contain the information that is on the OSHA form.

This information includes:

- Product Name and Manufacturer
- Hazardous Ingredients
- Physical/Chemical Characteristics
- Fire and Explosion Hazard Data
- Reactivity Data
- Health Hazard Data
- Precautions for Safe Handling and Use
- Control Measures

OSHA does not allow blank sections on an MSDS. If the section does not apply, the MSDS must state that it does not apply (N/A).

The sections of an MSDS are explained in detail on the following pages



SECTION 1: Product Name and Manufacturer



The name of the product is listed here—chemical name, trade name, or both. The name listed should be the same as the name on the container label.

The MSDS must list any other names that are used for the chemical. For example, methyl alcohol is also called methanol or wood alcohol.

This section of the MSDS includes the manufacturer's (or supplier's) name, address, business phone number, and an emergency phonenumber to call after business hours. (It's a good idea to call the emergency number for information **before** an emergency occurs.)

The date the MSDS was prepared must be listed here. Check that the MSDS is recent. Older MSDSs may contain out-of-date information.

SECTION 2: Hazardous Ingredients



The information in this section of the MSDS includes:

- Names of the hazardous chemical ingredients in the product
- Worker exposure limits for each hazardous ingredient.

This section lists chemical ingredients **only** if they are hazardous (as defined by OSHA) **and** if they make up one percent (%) or more of the product. Chemicals that cause cancer must be listed if they make up one-tenth of one percent (0.1%) or more. The MSDS must give the exact chemical name of each hazardous ingredient listed here.

Two kinds of workplace exposure limits must be shown for each ingredient listed:

- The *OSHA Permissible Exposure Limit (PEL)* is the maximum amount of a chemical, which OSHA allows in the air averaged over an eight-hour work day. Very toxic chemicals have lower PELs—less of the chemical is allowed

in the air. OSHA has PELs for only a few hundred chemicals. They are enforced by OSHA inspectors.

- The *Threshold Limit Value (TLV)* is the maximum amount of the chemical which should be in the air. TLVs are only recommendations by a private scientific organization called the American Conference of Governmental Industrial hygienists (ACGIH). OSHA does not enforce TLVs. TLVs may be lower than OSHA PELs.

There is another workplace exposure limit that is not usually found on the MSDS.

- *The Recommended Exposure Limit (REL)* is the maximum amount of a chemical allowed in the air according to the National Institute for Occupational Safety and Health (NIOSH). NIOSH is the government agency which conducts research on safety and health hazards. The REL is often lower (stricter) than the Permissible Exposure Limit (PEL). However, RELs are only recommendations. Only PELs are legal limits. RELs are listed in the *NIOSH Pocket Guide to Chemicals*.

When an MSDS gives information on PELs and TLVs, it uses special terms, which you should know.

PELs and TLVs: How Are They Measured?

When you see PELs or TLVs, you'll notice that they are listed like this:

Benzene 1 ppm

Sulfuric acid 1 mg/m³

What do “ppm” and “mg/m³” mean? They are ways of measuring the amount of a chemical in the air. The amount is called the concentration. “ppm” means parts per million—how many parts of the chemical there are in every million parts of air. It is difficult to picture the very small chemical concentrations we are talking about. One part per million (1 ppm) is the equivalent of:

- 1 cent in \$10,000
- 1 second in 11.5 days
- 1 inch in 15.8 miles
- 1 ounce in 62,500 pound

“mg/m³” means milligrams per cubic meter—how many milligrams of the chemical there are in every cubic meter of air. (Milligrams are a measure of weight, and cubic meter is a measure of volume, so mg/m³ tells you how much of the chemical there is by weight in a volume of air.) mg/m³ is generally used to measure dusts.

To picture one milligram per cubic meter, think of one scoop of ice cream inside a railroad tank car of root beer, or one jigger of chemical in an Olympic swimming pool.

PELs and TLVs are usually given as one or the other—ppm or mg/m³.

PELs and TLVs: What is a Time-Weighted Average?

PELs and TLVs are usually eight-hour *Time Weighted Averages (TWAs)*. You may see the term “TWA” next to these exposure limits on a Material Safety Data Sheet.

What’s a TWA? The amount of a chemical that you breathe in may go up and down during the day. But when all the peaks and valleys of exposure during an eight-hour day are averaged, the result is your eight-hour TWA exposure to the chemical.

Just add up all your exposure for eight hours, and divide by 8 to get the average.

Forget about chemicals for a minute and think about average hourly wage. Suppose you earn \$12 an hour for four hours, and \$8 an hour for four hours. What is your average hourly rate?

To find out, you multiply \$12 x 4 hours = \$48, plus \$8 x 4 hours = \$32, total \$80, divided by 8 hours worked = \$10 is your average hourly rate.

EXAMPLE 1

TWAs are just like average hourly pay. Suppose you breathe in 100 ppm of “Chemical A” for four hours, and then none at all for the other four hours of your eight-hour shift. What is your eight-hour TWA?

100 ppm x 4 hours = 400, plus 0 ppm x 4 hours = 0
total 400 ppm, divided by 8 hours worked = 50 ppm is your eight-hour TWA exposure on your average exposure for the whole 8 hours.

EXAMPLE 2

The eight-hour OSHA PEL for ethyl formate is 100 ppm.

Remember that the amount you breathe in can go up and down. It may go over 100 ppm for part of your shift, and still be legal. For instance, if you breathe 300 ppm of ethyl formate for two hours and don't breathe any more for the other six hours:

$300 \text{ ppm} \times 2 \text{ hours} = 600$, plus $0 \text{ ppm} \times 6 \text{ hours} = 0$
total 600 ppm, divided by 8 hours worked = 75 ppm is your eight-hour TWA exposure. Your eight-hour TWA exposure in this case does not exceed the PEL, which is 100 ppm.

PELs and TLVs: What is a Short-Term Exposure Limit?

Along with the Time Weighted Average (see box on page 15), many chemicals also have another kind of exposure limit. It is called the *Short Term Exposure Limit (STEL)*. On a Material Safety Data Sheet, you may often see both a TWA and a STEL given for a particular chemical.

STELs are designed to make sure the peaks of chemical exposure don't get too high for too long. They are limits on your average exposure during any 15-minute period (unless other information is given). Here's an example:

The OSHA Permissible Exposure Limit (PEL) for styrene is:

- 50 ppm TWA
- 100 ppm STEL

Suppose you breathe in 200 ppm of styrene for one hour, and then don't breathe any more for the next seven hours of your eight-hour shift. Is this exposure legal?

Your exposure is:

$200 \text{ ppm} \times 1 \text{ hour} = 200$, plus $0 \text{ ppm} \times 7 \text{ hours} = 0$
total 200 ppm, divided by 8 hours worked = 25 ppm is your eight-hour TWA exposure.

Your TWA exposure is below the OSHA PEL (TWA), which is 50 ppm.

But look at the STEL! OSHA says your exposure in any 15-minute period may not exceed 100 ppm. Since you were exposed to 200 ppm for an hour, the STEL has been violated and you have been overexposed!

SECTION 3: Physical/Chemical Characteristics



This section of the MSDS tells you about the chemical's properties, including:

- Vapor pressure
- Vapor density
- Boiling point
- Melting point
- Solubility
- pH

You can use the information in this section to figure out some of the hazards of the chemical product. The information can give clues about how to handle the substance safely.

Many of the properties listed in Section III of the MSDS are explained in detail below.

Vapor Pressure

A vapor enters the air when a liquid evaporates. A vapor is like a gas, but a vapor comes off a substance which is liquid at room temperature.

For example: a vapor of rubbing alcohol forms when alcohol in an open bottle evaporates.

Vapor pressure tells you which liquid chemicals are most likely to become vapors and get into the air. Chemicals with high vapor pressures are more likely to get into the air than chemicals with low vapor pressures. They are also more likely to cause pressure build up in a closed system.

Vapor pressure is measured in millimeters of mercury (mmHg), generally at room temperature. (Room temperature is between 68°F and 72°F, or about 20°C.)

As the temperature rises, more of the liquid will turn into vapor. At higher temperatures, even a chemical with a low vapor pressure may get into the air.

You Figure It Out. . .Vapor Pressure—A Clue to Hazards

High—A chemical's vapor pressure is high if it is over 10 mmHg. (millimeters of mercury)

Example: Acetone (266 mmHg)

Moderate—A chemical's vapor pressure is moderate if it is between 1 and 10 mmHg.

Example: Turpentine (5 mmHg)

Low—A chemical's vapor pressure is low if it is under 1 mmHg.

Examples: Sulfuric acid (.001)

The vapor pressures listed assume the chemicals are at room temperature. If the temperature changes, the vapor pressure can also change.

Questions:

1. Which of the chemicals above is most likely to get into the air?

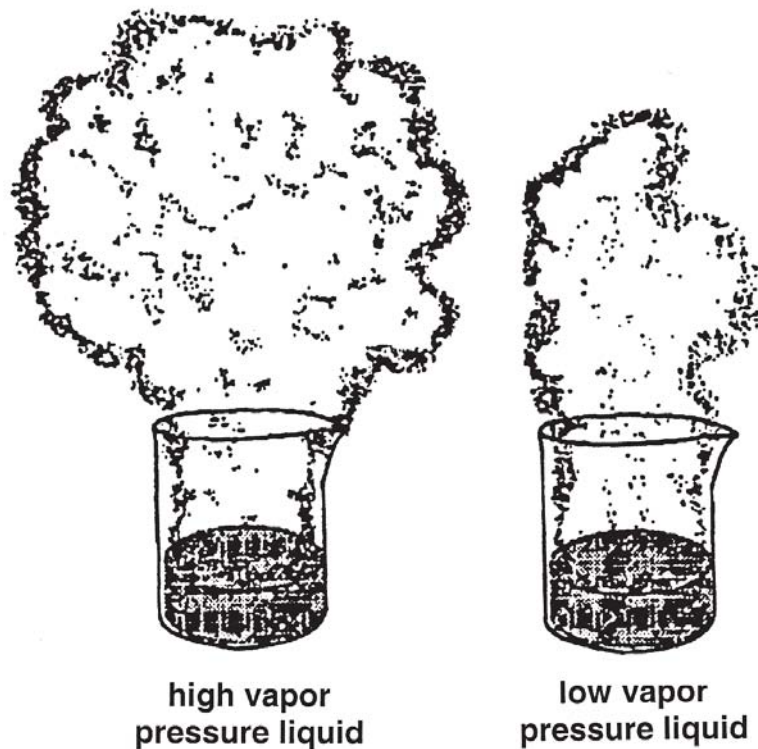
Answer: Acetone, because it has the highest vapor pressure.

2. If you are using sulfuric acid, which would be the greater hazard, breathing the vapor or splashing it on your skin?

Answer: Splashing it on your skin. It won't produce much vapor because of its low vapor pressure.

What Can Vapor Pressure Tell You?

- It tells you which liquid chemicals are more likely to be breathing hazards.
- It warns you about the risk of pressure build-ups or ruptures. A sealed container of chemical with a high vapor pressure might burst or rupture. There can also be an explosion if the substance has a high vapor pressure and is inflammable.



Vapor Density

Vapor density measures how “heavy” a vapor or gas is.

Vapor density compares the weight of the vapor or gas to the weight of air. Air has a vapor density of 1. A high concentration vapor density tells you which way the gas will move.

A vapor density of less than 1 means that the vapor or gas is lighter than air. Vapors which are lighter than air rise. They can collect in pockets near the ceiling or at the top of a tank or vessel.

A vapor density of more than 1 means the vapor or gas is heavier than air. Vapors which are denser than air sink toward the ground or floor. They can collect in low-lying areas, in pits, or at the bottom of a tank or vessel.

HINT: If you know the molecular weight (MW), divide it by 28 to get the vapor density.

You Figure It Out. . .Vapor Density—A Clue to Hazards

Here are the vapor densities of some common chemicals:

Chemical	Vapor Density
Fluorine	1.3
1,1,1-Trichloroethane	4.6
Ammonia	0.6
Bromoform	8.7

Questions:

1. If there is a leak, which of these four chemicals would you expect to collect near the ceiling?

Answer: Ammonia vapor, because it is the only chemical on the list which is lighter than air.

2. Which vapor would be most likely to hang around your breathing zone?

Answer: Fluorine, because its vapor density is almost the same as the vapor density of air. It would neither rise nor sink.

What Can Vapor Density Tell You?

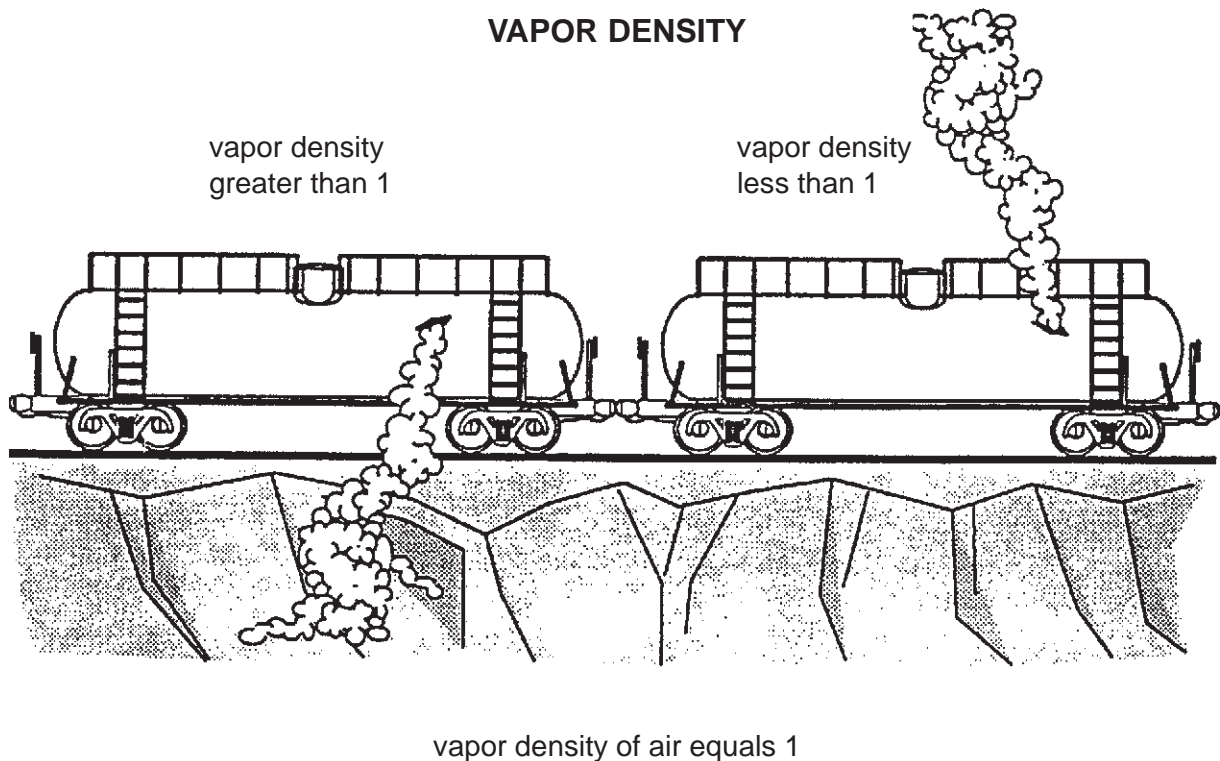
It tells you:

- Whether a particular gas or vapor is likely to collect near the ceiling or the ground.
- Where to use instruments to check for the gas or vapor.
- Which chemicals might be a danger in a confined space or low-lying area.

Some points to remember about vapor density:

- The amount of the gas or vapor matters. If there is just a little in the air, a heavy chemical may not sink and a light one may not rise. Small amounts may just mix with the air instead.

- Under hot conditions, even a dense vapor can rise—sometime near your face, where you might breathe it in.
- Dense vapors do not have to be toxic to kill. When enough dense vapor collects in a confined space or low-lying area, it can replace the oxygen. If you are at the bottom of the tank or pit you could die from lack of oxygen.
- If a dense vapor near the ground or floor is flammable, throwing down a match, or cigarette stub could start a fire.
- Dense vapors can travel far from their source, and collect in areas where you would not expect them.
- Light vapors can cause problems near ceilings or in high air



Boiling Point and Melting Point

The **boiling point** and **melting point** tell you what state a chemical is in at different temperatures. It may be a solid, liquid, or gas, depending on the temperature.

Knowing the boiling point or melting point of a chemical can help you figure out:

- What kind of hazards to look out for.
- How to handle the chemical safely.
- What personal protective equipment (such as gloves, respirator, or splash suit) you should use to work with the chemical

Boiling point is the temperature at which a liquid becomes a gas or vapor. When a liquid becomes a gas or vapor, it gets into the air quickly.

The lower the boiling point of a liquid, the more easily it gets in the air. Once in the air (as a gas or vapor), it may become a breathing hazard. Then you may need protection, like a respirator. You might want to keep such a chemical cold (below its boiling point), so less will get into the air.

A flammable chemical with a low boiling point also may be a greater fire hazard.

Melting point is the temperature at which a chemical goes from a solid to a liquid, just like melting ice becomes water.

A solid can be safer and easier to handle than a liquid. If chemical has a low melting point, you may want to keep it cold so it would stay a solid.

You Figure It Out. . .Boiling Point—A Clue to Hazards

- The boiling point of ethylamine is 62°F.
- The boiling point of ethylene glycol is 378°F

Question: Which of these chemicals could be a breathing hazard at normal room temperature?

Answer: Ethylamine would go from liquid to vapor at only 62°F. It would get in the air at room temperature (70°F), and could be a breathing hazard. Ethylene glycol would have to be heated to reach its boiling point. It would remain a liquid even on a hot day.

Solubility

Solubility is a chemical's ability to dissolve in water. For example, table salt is soluble in water.

On an MSDS, solubility is listed in percentages:

Less than 1%	does not dissolve
1% to 10%	dissolves moderately well
More than 10%	dissolves easily

A liquid chemical that is completely soluble in water is called *miscible*. It will mix fully and evenly with water.

Oil and water are not miscible. Oil remains separate and stays on the top of the water.

What Can Solubility Tell You?

It tells you:

- Which chemicals can be cleaned up using water, and which ones can't.
- Which chemicals can be diluted with water.

pH

The pH of a chemical tells you if it is an acid, a base, or neutral.

The pH scale goes from 1 to 14.

pH 0 to 7 Acid The lower the pH, the stronger the acid. A chemical with a pH of 1 is a much stronger acid than a chemical with a pH of 6.

pH of 7 Neutral Water has a pH of 7. It is neither an acid nor a base.

pH 7 to 14 Base The higher the pH, the stronger the base. A chemical with a pH of 13 is much a stronger base than a chemical with a pH of 8. Bases are also called caustics and alkalis.

The stronger the acid or base, the more corrosive it is to the skin. The closer the pH is to 7, the milder the acid or base.

What Can pH Tell You?

- It tells you if a chemical is corrosive. Acids and bases are corrosive. Corrosives can destroy body tissue, especially the skin, eyes, and mucous membranes.. Corrosives also can attack metals and building materials.
- It warns you about eye damage. Bases can cause permanent eye damage quickly. Acids are not as bad as bases, but still may be dangerous to the eyes.

If your eyes get splashed with an acid or base, wash them with lots of water at once.

You Figure It Out. . .pH—A Clue to Hazards

Here are the pHs of some common chemicals:

Chemical	pH
Concentrated hydrochloric acid	2
Sodium hydroxide	13
Electroplating bath	6

Questions:

1. Which of the above is a base?

Answer: Sodium hydroxide.

2. Is it a strong or weak base?

Answer: Very strong.

3. Which is a stronger acid, hydrochloric acid or electroplating bath?

Answer: Hydrochloric acid is much stronger. Electroplating bath is closer to neutral.

SECTION 4: Fire and Explosion Hazard Data



This section of the MSDS tells you about the chemical's fire and explosion hazards, including:

- **Flashpoint**
- **Flammability**
- **Lower Explosive Limit**
- **Upper Explosive Limit**
- **Explosive Range**
- **Whether it is an oxidizer**

The information in this section can help you prevent and prepare for chemical fires and explosions.

Many for the properties listed in Section IV of the MSDS as explained in detail below.

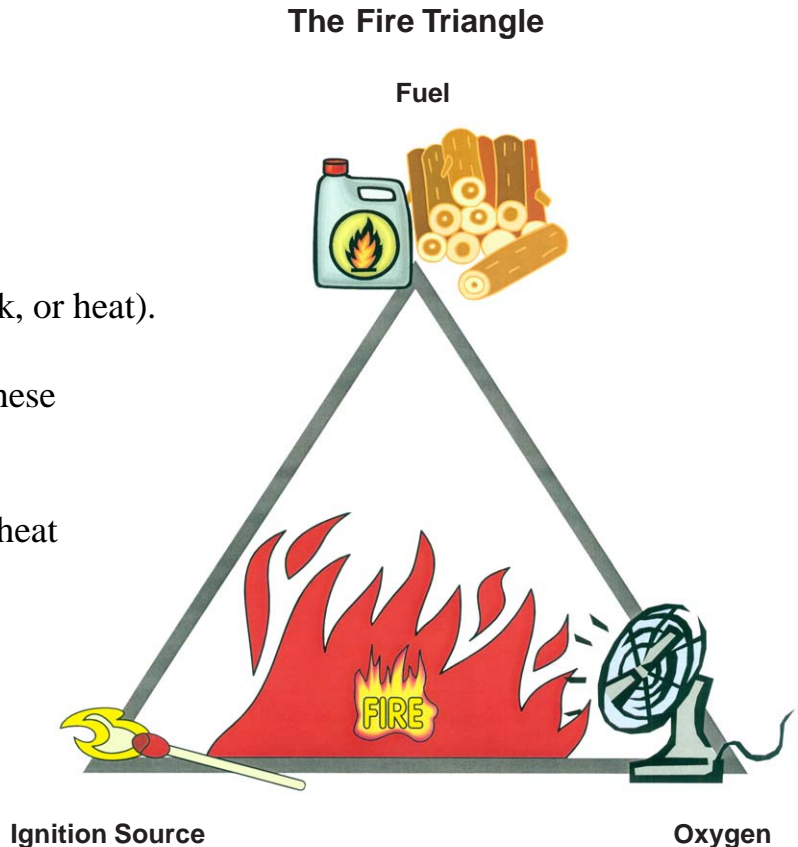
In order to have a fire you need:

- oxygen
- fuel (such as wood, oil, paper, or a chemical)
- ignition source (a flame, spark, or heat).

Most fires can be put out if one of these three things is taken away.

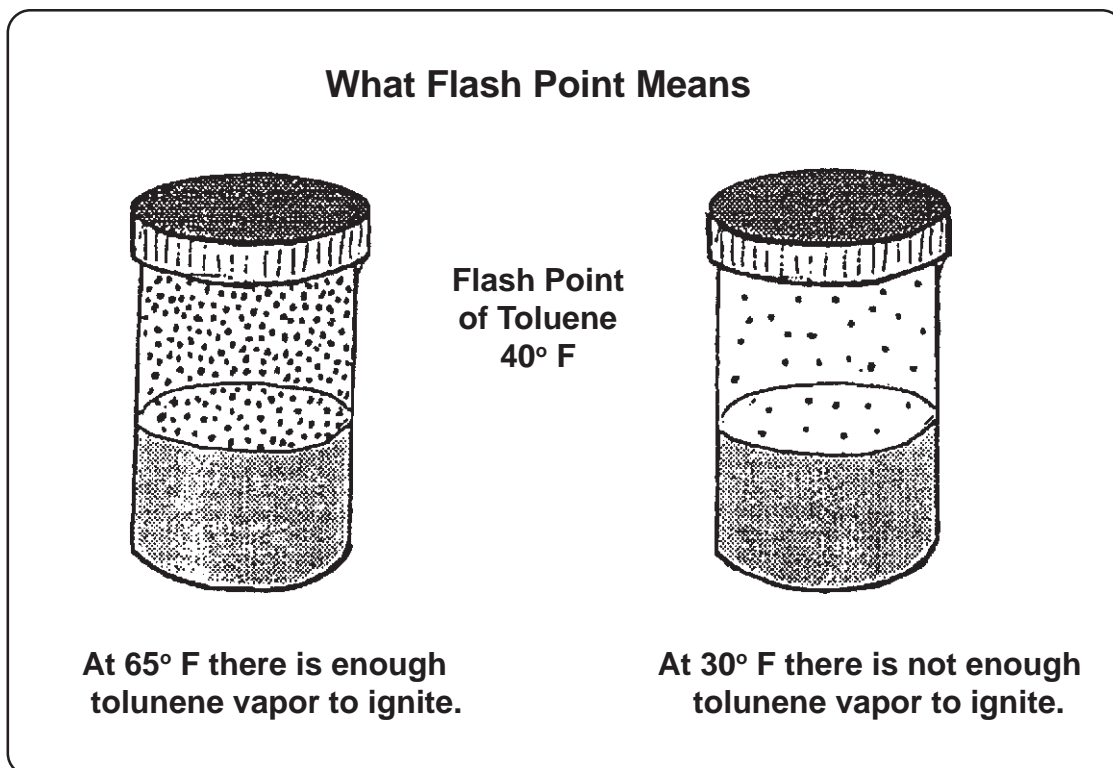
Water removes the ignition source (heat or flame).

Sand and foam remove the oxygen. They smother fires by keeping air away from the burning fuel.



Flashpoint

The *flashpoint* of a chemical is the lowest temperature at which a liquid gives off enough vapor to burn if exposed to a source of ignition. It is the vapors that catch fire. Below the flashpoint, there aren't enough vapors to keep a fire going.



The lower the flashpoint, the greater the risk of fire.

Flammable and Combustible Chemicals

Flammable chemicals catch fire easily and burn rapidly. They have flashpoints below 100°F. All flammable chemicals are serious fire risks.

Combustible chemicals have flashpoints above 100°F. Combustible chemicals with flashpoints between 100°F and 200°F are moderate fire risks. Combustible chemicals with flashpoints above 200°F are low fire risks.



You Figure It Out. . .Flashpoint—A Clue to Hazards

Here are the flashpoints of some common chemicals:

Chemical	Flashpoint
Benzene	12°F
Nicotine	203°F
Nitroglycol	419°F
Turpentine	95°F

Questions:

1. Which of these chemicals is the greater fire risk?

Answer: Benzene, because it has the lowest flashpoint.

2. Which of these chemicals are flammable?

Answer: Benzene (flashpoint of 12°F) and turpentine (flashpoint of 95°F) are both flammable chemicals. Both have flashpoints below 100°F.

3. Which of these chemicals is a low fire risk?

Answer: Nitroglycol (flashpoint of 419°F).

Explosive Limits

If you don't have enough fuel, you won't have a fire. That's true if the fuel is wood or if the fuel is a gas or chemical vapor.

The *Lower Explosive Limit (LEL)* for a chemical is the minimum amount of gas or vapor which has to be in the air to give fire enough fuel. If the amount of chemical in the air is below the LEL, there won't be enough fuel for a fire.

For example, the LEL for benzene is 1.3% (3000 ppm). If the air has less than 1.3% benzene, there isn't enough benzene to fuel the fire. Below the LEL, the mixture of air and fuel is too lean to burn.

On the other hand, if there is too much gas or vapor in the air, it can displace oxygen. Without oxygen there can be no fire either.

Important: Detectable amounts of explosive gases in chemical emergencies may be a reason to evacuate.

The **Upper Explosive Limit (UEL)** for a chemical is the maximum amount of gas or vapor which can be in the air and still allow enough oxygen for a fire to burn. Above the UEL there is too much chemical (and not enough oxygen left) for there to be a fire.

For example, the UEL for benzene is 7.1% (7100 ppm). If there is more than 7.1% benzene in the air, there is not enough oxygen left to keep a fire going. Above the UEL, the mixture of air and fuel is too rich to burn.

The **Explosive Range** for a chemical is between the LEL and the UEL. When the concentration of the chemical in the air is within the explosive range, there is a fire hazard.

For example, the Explosive Range for benzene is between 1.3% and 7.1%.

Note: In emergencies, any reading can change rapidly.



You Figure It Out. . .LEL and UEL—A Clue to Hazards

Here are the LELs and UELs for two common chemicals:

Chemical	LEL	UEL
Carbon disulfide	1.3%	50.0%
Octane	1.0%	6.5%

Questions: Which of these chemicals is a fire hazard if there is 25% in the air?

Answer: Carbon disulfide..

Important: The Danger zone is between the LEL and the UEL

In Other Words...

- Another name for the LEL is *Lower Flammable Limit*
- Another name for the UEL is *Upper Flammable Limit*
- Another name for the Explosive Range is *Flammable Range*

Always allow wide margin of error when you deal with explosive limits. A fuel/air mixture which seems to be too lean (below the LEL) can have a “pocket” of chemical, which is richer and could ignite. A mixture which appears to be too rich can change and fall into the explosive range. When air is added, many rich mixtures fall into the explosive range.

Oxidizers

Oxidizers are chemicals which give off oxygen during chemical reactions. Fires need oxygen. Because oxidizers help supply oxygen they can make fires worse. They also make it easier for fires to start.

Important: Never store a flammable or combustible chemical near an oxidizer.

Why is it important to know about oxidizers?

- Oxidizers feed fires and make them worse.
- Oxidizers near flammable materials can cause spontaneous combustion (a fire that starts without a source of ignition).
- Oxidizers may react violently with water.
- Oxidizers must be handled and stored carefully. Keep them away from flammable and combustible materials, and away from moisture.



Oxidizers—A Few Examples

- Bromine
- Chlorine
- Chromic acid
- Fluorine
- Hydrogen peroxide
- Nitric acid
- Nitric oxide
- Nitrogen dioxide
- Ozone
- Sulfuric acid

You Figure It Out. . .Oxidizers—A Clue to Hazards

Stoddard solvent has a flashpoint of 110°F.

Question: Should you store Stoddard solvent near nitric acid?

Answer: No! Stoddard solvent is combustible, and nitric acid is an oxidizer.

SECTION 5: Reactivity Data



This section of the MSDS tells you:

- If the chemical product is stable or not.
- If it is likely to react with other nearby chemicals.

Stability

Some chemicals are unstable. Heat, cold, moisture, age, shock, light, or even air can cause them to become hazardous. For example, tert-butyl lithium, a chemical often found in laboratories, ignites on contact with water. A solution with more than 20% tert-butyl lithium ignites spontaneously in air.

The state of a chemical can affect its stability. For example, silver as a solid won't burn, but in dust or powder form it becomes flammable.




Incompatible Chemicals

Chemicals which react if they come in contact with each other are called incompatible. Depending on the particular chemical, the reaction might produce heat, fire, explosion, or a dangerous gas or vapor. If a gas or vapor is produced, it may be much more hazardous than either of the original chemicals. One example of incompatibles that we've seen before: oxidizers are incompatible with flammable and combustible chemicals. They can react together to start a fire.




Polymerization

Polymerization is like a chain reaction. A chemical forms a new substance. For instance, styrene polymerizes to become polystyrene. Some chemicals can undergo violent and rapid polymerization. When violent polymerization is possible, the MSDS should tell you under what conditions it might occur.

Examples of Incompatibles—Never Store “A” Near “B”

A	B	RESULT
Acids or Bases (Corrosives)	Reactive Metals <i>such as</i> <ul style="list-style-type: none"> – aluminum – beryllium – calcium – lithium – potassium – magnesium – sodium – zinc powder 	
Water or Alcohols	Concentrated Acids Concentrated Bases Calcium Lithium Potassium Other Wastes reactive with water	 <p style="text-align: center;">Toxic Vapor or Gas</p>
Solvents or Reactive Organic Materials <i>such as</i> <ul style="list-style-type: none"> – alcohols – aldehydes – nitrated hydrocarbons 	Concentrated Acids Concentrated Bases Reactive Metals	

Examples of Incompatibles—Never Store “A” Near “B”

A	B	RESULT
Cyanide and Sulfur Mixtures	Acids	
Strong Oxidizers <i>such as</i> <ul style="list-style-type: none"> – chlorates – chlorine – chlorites – chromic acid – hypochlorites – nitrates – perchlorates – permanganates – peroxides 	Organic Acids Concentrated Mineral Acids Reactive Metals	 Toxic Vapor or Gas
	Reactive Organic Solvents Reactive Organic Materials Flammable or Combustible Wastes	



Don't Mix What You Don't Know



“Right To Know”

Hazard Communication Standard

The Hazard Communication Standard (GISO 5194) gives you the right to information that can answer the following questions:

1. What is hazardous in this material?
2. How can this affect my health?
3. What other hazardous materials are used at my workplace?



Federal and state OSHA programs give workers the right to know what hazardous materials they could be exposed to by requiring employers to set up a “Hazard Communication Program,” including:

- **LABELS** on all hazardous materials
- **MSDSs (Material Safety Data Sheets)** for all hazardous materials
- **TRAINING** for all employees

Labels must include:

- the name of the hazardous substance (the same name as is on the MSDS).
- specific warnings about potential hazards and short- and long-term health effects.
- the name and address of the chemical manufacturer, importer, or other responsible party.

MSDSs must include:

- the product name and ingredients.
- physical and chemical characteristics.
- fire, explosion, and reactivity hazards.
- health hazards: symptoms, routes of exposure, potential to cause cancer.
- legal exposure limits.
- precautions for safe handling and use.
- protective control measures.
- personal protective equipment.
- emergency and first aid measures.
- spill and leak procedures.



Training must include:

- physical and health effects of the hazardous substances.
- methods used to detect the presence or release of hazardous chemicals.
- measures employees can take to protect themselves from hazards (including how to read and use labels and MSDSs to protect themselves).

Chemical Labels

What Can I Find Out from a Chemical Label?

Under the Right to Know laws, labels from suppliers **only** need to contain the following information:

1. Product Identity, such as chemical or trade name.
2. Hazard Warning, including what type of hazard (for example, lung or kidney damage).
3. Name and Address of the Manufacturer.

Some labels may include additional information and include words like “**caution**” or “**harmful if breathed**”.

SODIUM HYDROXIDE

CAUSTIC SODA: LYE

POISON!

DANGER!

**CAUSES SEVERE BURNS
MAY BE FATAL IF SWALLOWED**

Do not get in eyes, on skin, on clothing. Avoid breathing dust. Keep in tightly closed container. Use adequate ventilation. Wash Thoroughly after handling.

EFFECTS OF OVEREXPOSURE: Ingestion may result in severe intestinal irritation with burns to mouth. Contact with skin or eyes may cause severe irritation or burns.

FIRST AID PROCEDURE: If swallowed, do NOT induce vomiting. If conscious, give large amounts of water. Follow with diluted vinegar, fruit juice, or whites of eggs, beaten with water. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before re-use.

Consult MSDS for further hazardous information and instructions.

CAS No. [1310-73-2]

What Is Often Missing from a Chemical Label?

There is a lot of information that you cannot find out from a chemical label:

1. What to do if the chemical spills.
2. How to store the chemical safely.
3. How to protect yourself from harmful health effects.

Remember: All chemical products in the workplace should have labels. If a chemical is poured into a smaller container and taken to another department in the plant, it needs to have a label.

What Information Does an MSDS Have To Include?

Under the Right-To-Know law, an MSDS must contain certain information. However, there is no requirement that all MSDS's be designed or formatted the same. Some MSDS's may have 8 sections; some may have 16 sections. Some MSDS's are 1 or 2 pages; others are as long as 20 pages!

MSDS's Must Include:

1. Product identity and ingredients.
2. Physical and chemical characteristics.
3. Fire and explosion hazards.
4. Reactivity information.
5. Health hazards: symptoms and routes of exposure and potential to cause cancer.
6. Legal exposure limits.
7. Precautions for safe handling and use.
8. Protective control measures.
9. Personal protective equipment.
10. Emergency and first aid measures.
11. Spill and leak procedures.

Material Safety Data Sheets

Material Safety Data Sheets (MSDS) contain information about the properties of workplace chemicals. They are usually written by the supplier or manufacturer of the chemicals.

What Can I Find Out from a Material Safety Data Sheet?

An MSDS is divided into sections, each with different information about the chemical. The table below tells you some of the information you can find.

Questions	What to look for	Sections of an MSDS
Who makes it?	Manufacturer's name	Section one
What is this stuff?	<ul style="list-style-type: none"> • Ingredients • Who makes it 	Hazardous ingredients Identity
Can this product hurt my health?	<ul style="list-style-type: none"> • Health effects • Symptoms • Cancer hazard • First Aid 	Health Hazard Data
Is this product dangerous?	<ul style="list-style-type: none"> • Fire and explosion hazard • Materials to avoid • Stable or unstable 	Fire and Explosion Hazard Data Reactivity Data Special Precautions
How can I protect myself?	<ul style="list-style-type: none"> • Personal protective equipment • Control measures • Work/Hygiene practices 	Controls Measures Special Precautions Spill Procedures
How should the product be handled?	<ul style="list-style-type: none"> • Safe handling & storage • Fire & spill procedures • Waste disposal 	Precautions for Safe Handling & Storage Spill Procedures
Where do I get more information?	<ul style="list-style-type: none"> • Name and telephone number 	Section one

Hazardous Materials Identification System

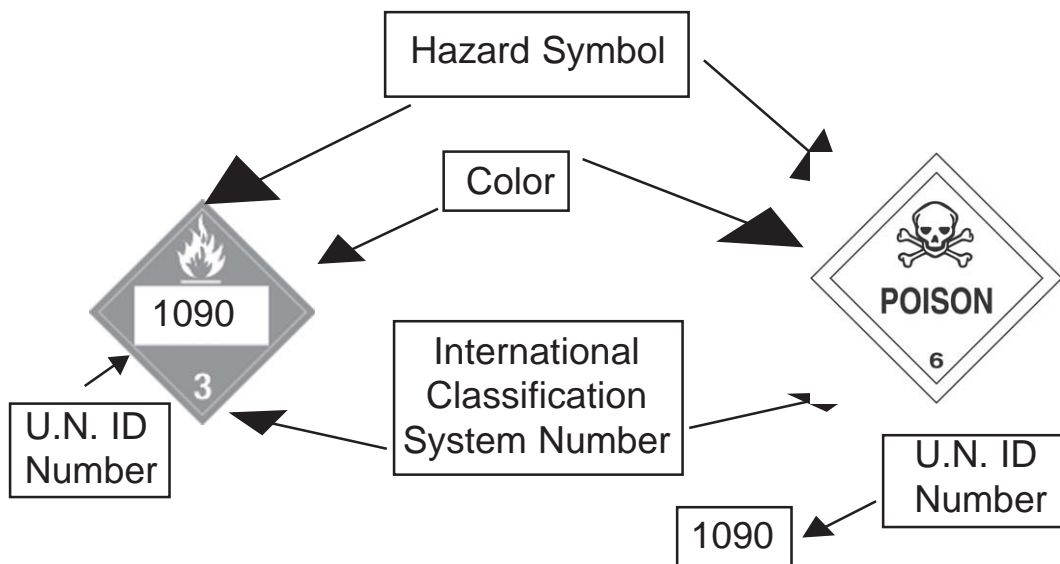
The Hazardous Materials Identification System may be seen in many workplaces. It provides some information about the kinds of protective equipment that may be needed in the work area. It must be supplemented by training and more specific labeling as required by the Hazard Communication Standard.

This system differs in some ways from NFPA and the EPA. Although the colors are the same as the NFPA 704 diamond (Health, Flammability, and Reactivity), the hazard ranking may differ. Also note that the Protective Equipment Index differs from the EPA Levels of Protection.



Overview of DOT Placards

DOT placards and labels on trucks and rail cars can give first responders quick information on potential hazards. If you work in areas where vehicles carrying these placards are used, it is in your interest to know what the symbols, colors and numbers mean.

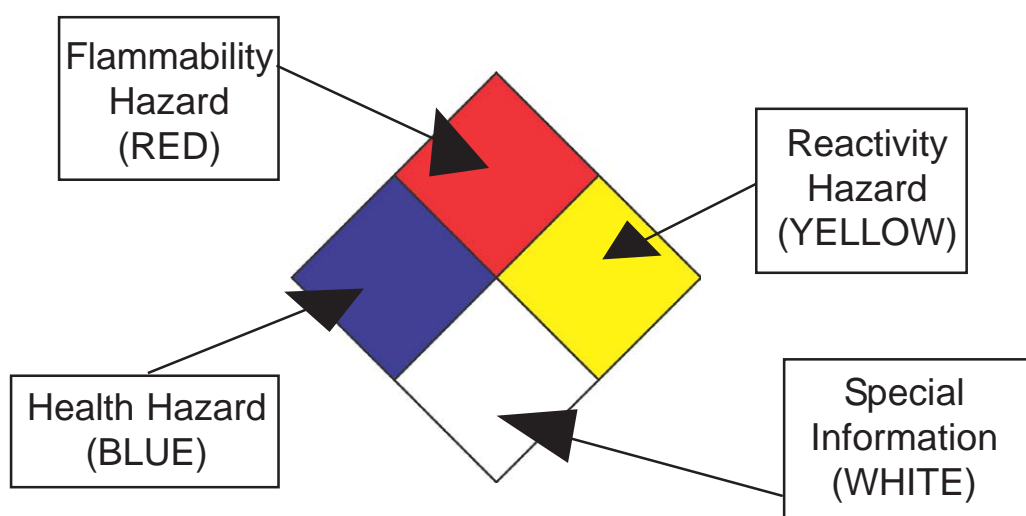


U.N. ID Number

- The four-digit number must also be on shipping papers and waste manifests.
- Use the yellow section of the DOT Book (North American Emergency Response Guidebook) to look up the chemical name of a substance with an ID number.

NFPA 704 Hazard Identification System Overview

NFPA 704 is a standardized system which uses numbers and color signs to define the basic hazards of special materials. Health, flammability, and reactivity are identified and rated on a scale of 0 (no hazard) to 4 (high hazard) depending on the degree of hazard present.



The ratings for individual chemicals can be found in the NFPA *Fire Protection Guide on Hazardous Materials*. Other references, such as the U.S. Coast Guard manual *CHRIS Volume 2* and the National Safety Council's *Fundamentals of Industrial Hygiene* contain the NFPA ratings for specific chemicals.

For example, the chemical represented here has a health hazard of “4”, a flammability hazard of “2”, a reactivity hazard of “3”, and it is water reactive.



Checklist To Evaluate Your Plant's Hazard Communication Program

The following checklist is adapted from the list Cal/OSHA inspectors use to evaluate the plant's Hazard Communication Program.

Review of the Written Plan:

- Describe how in-plant labeling will be accomplished. (5194 e 1)
- Who is responsible for making and maintaining labels?
- Describe the labeling system used.

- Describe how MSDS requirements will be met? (5194 e 1)**
- Who is responsible for the MSDS program?
- How will MSDSs be obtained and kept for every product used?
- How will MSDSs be made accessible to employees?
- How will MSDSs be checked for omissions?
- How are missing MSDSs requested from vendors?
- How will Cal/OSHA be notified if vendor fails to respond?

- Describe how employees are trained.**
- Who is responsible for training?
- Describe your initial training plan.
- Update (on new hazards) and refresher training plans.
- A complete list of on-site hazardous substances.
- How will employees be informed of hazards of non-routine tasks and hazards of unlabeled pipes?

Implementing the Plan:

- How will contractors be informed of hazardous substances?
- The written program is available upon request to workers and Cal/OSHA?

- Labels:** (5194 f) Each container is labeled with product identity and hazard warnings.
- Labels are displayed and legible on all in-plant containers.

- MSDS:** (5194 g) Plant has MSDS for each hazardous substances.
- MSDS are accessible to all employees.

- Training:** (5194 h) Explains what an MSDS is and info it contains.
- MSDS contents for each substance or class of substances used.
- Explain and make available written Hazard Communication Program.
- Location of work areas using hazardous substances and specific hazards and precautions.
- Methods used to observe and detect hazards.
- Details on plant labeling and MSDS system.

Training

Effective training is an important means of providing information on chemical hazards. If you work with chemicals, your employer should provide you with training for the chemicals you use. Training should include:

- information on the possible or known hazards of specific chemicals, including any health effects;
- information on how to work safely with the particular chemicals;
- emergency and first aid measures;
- use and care of any protective equipment that may be necessary;
- how to identify whether control measures are operating effectively;
- how to interpret labels, hazard data sheets and other hazard information provided on the chemicals.

Training is essential for new workers and existing workers should receive refresher courses periodically.





Workers' Rights



Outline

1. Employer Responsibility
2. Cal/OSHA's Role in Workers' Rights
3. Structure of Cal-OSHA
4. Health and Safety Laws
 - ◆ "Right To Know" About Workplace Hazards
 - Hazard Communication Standard
 - Access to Medical and Exposure Records Standard
 - OSHA Log of Injuries and Illnesses
 - ◆ "Right to Protection" from Workplace Hazards
 - Hazardous Waste Operations and Emergency Response
 - Injury and Illness Prevention Program
 - Confined Space Operations Standard
 - Respiratory Protection Standard
 - Airborne Contaminants Standard
 - California Corporate Criminal Liability Act
 - ◆ "Right To Act" to Improve Workplace Health and Safety
 - Right To Union Representation
 - Right To File a Complaint with OSHA/Cal-OSHA
 - Right To Refuse Unsafe Work
 - Right To Claim Workers' Compensation
 - Right To File a Complaint for Discrimination or Retaliation
5. Steps for Resolving Health and Safety Problems

Objectives

Participants will be able to:

1. Explain the employer's responsibility under the Cal-OSHA General Duty Clause.

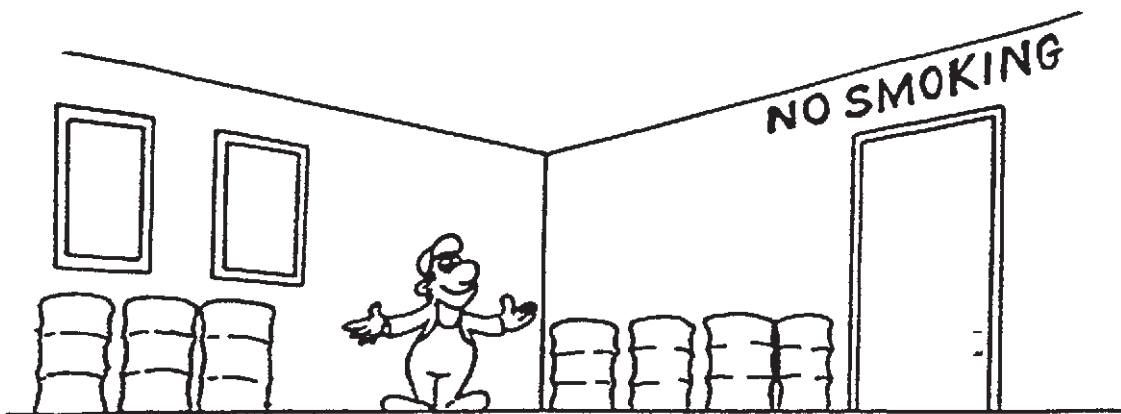
2. Describe at least four rights provided by Cal-OSHA regulations.
3. Apply at least three steps that can be taken to resolve health and safety problems.
4. Identify the steps workers should take if they must refuse to perform unsafe work.

Employer Responsibility

Federal and California laws require employers to provide safe and healthful employment (Federal OSHA: Public Law 91-596, General Duty Clause and California Labor Code, Division 5, Part 1, Chapter 3).

In California, it is the employer's responsibility to provide a safe and healthful work environment. This should include:

- 6400 Every employer shall furnish employment and a place of employment that are safe and healthful for the employees therein.
- 6401 Every employer shall furnish and use safety devices and safeguards, and shall adopt and use practices, means, methods, operations and processes that are reasonably adequate to render such employment and place of employment safe and healthful. Every employer shall do every other thing reasonably necessary to protect the life, safety and health of employees.



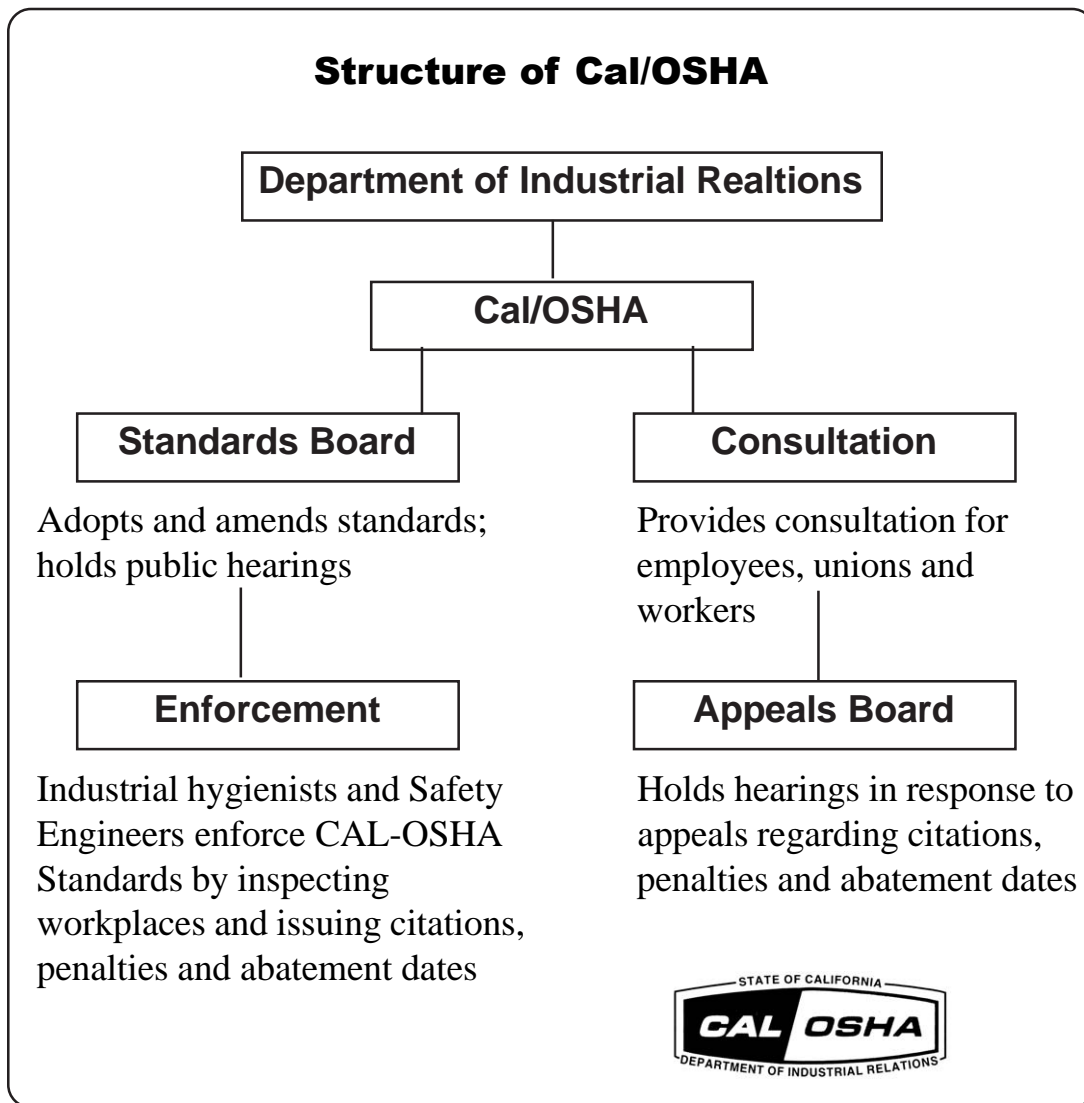
Cal/OSHA's Role in Workers' Rights

The Occupational Safety and Health Act (OSHAct) is the law that provides health and safety protection for private sector workers throughout the country. OSHA (Occupational Safety and Health Administration) is the agency responsible for enforcing the law.

States can also administer their own occupational health and safety programs, but they must be at least as protective as federal OSHA's. State agencies can also provide protection for public sector workers (city, county and state workers) as well as private sector workers.

In California, Cal-OSHA covers private and public sector workers and offers workers more protection than federal OSHA.

To assist employers in meeting their responsibility to provide a safe workplace, Cal/OSHA Standards are compiled in the California Code of Regulations Title 8 (Industrial Relations). Many of the safety standards fall under the General Industry Safety Orders (GISO).



Important Health and Safety Laws

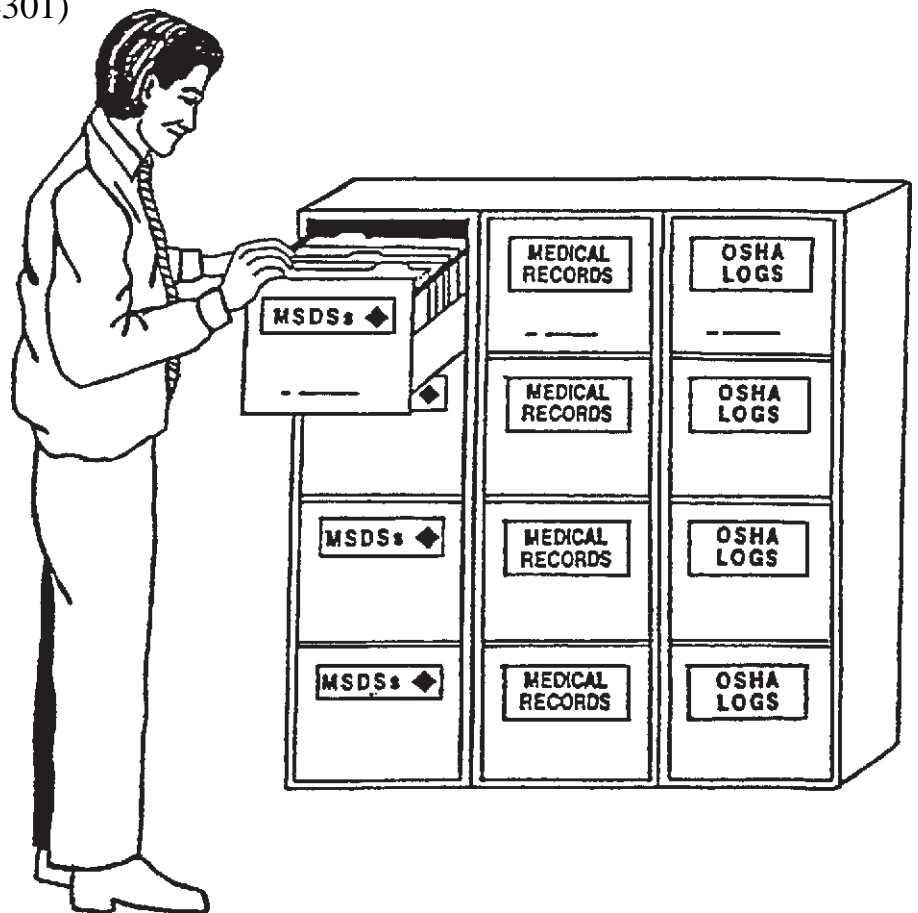
Many of the laws and regulations that provide workers with the right to a safe workplace fit into the following categories:

1. “Right To Know” about Workplace Hazards
2. “Right To Protection” from Exposure to Workplace Hazards
3. “Right To Act” to Improve Workplace Health and Safety

Right To Know About Workplace Hazards

“Right To Know” regulations include:

1. Hazard Communication Standard (GISO 5194)
2. Access to Medical and Exposure Records Standard (GISO 3204)
3. OSHA Log 300 of Injuries and Illnesses (Division of Labor Statistics and Research, Section 14301)



“Right To Know”

Hazard Communication Standard

The Hazard Communication Standard (GISO 5194) gives you the right to information that can answer the following questions:

1. What is hazardous in this material?
2. How can this affect my health?
3. What other hazardous materials are used at my workplace?



Federal and state OSHA programs give workers the right to know what hazardous materials they could be exposed to by requiring employers to set up a “Hazard Communication Program,” including:

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- emergency and first aid measures.
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Training must include:

- physical and health effects of the hazardous substances.
- methods used to detect the presence or release of hazardous chemicals.
- measures employees can take to protect themselves from hazards (including how to read and use labels and MSDSs to protect themselves).

“Right To Know”

Access to Medical and Exposure Records Standard

The Access to Medical and Exposure Records Standard (GISO 3204) is one of the most important, yet least known, “right-to-know” regulations for workers. This standard gives you the right to information that can help to answer the following questions:

1. What levels of chemicals and other hazards am I exposed to?
2. Do I have a medical problem?

The “**Access to Records**” standard gives you the right to examine and copy certain records kept by your employer. These records include:

- your own medical records
- all workplace exposure records

The “Access to Records” standard does not require your employer to conduct medical tests or monitoring, but it does require the employer to give you access to these records. It also requires your employer to keep the records for **30 or more years**. Your employer must let you see and copy the records you request within 15 days of receiving a written request.

Access can mean one of three things:

1. a free copy provided by your employer;
2. use of copying facilities; and
3. a loan of the record for you to make a copy at your own expense.

Medical Records

Although not required by the standard, your medical records should include all of the following, whether done in-house or contracted out:

- medical histories and questionnaires

- results of laboratory tests
- results of medical exams
- employee medical complaints
- medical opinions, diagnoses and recommendations
- originals of X-rays and interpretations
- description of treatment and prescription

Workplace Exposure Records

Your exposure records should include all of the following, whether done in-house or contracted out:

- monitoring information from personal, area, grab, wipe, or other forms of samples for chemicals, noise, heat, radiation, biological hazards, etc.
- results of tests on blood, urine, breath, hair, etc., for toxic chemicals.
- Material Safety Data Sheet (MSDS). In the absence of MSDSs, you should be given any other record that reveals the identity of a toxic substance or physical hazard.



Confidentiality

Medical records are confidential. You have the right to sign a release to let your doctor or union representative see your records.

Exposure records are not confidential. Union representatives can request all environmental monitoring (exposure) records. They can also request summaries of medical tests, without names, to look for trends (for example, hearing loss among a group of workers).

“Right To Know”

New Cal/OSHA Standard—January 2002

Log 300 of Injuries and Illnesses (Replaces Log 200 reporting requirements) - Begins January 1, 2002.

Under this new Cal/OSHA regulation, every employer with 10 or more employees (except for those in the exemption list) must record an occupational fatality, injury, or illness if it meets one of the general recording criteria: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, loss of consciousness, or is a significant injury or illness diagnosed by a physician or other licensed health care professional.

- The log must be kept at the local worksite. When employees do not work at a fixed worksite, as in construction, the worksite is the home base office, or station where the employees are supervised.
- Workers have a right to get a copy of the Log 300, the Annual Summary (Form 300A), and Incident Report (Form 301) by the end of the next business day.
- Employers must record all needlestick and sharps injuries involving contamination with another person’s blood or other potentially infectious materials.
- The Annual Summary must be posted for 3 months, from February 1 to April 30, beginning in 2003.

Why is the OSHA Log Important?

- Although the Log 300 does not list all injuries and illnesses in the workplace, it can provide valuable information about serious hazards and problems that need to be corrected.
- Cal/OSHA reviews these forms when conducting an inspection.
- False or incomplete information can result in large penalties for the employer.

Right to Protection from Workplace Hazards

There are several Cal-OSHA standards that protect workers, including hazardous waste workers. The following standards (found in the General Industry Safety Orders-GISOs of the California Code of Regulations, Title 8) are summarized in this section:

1. Hazardous Waste Operations and Emergency Response (GISO 5192)
2. Injury and Illnesses Prevention Program (GISO 3203)
3. Confined Space Operations (GISO 5159)
4. Respiratory Protection Standard (GISO 5144)
5. Airborne Contaminants Standard (GISO 5155)

Other Cal-OSHA standards may apply to specific hazards at your workplace. Also, the California Corporate Criminal Liability Act, effective January 1991, is enforced by the district attorney's office of each county.

“Right to Protection”



Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard

The Cal-OSHA Hazardous Waste Operations and Emergency Response Standard (GISO 5192) gives you the right to:

1. inspect a written site safety and health plan provided by your employer that addresses the safety and health of each phase of site operations, including requirements and procedures for employee protection.
2. be informed of specific risks at a particular site, including any information concerning chemical, physical and toxicologic properties for each substance known or expected to be present on site.
3. receive health and safety training.
4. receive medical exams where appropriate and without costs.

5. have access to the results of medical exams and monitoring data.
6. inspect a written emergency response plan or emergency action plan provided by your employer.

“Right to Protection”

Injury and Illness Prevention Program (IIPP)

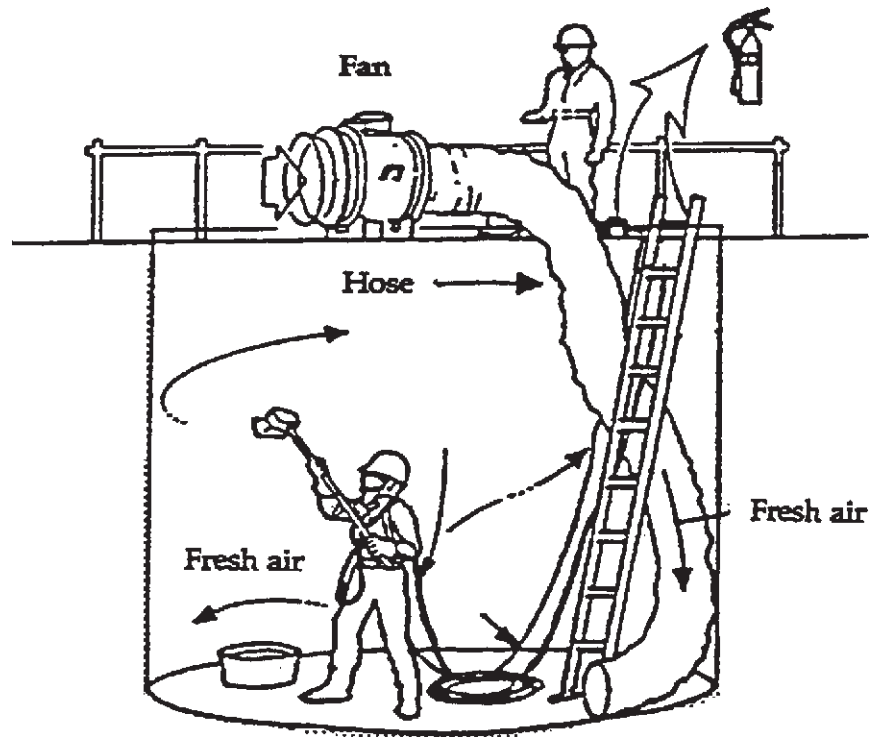
The Cal-OSHA Injury and Illness Prevention Program (GISO 3203) used to be called the Accident Prevention Program. It was updated and renamed in July 1991 as a result of Senate Bill 198. The standard now requires every employer to establish, implement and maintain an effective injury and illness prevention program which is in writing and:

1. identifies person(s) responsible for the program.
2. provides a system for ensuring employee compliance (recognition, training, disciplinary actions).
3. includes a system for communicating with employees (including meetings, trainings, postings, written communications and/or labor/management safety and health committees).
4. includes procedures (including inspections) for identifying and evaluating workplace hazards.
5. includes procedures to investigate occupational injury/illness.
6. includes methods for correction of unsafe/unhealthful conditions, work practices or procedures in a timely manner.
7. provides training and instruction in appropriate language.
8. maintains records of scheduled inspections, action taken to correct problems, and types, dates, and providers of trainings.

“Right to Protection”

Confined Space Operations Standard

The Confined Space Standard (GISO 5157) applies to workers who enter and work within a confined space in which air contaminants (chemicals) are present and/or there is not enough oxygen. (See Section 7 for more information on the Confined Space Standard.)



“Right to Protection”

Respiratory Protection Standard (GISO 5144)

This standard requires that:

1. Respiratory protective equipment be worn when it is not possible to remove harmful dusts, mists, vapors, or gases from the air or when emergency protection against relatively brief exposure is needed.
2. Only MSHA- or NIOSH-approved respiratory equipment be used.

3. Employees be trained in the use and limitations of the equipment they are expected to use.
4. Employers provide, repair, replace, inspect, sanitize, and properly store all respiratory protective equipment that employees may have to use.
5. Breathing air used meets specific medical or breathing oxygen requirements.
6. A written respiratory protection program include: procedures for selection, instruction, cleaning, inspection, and maintenance of respiratory protective equipment.
7. A licensed physician determine the ability of a person to wear a respirator and that the medical status of persons assigned to wear respirators be reviewed at least annually (see Module 7 for detailed information on respirator protection).



“Right to Protection”

Airborne Contaminants Standard (GISO 5155)

This standard lists **legal** limits for the amount of chemicals that may be present in the air at work. It also states whether chemicals can be absorbed through the skin. It lists the Permissible Exposure Limits (PELs) and Ceiling Limits for approximately 700 chemicals. The standard also defines various exposure limit terms (including PEL, Ceiling Limit, Excursion Limit) according to Cal-OSHA.

“Right to Protection”

California Corporate Criminal Liability Act (California Penal Code, Section 387)

The California Corporate Criminal Liability Act (SB 198) went into effect in January 1991. It allows for the prosecution of corporations and/or their representatives in the criminal courts under the jurisdiction of the District Attorney’s office if the corporation or manager:

1. has actual knowledge of a serious concealed danger that is subject to regulatory authority, and
2. fails to take the following action:
 - a. correct the hazard, or
 - b. inform Cal-OSHA and affected employees of the hazard.

If the hazard creates an imminent risk of bodily harm or death, the above action must be taken immediately; otherwise action must be taken within 15 days.

Under this law, failure to notify Cal-OSHA and affected employees can result in criminal prosecution leading to imprisonment and/or fine.

Right to Act To Improve Workplace Health and Safety

You have a right to information and protection according to Cal-OSHA, the National Labor Relations Board (NLRB), and the California Labor Code. You also have the right to discuss health and safety problems with your supervisor or others at your workplace without fear of discrimination.

Rights that are grouped under the “Right To Act” include:

- right to union representation (under the NLRB).
- right to file a health and safety complaint with OSHA.

- right to refuse unsafe work (under the California Labor Code, Section 6311).
- right to claim workers' compensation.
- right to file a complaint for discrimination or retaliation.

“Right To Act”

Right to Union Representation

The national Labor Relations Board (NLRB) oversees federal labor laws. These laws describe responsibilities and rights of employers, employees and unions. Many of these rights can be used to identify and eliminate health and safety hazards.

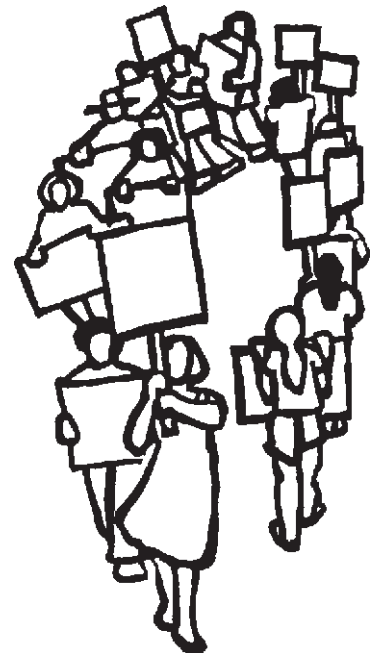
Right to Health and Safety Information: The NLRB gives unions the right to health and safety information in order to bargain intelligently about working conditions.

Unions have requested a wide range of health and safety information, including names of chemicals, MSDSs, monitoring data, group summaries of medical tests, death and pension records, and written company health and safety plans and policies.

If there is a violation of a health and safety contract, it may be faster to ask the union for help rather than OSHA or the NLRB.

Right to an Outside Industrial Hygienist: the NLRB also gives unions the right to bring in a union-designated industrial hygienist to inspect a facility.

Right to Representation without Discrimination: The NLRB requires an employer to bargain in good faith with the representative of the employees: the union. The union must represent fairly and without discrimination all of the employees covered by the contract. This is referred to as “duty of fair representation.”



“Right To Act”

Right To File a Complaint with OSHA or Cal/OSHA

You have the right to file a complaint and request an inspection of your workplace by Cal/OSHA without anyone knowing who made the request. Cal/OSHA responds more quickly to serious hazards and if it knows you have made an attempt to resolve the problem before calling.

In order to request an inspection from Cal/OSHA, call or file a written complaint with one of the Cal/OSHA compliance (enforcement) offices listed below:

Cal/OSHA Regional Offices:

San Francisco	Tel. (415) 557-1677	Los Angeles	Tel. (213) 736-3041
Oakland	Tel. (510) 622-2916	Sacramento	Tel. (916) 263-2800
Concord	Tel. (925) 602-6517	San Diego	Tel. (619) 637-5534
Fresno	Tel. (209) 445-5302	San Mateo	Tel. (650) 573-3812
San Jose	Tel. (408) 452-7286	Santa Rosa	Tel. (707) 576-2356

Cal/OSHA Consultation Offices:

In California, Cal-OSHA Consultation is also available to provide technical assistance to employers and groups of workers. Cal-OSHA consultation services are free of charge. In order to obtain Cal-OSHA consultation services, call one of the following offices in your area:

Oakland	Tel. (510) 622-2891
Fresno	Tel. (209) 454-1295
Sacramento	Tel. (916) 263-2855
Anaheim	Tel. (714) 935-2750
San Diego	Tel. (619) 467-4048
Santa Fe Springs	Tel. (310) 944-9366



“Right To Act”

Right To Refuse Unsafe Work (California Labor Code, Section 6311)

The California Labor Code, Section 6311, says workers can refuse to do unsafe work:

1. if doing the work would create a real and apparent hazard, and
2. if doing the work would violate a Cal-OSHA standard or an order of the California Labor Code.

You have the right to refuse unsafe work, but using this right can be risky if you are not covered by a union. If you lose your job or are otherwise discriminated against after refusing unsafe work, you can complain to the labor commissioner (see p 6-31). However, cases that go to the Labor commissioner can take two to three years to resolve. Refusing work is not something to do “lightly.” Refuse work only in an immediately dangerous situation.

Before you refuse to do an unsafe job, take the following steps:

1. Consult with your co-workers to be sure you are in agreement and that you will not be the only person stating that the job creates a serious hazard.
2. Tell your employer about the unsafe condition and ask him/her to correct the problem before work is done. State that you believe the unsafe condition creates a serious hazard.
3. Contact your union representative.
4. Request an immediate Cal-OSHA inspection.

When you refuse to do an unsafe job:

1. Clearly explain to your employer the reason for refusing to do the work. Make it clear that danger was the only reason for your refusal.
2. Explain to your employer that you are willing to do the work once the corrections have been made. Ask to be assigned to work in a safer area.
3. Stay at or near the job site unless ordered to leave by management.

“Right To Act”

Right To Claim Workers’ Compensation

What is workers’ compensation?

It is a no-fault insurance program for compensating workers and supervisors for work-related injuries, illnesses and deaths, regardless of pre-existing medical conditions. It is financed by employers and administered by the State Division of Workers’ Compensation and the Workers’ Compensation Appeals Board.

What is covered by workers’ compensation?

All employers are required to carry workers’ compensation insurance. Nearly every worker in California is covered by the law. (Railroad, maritime and federal government workers have separate programs with varying benefits.)

How and when should I file a claim?

First, get medical help. Then, notify your supervisor and union, even if you do not have any lost time from work. Generally, you have 30 days to file a claim for an injury, and one year for work-related disease (one year from when you first suffered disability and either knew or should have known it was work-related).

What benefits can I get if I’m injured on the job?

California law gives you four kinds of benefits:

- 1. Medical treatment:** fully paid by the employer for work-related injuries or illnesses. This includes the costs of hospitalization, X-rays, lab studies, and reasonably related transportation expenses.
- 2. Payments to replace lost wages:** benefits are calculated based on whether you qualify for temporary or permanent disability, and are set by state law. Temporary benefits are calculated by taking two-thirds weekly salary, up to \$399 per week (after a 3-day waiting period for most injuries). Public safety officers, however, (and those covered by some collective bargaining agreements), may be eligible for full-salary benefits for a certain time period. Permanent disability benefits are payable after your condition stabilizes. The amount of benefits is subject to your permanent disability rating, which is determined by your injury, your age and

occupation, and your ability to gain employment. Permanent disability benefits generally range from \$168 to \$504 per week.

3. **Vocational rehabilitation services**, available to eligible workers whose disability prevents them from being employed in their usual and customer occupation or the position they occupied at the time of injury, and who can be expected to benefit from a rehabilitation program.
4. **Death benefits** and burial expenses for eligible dependents.

Choosing Your Own Doctor

You have the right to use your own health care provider (with expenses paid by your employer), but you must file a notice with your employer before you are injured. Your employer must notify you of this right. If you have not filed this notice, the employer can select the doctor you see for the first 30 days of treatment. After that time, you can choose your own physician.

“Right To Act”

Right To File a Complaint for Discrimination or Retaliation (California Labor Code Section 6310)

You have the right to file a complaint if you believe that your employer has punished or discriminated against you because you made a complaint to CAL-OSHA or used any other rights under Cal-OSHA law. Discrimination or retaliation might include: firing, taking away your seniority, taking away your benefits, transferring you to an undesirable job or shift, threatening you or harassing you for using your Cal-OSHA rights.

If this has happened to you, contact the nearest office of the California Labor Commissioner (Department of Industrial Relations–Division of Labor Standards Enforcement) for assistance.

When you make this complaint, be prepared to explain:

- what your employer has done to punish or discriminate against you for your job safety and health activities.

- names and addresses of people involved or witness to the punishment. Also, show any documents, letters, or other material that relates to the incident.

When calling the California Labor Commission about filing a complaint, ask to be sent a form or list of information to include in your complaint.

If the labor commissioner finds that your employer has punished you for making a complaint to Cal-OSHA or using any other rights granted to you under Cal-OSHA law, the commissioner will order your employer to return you to your job and to give you any pay or benefits that are due to you. It may take several years to resolve your case. The assistance you receive from the Division of Labor Standards Enforcement or the Labor commissioner is free.

Steps for Resolving Health and Safety Problems

Using these laws and rights to your advantage is not easy. You must be organized and persistent, pressing the company as well as the government to fulfill their legal responsibilities. Here are some tips.

1. Identify the problem and build a strong foundation for your case

- gather information in writing to document the problem. This includes requesting your medical and exposure records and records of past accidents or illnesses.
- document your attempt to get management to correct the problem (notes of meetings, grievances).

2. Know what problem you want to correct and have a timetable

- decide how to correct the problem: develop an outline of demands (which can include bringing in outside technical experts like Cal-OSHA Consultation Services).

3. Involve other workers and keep them informed

- use co-workers as your base of support for advice and direction; this will help you determine which problem(s) affect most people and what solutions are needed.
- work with the union if there is one at your workplace.

4. Bring in a government agency as a last resort

- first, try to solve the problem through direct negotiation with the company; it's faster, easier and there is more control over the outcome.
- decide which government agency to call based on careful research to determine the odds of the agency helping you solve the problem.

5. Persistent follow-up

- participate in all meetings between the company and the agency; keep co-workers informed.