CHAPTER 7: DECONTAMINATION

Decontamination is the process of removing contaminants from personnel and equipment to protect yourself, your fellow workers, and your family and community. It may include neutralizing contaminants by chemical means. Proper disposal is an important part of decontamination.

Chapter Objectives

After this training, you will be able to:

- Properly decontaminate your protective gear, yourself, your tools and equipment to protect yourself, your family, and your community.

CASE STUDY
Two workers finished a day of pumping out a tank full of xylene. They rinsed off their reusable suits with water and hung them up to dry. When they came back the next day the suit material felt strange--it had become soft and sticky. The suits had to be thrown away. What happened?

The workers were wearing the right suits, but they did not clean them off with soap--they did not **decontaminate** properly. Poor decontamination can damage suits or equipment and poison you or your family. In this chapter you will learn about how to decontaminate properly to prevent this kind of problem.

WHAT IS DECONTAMINATION?

Every time you leave the hot zone you need to decontaminate (decon). You will leave the hot zone through a series of wash stations in the warm zone that are called the **decon line** or **decontamination line**. Workers in suits and respirators may be assigned to the decon line to scrub and rinse protective gear and help you take it off.

The only way out of the hot zone should be through the decon line. You must go through decon every time you leave the hot zone.

On most decon lines you will stand in a tub and your suit gloves and outer boots will be scrubbed with brushes and compatible cleaner. Then you will step into two other tubs in succession, one for a full-body wash and the last tub for a rinse. (The number of stations and tasks per station is site specific.) You will take off your outer boots, inner gloves, and then your suit, carefully rolling them inside out so you do not get chemicals from the outside of the suit on your skin. You take off your respirator last. Some decon lines are very long and complicated, some are short. But the basic idea is always the same.

The decon line has to be set up and operational **before anyone starts work in the hot zone.**

Decontamination Procedures

Decontamination procedures are described in the employer's safety and health plan. Proper decontamination procedures must --

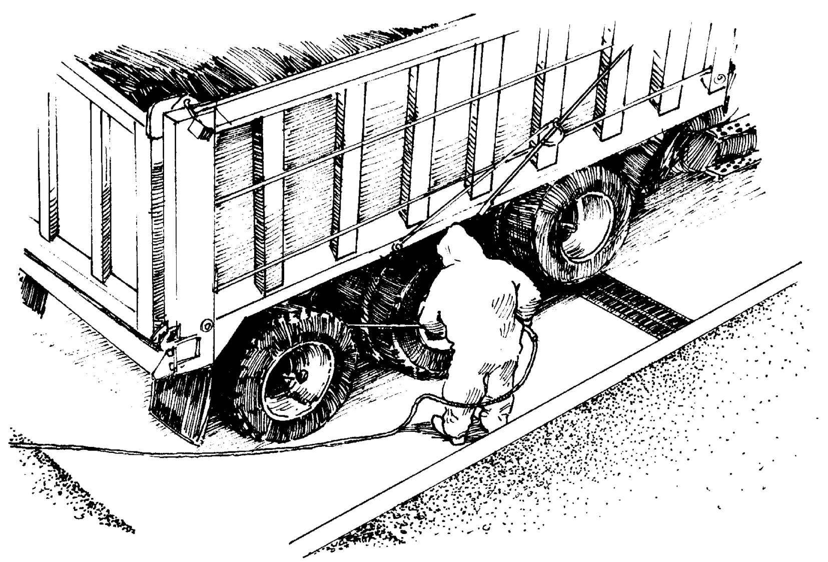
- be communicated to employees and implemented before employees or equipment enter the work site
- control hazards, including runoff
- protect workers from exposure to hazardous substances or contaminated equipment
- prevent continued contamination and permeation of the hazardous substance into PPE, other equipment, and tools
- prevent the mixing of incompatible substances
- prevent the uncontrolled transfer of contaminants to the home and community and to employees in clean areas
- be monitored by the safety and health supervisor and revised as necessary

When Is Decontamination Required?

Each waste site presents different risks of contamination. The site-specific safety and health plan should state when, where, and how decontamination will occur. Decontamination is needed:

- when PPE or clothing becomes contaminated;
- before personnel go from a hot zone to a cold zone;
- before workers eat, drink, smoke, or use rest room facilities; and
- before equipment and transport trucks leave the site.

The site decontamination plan must appear in the required safety and health plan. The plan must be operational before any personnel or equipment enters areas with hazardous substances. The plan must be monitored by the site safety and health supervisor.



Worker using high-pressure water to decontaminate tires of a truck leaving a Superfund site.

The Decontamination Plan Must Contain The Following Information:

- A description of the **location** and **layout** of decontamination stations
- A list of the decontamination **equipment** needed (for example, water, scrubbing brushes)
- **PPE** to be worn by decontamination workers
- Specific **procedures** for decontamination of substances that may be encountered on the site
- Methods for **preventing** contamination of clean areas
- Procedures for **minimizing worker contact** with contaminants during removal of PPE
- Safe **disposal methods** for clothing and equipment which are not completely decontaminated
- **Revisions** whenever the type of PPE changes, the site conditions change, or the site hazards are reassessed based on new information

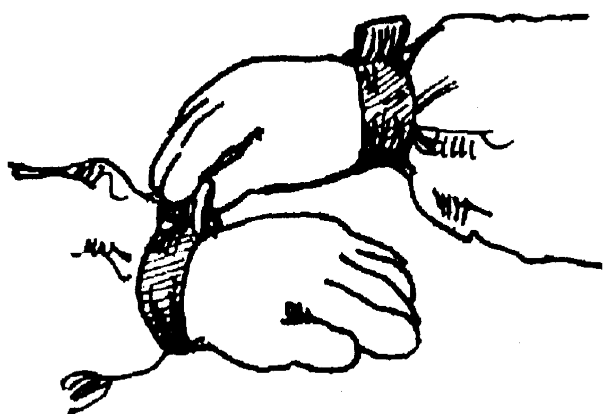
Protective clothing and equipment must be decontaminated, cleaned, maintained, or replaced as often as necessary to protect the worker effectively. Whenever a hazardous substance gets on permeable non-chemically resistant clothing you must remove and discard the clothing and remove the contamination.

Preventing Contamination

It is important to minimize contact with hazardous substances. SOPs should establish practices which minimize exposure and maximize worker protection.

For example, these PPE practices can minimize worker exposure --

- before each use inspect PPE to ensure it is in good condition
- close zippers, buttons, and snaps fully
- tuck inner gloves under the sleeves and outer gloves over sleeves
- wear a third pair of tough outer gloves over the sleeves
- tuck boots under the legs of outer clothing
- wear hoods over the respirator harness
- tape and tab all joints (if tape adhesive is compatible with suit materials) to help prevent contaminants from getting inside gloves, boots, and jackets



Close-up of Taping Joints

Reducing Contamination

Safe work practices can help **reduce** the amount of contamination during routine work activities, for example --

- follow SOPs that minimize contact with hazardous substances
- do not kneel or walk through puddles or areas of obvious contamination
- properly dispose of decontamination equipment and solvents
- use drum grapplers, impact wrenches, and remote techniques for sampling, handling, and drum-opening
- cover monitoring and sampling instruments with plastic bags
- wear disposable outer garments and use disposable equipment whenever possible

Decontamination Procedures

All personnel, clothing, equipment, and sample containers leaving contaminated areas must be decontaminated. Decontamination may **--**

- physically remove contaminants
- chemically remove contaminants
- rinse off contaminants
- disinfect and sterilize (infectious materials)
- combine the above methods

Physical Removal of Contaminants

Some contaminants stick to the surface of PPE and other equipment. They can be removed by scraping, brushing, washing, and wiping.

Dust and vapors that cling to PPE and machinery may become trapped in small openings, such as the weave of the fabric, and can be removed with water or a liquid rinse.

Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Be careful not to inhale vaporizing chemicals.

Chemical Removal of Contaminants

Chemical neutralization decontamination requires planning and training. The chemicals in the solution must be compatible with the clothing and equipment being cleaned.

Rinsing off Contaminants

Soap and water solutions are commonly used to help remove contaminants.

Multiple rinses with clean solutions will remove more contaminants than a single rinse with the same volume of solution.

Disinfecting and Sterilizing

Chemical disinfectants can kill some infectious agents. Disposable PPE is recommended for use with infectious agents.

All equipment that cannot be decontaminated, such as wooden handles, and any solvents used must be properly disposed of or packaged for transport to the next work site.

Personnel Decontamination Line

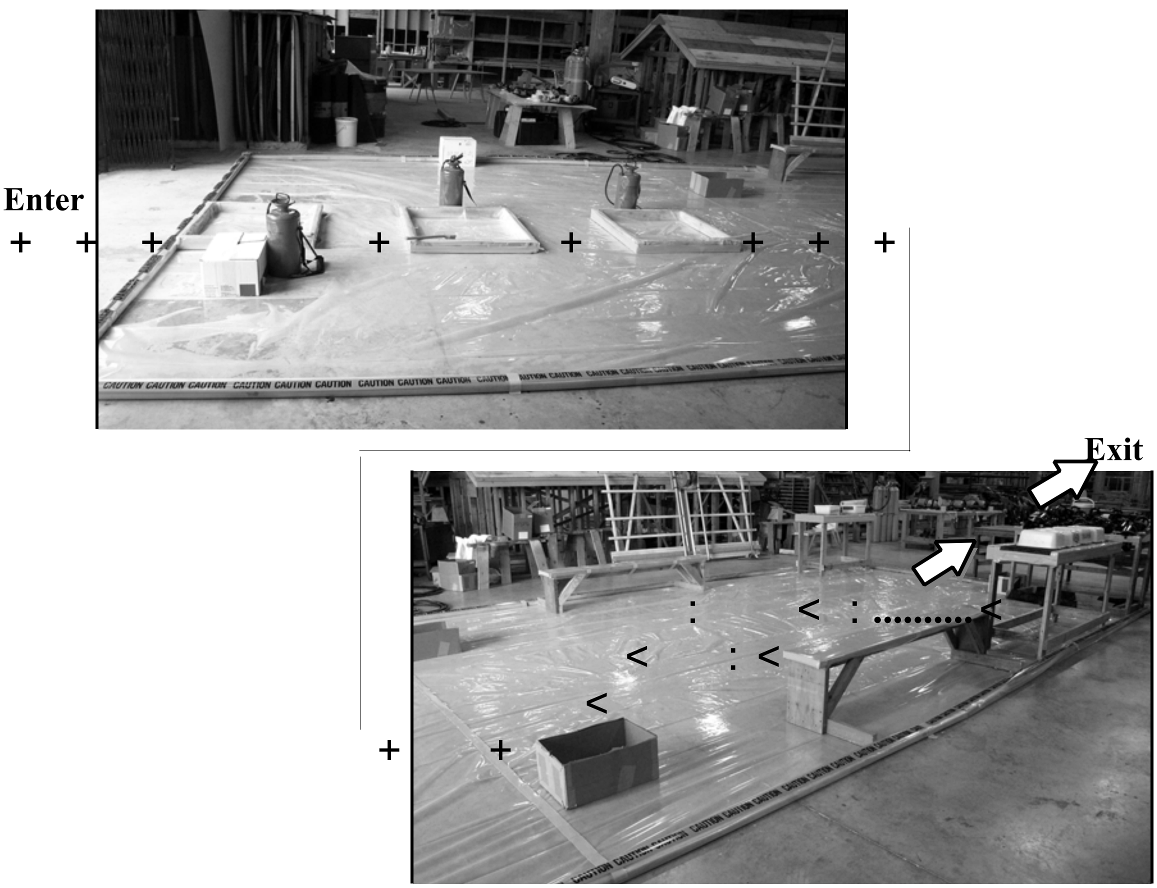
Decontamination must occur before personnel enter any clean areas. Procedures will vary depending on the nature and extent of contamination.

The decontamination line is made up of a series of stations that reduce contamination. The stations are arranged in order of decreasing contamination, preferably in a straight line. All decontamination activities are located in the Contamination Reduction Corridor (CRC).

Outer, more heavily contaminated items such as boots, gloves, and suits should be decontaminated and removed first. Less contaminated items, for example inner boots and gloves, are removed next.

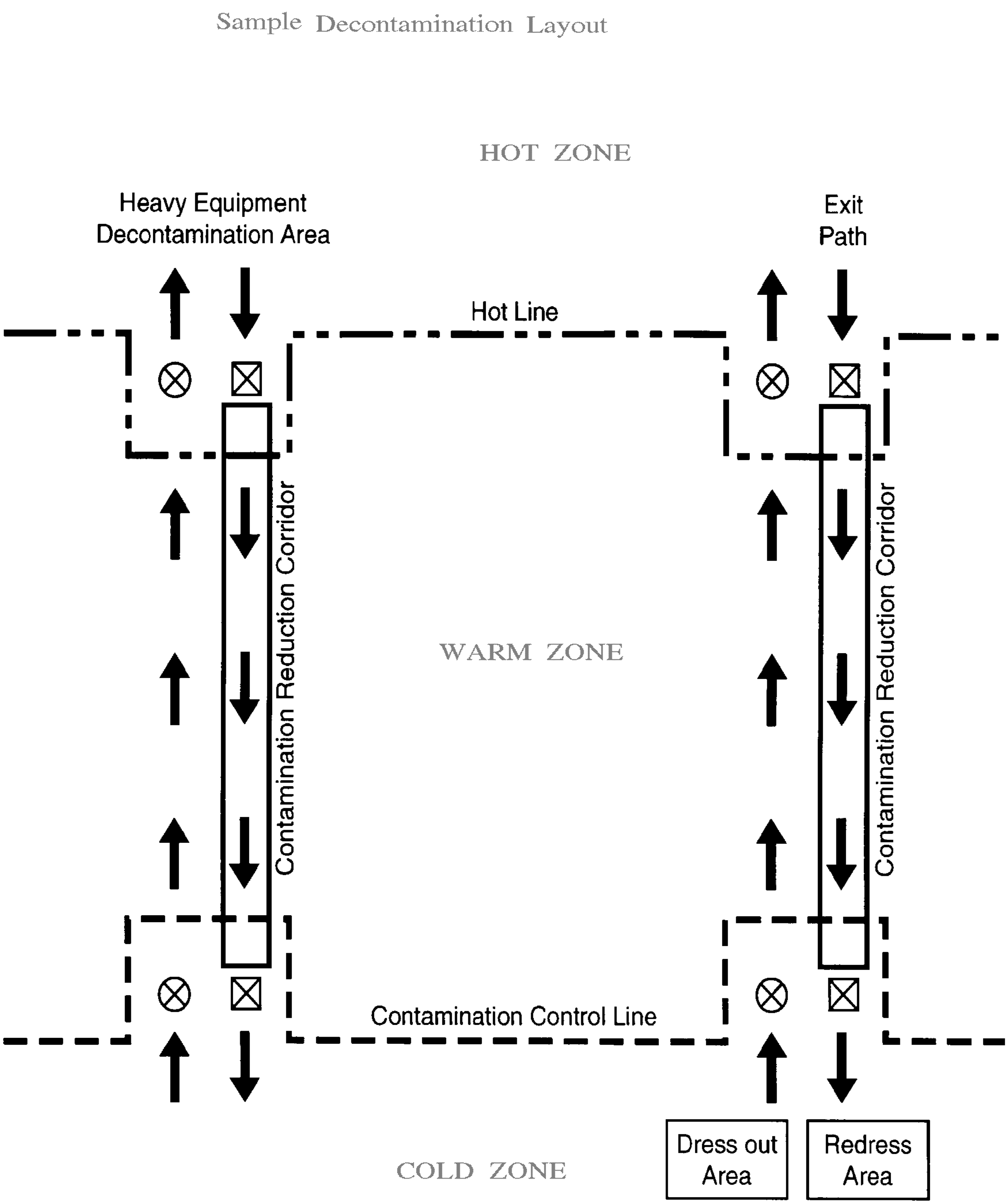
See the sample decontamination line diagram shown on the next page.

¶ To Hot Zone -- To Cold Zone ,



¶ To Hot Zone -- To Cold Zone ,

SAMPLE DECON LAYOUT



Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, DHHS 85-115 NIOSH, OSHA, U.S. Coast Guard, EPA.

Decontamination Steps by Work Zone

Decontamination begins as you exit the Hot Zone. It ends before you enter the Cold Zone.

Hot Zone: Hazards are in the Hot Zone. The "Hot line" is the outer boundary and should be clearly marked with hazard tape, signs, or ropes.

Warm Zone: Decontamination activities occur in this zone. Protective equipment and clothing are removed to prevent the transfer of hazardous substances to cleaner areas.

Cold Zone: The Cold Zone is free of contamination. Workers who have been in the Hot Zone are medically checked out in the Cold Zone. This zone contains the administrative and other support functions that keep the zones running smoothly.

Protecting Decontamination Line Workers

Workers at the start of the decon line (toward the Hot Zone) will need more protection from contaminants than workers at the end of the decon line. **Decon workers wear the same level of protection or no more than one level of protection below Hot Zone workers. Decon workers must never wear less than a Level C protection.** The safety and health plan should specify the level of PPE to be worn at all positions by decon line workers.

Decontamination of Equipment and Breathing Apparatus

Decontamination of equipment prevents deterioration of the equipment and controls the spread of hazardous substances.

- **Monitors:** Contaminated monitoring equipment requires special cleaning. EPA regional laboratories or the manufacturer can provide information on proper decontamination methods.

- **Tools:** Metal tools should be cleaned, as appropriate, by chemical or physical means. Wooden tools and tools with wooden handles are difficult to decontaminate because they absorb chemicals.

- **Respirators:** The safety and health plan must detail the methods for decontaminating all respirators. Certain parts of contaminated SCBAs and other respirators, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush, depending on the contaminant. Regulators must be maintained according to the manufacturer's recommendations.

Preventing Spread of Contamination

Contaminated wash and rinse solutions must be contained and properly disposed of. Tools used in the Hot Zone must not be removed from the Hot Zone unless they are decontaminated. Contaminated clothing, tools, buckets, brushes, etc. must be secured in drums or other containers and properly labeled. The spent solutions and runoff must be transferred to properly labeled drums and disposed of according to local, state, and federal regulations.

Safety Precautions for Decontamination

- Make sure that decontamination solutions are **compatible** with the hazardous substances being removed to prevent a reaction which could produce an explosion, heat, or toxic products
- Make sure there are **enough decon workers** to help each person through the line
- Provide **hand-holds** while boots are being washed or boot covers removed
- Apply **"gripper"** decals to slippery surfaces to reduce the likelihood of slips
- Provide **benches** (not wooden unless they will be disposed of after the job) for personnel to sit on at stations where boots or suits are removed
- Be sure all areas are **cleaned**
- Prevent **unauthorized employees** from removing protective clothing or equipment from change rooms

Did The Decon Work?

You can inspect decontaminated items to make sure all visible signs of contamination are gone. There is no on-the-spot test to use to assure total decontamination. PPE can be sent to a lab to be analyzed for the presence of contamination. The final rinse can also be analyzed to help determine the effectiveness of decontamination.

SUMMARY: DECONTAMINATION

Decontamination is important to prevent the spread of hazardous substances beyond the site. Proper procedures must be developed before a clean-up job begins. Remove contamination of personnel and expensive equipment such as SCBAs and monitors. During the development of the work plan, work zones should be established to control the spread of contaminants. There are three zones --

The **hot zone** is the work area. Only personnel in adequate PPE should be in this zone.

The **warm zone** is the area where decontamination occurs. Decon workers usually wear PPE equal to, or one level less than, cleanup workers.

The **cold zone** is the area for support personnel. There are no hazardous waste materials in the cold zone.

The **decon line** must be **set up** and ready to go before anyone enters the hot zone.

Methods for decontaminating PPE and equipment vary depending on the substance at the site. Basic methods include –

rinsing or dissolving	scraping, brushing, and wiping
evaporation, then rinsing	using soap
chemical disinfection	combinations of the above.

The decontamination line is an organized series of procedures that is performed in a specific **sequence**. It reduces levels of contamination on personnel, PPE, and equipment until no contaminant is present.

Each procedure is performed at a **separate station**. Stations are arranged in order of decreasing contamination. Anything that cannot be decontaminated or packaged for reuse must be disposed of.

Decon workers must be decontaminated before they leave the decon line. All decon equipment must be properly decontaminated or disposed of properly.

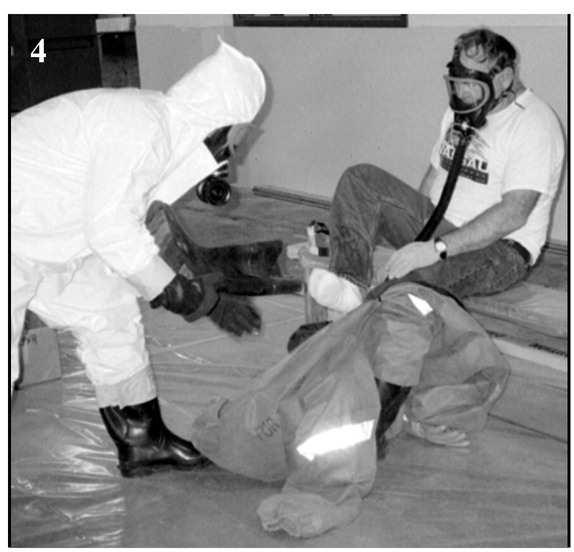
BACKGROUND READING MATERIAL: DECONTAMINATION

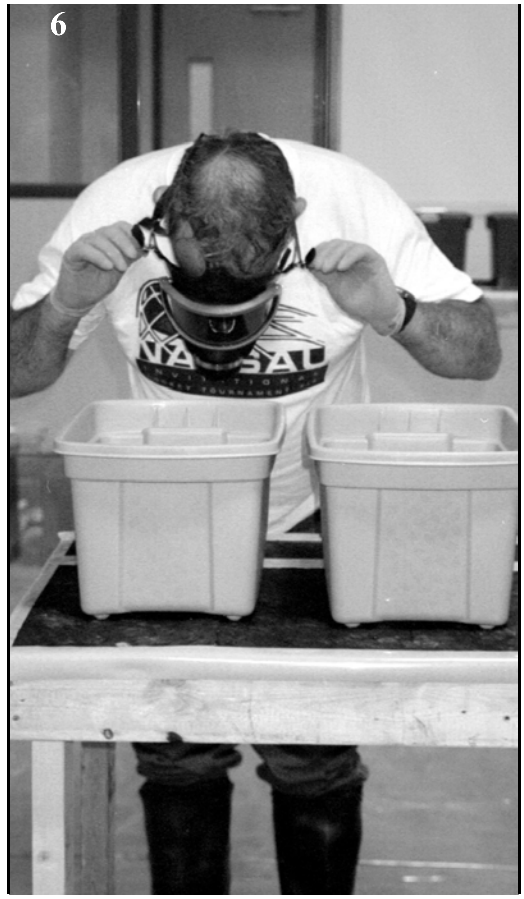
Hazardous Waste Operations and Emergency Response; Final Rule
OSHA, March 6, 1989 (29CFR1926.65)

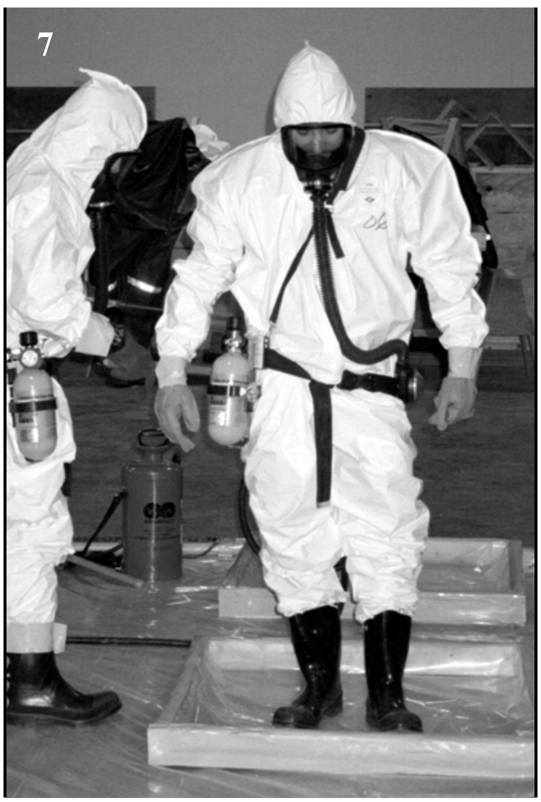
Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities
(NIOSH #85-115) October, 1985

Chapter 9	Site Control, p. 1-7
Chapter 10	Decontamination, p. 1-7

Pictures 1 - 6 take a Level A worker through the decon.







Picture 7 shows a Level B decon worker about to be scrubbed down by a fellow Level B decon worker.

Picture 8 shows a Level C decon worker helping another Level C decon worker open a splash suit.

Activity 9: Decon

Your group has been given the identity of a chemical that has been found on site. Your task is to design a decontamination line to properly decontaminate workers. Research your chemical in the *NIOSH Pocket Guide*, and as a group, decide what level of protection the workers in the exclusion zone and all levels of the decon line will be wearing. Another consideration is what materials will be used in the decon line.

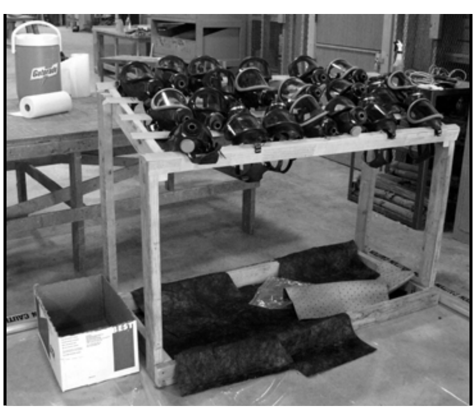
Design your decon line on the overhead transparency, listing materials to be used in the process and the level of protection required. Be prepared to present your decon process to the class at the end of the exercise, citing reasons and concerns for each step of the process.

Chemical: ______________________________

1. What level of protection will your "Exclusion Zone" workers be wearing and why?

2. What level of protection will your "CRZ" workers be wearing and why?

3. List any special hazards that this chemical might present.



Activity 9: Decon

Student Group Handout from ***40HSW*** Instructor's Manual

Chemical Name	Trade Name	CAS #	DOT #	Page #	Concentration
Chloro-acetaldehyde	2-Chloro-ethanol	107-20-0	2232	60	40ppm
Boron Oxide		1303-86-2		31	Unknown
Bromoform	Methyl Tribromide	75-25-2	2515	34	900ppm
Nitric Oxide	Nitrogen Monoxide	10102-43-9	1660	225	50ppm
Calcium Oxide	Lime	1305-78-8	1910	48	15mg/m^3

Activity 9: Decon

Answer Copy - Chloroacetaldehyde

Your group has been given the identity of a chemical that has been found on site. Your task is to design a decontamination line to properly decontaminate workers. Research your chemical in the NIOSH Pocket Guide, and as a group, decide what level of protection the workers in the exclusion zone and all levels of the decon line will be wearing. Another consideration is what materials will be used in the decon line.

Design your decon line on the overhead transparency or flip chart paper, listing materials to be used in the process and the level of protection required. Be prepared to present your decon process to the class at the end of the exercise, citing reasons and concerns for each step of the process.

Chloroacetaldehyde	2-Chloroethanol	107-20-0	2232	60	40ppm

1. What level of protection will your “Exclusion Zone” workers be wearing and why?
   Level B or C.......Concentration of 40ppm allows an APR, but being so close to the IDLH of 45ppm, an SAR could be indicated. The absorption problem has to be taken into consideration, but with a boiling point of 186^0 F, the material will most likely be a liquid. Unless special circumstances are present, Level A would not be required.

2. What level of protection will your “CRZ” workers be wearing and why?
   The level of protection required in the decon line should be no more than one level less than the workers in the exclusion zone. If workers are in level A, decon should be in no less than level B. If workers are in level B, Decon should be in no less than level C. Keep in mind that if the workers are in level C, decon must also be in level C. Having the first decon workers in the same level of protection as the exclusion zone workers would be acceptable.

3. List any special hazards that this chemical might present.
   Combustible Liquid
   Eye, skin irritant
   Severe respiratory problems

Answer Copy - Boron Oxide

Boron Oxide		1303-86-2		30	Unknown

1. What level of protection will your “Exclusion Zone” workers be wearing and why?

   In this situation, Level B would be acceptable. Boron oxide is not a strong contact or absorption hazard. This material will most likely be a solid, minimizing the risk of skin exposure. However, many will worry about the statement that it reacts with water (sweat) to form boric acid and will opt for Level A, especially with the unknown exposure. Level C would not be acceptable because of the unknown exposure.

2. What level of protection will your “CRZ” workers be wearing and why?

   The level of protection required in the decon line should be no more than one level less than the workers in the exclusion zone. If workers are in level A, decon should be in no less than Level B. If workers are in Level B, Decon should be in no less than Level C. Keep in mind that if the workers are in Level C, decon must also be in Level C. Having the first decon workers in the same level of protection as the exclusion zone workers would be acceptable.

3. List any special hazards that this chemical might present.

   Mixture forms boric acid. This can be overcome by using a dry method of decon (HEPA - vac) or by using a quick drench neutralizing chemical shower to dilute the material for the first station of the decon process.

Answer Copy - Bromoform

Bromoform	Methyl Tribromide	75-25-2	2515	34	900ppm

1. What level of protection will your "Exclusion Zone" workers be wearing and why?

   Levels A would be required for the workers in this scenario. This chemical is an eye and skin irritant. Being a liquid, there is the danger of splash. The chemical has an exposure limit of 5mg/m^3 for skin, meaning that route of exposure is a very high concern.

2. What level of protection will your "CRZ" workers be wearing and why?

   The level of protection required in the decon line should be no more than one level less than the workers in the exclusion zone. If workers are in Level A, decon should be in no less than Level B. If workers are in Level B, Decon should be in no less than Level C. Keep in mind that if the workers are in Level C, decon must also be in Level C. Having the first decon workers in the same level of protection as the exclusion zone workers would be acceptable.

3. List any special hazards that this chemical might present.

   The routes of entry and the low exposure limits concerning skin contact. A shower at the beginning of the decon line or having the first decon workers dressed in level A would be acceptable.

Answer Copy - Nitric Oxide

Nitric Oxide	Nitrogen Monoxide	10102-43-9	1660	224	50ppm

1. What level of protection will your “Exclusion Zone” workers be wearing and why?

   At this concentration, Level C would be acceptable. This substance in its gaseous form will not cause irritation to skin unless the skin is wet.

2. What level of protection will your “CRZ” workers be wearing and why?

   The level of protection required in the decon line should be no more than one level less than the workers in the exclusion zone. If workers are in Level A, decon should be in no less than Level B. If workers are in Level B, Decon should be in no less than Level C. Keep in mind that if the workers are in Level C, decon must also be in Level C. Having the first decon workers in the same level of protection as the exclusion zone workers would be acceptable.

3. List any special hazards that this chemical might present.

   This substance is often confused by many with Nitrous Oxide (Laughing Gas). This substance is a strong oxidizer and will accelerate the burning of combustible materials. Some health effects (pulmonary edema) are delayed for up to 24 hours after exposure.

Answer Copy - Calcium Oxide

Calcium Oxide	Lime	1305-78-8	1910	48	15mg/m^3

1. What level of protection will your “Exclusion Zone” workers be wearing and why?

   Level C would be acceptable in this scenario. Being a dry substance, skin contact is a minimal concern.

2. What level of protection will your “CRZ” workers be wearing and why?

   The level of protection required in the decon line should be no more than one level less than the workers in the exclusion zone. If workers are in Level A, decon should be in no less than Level B. If workers are in Level B, Decon should be in no less than Level C. Keep in mind that if the workers are in Level C, decon must also be in Level C. Having the first decon workers in the same level of protection as the exclusion zone workers would be acceptable.

3. List any special hazards that this chemical might present.

   This material is also a strong oxidizer. Being a material that most people use around the home, many disregard the hazards associated with this chemical.

ALTERNATIVE DECON ACTIVITY 9: Decon

A. Outline the Decontamination Procedure needed for this site.
B. Identify the hazard of the given Chemical.
C. Establish a PPE Level for Clean Up and Decon Workers.
D. Establish the Respirator Protection Level Required for Entry and Decon Workers.
E. Lay out the appropriate Decon Line (Paper or Transparency Exercise)

GROUP ONE

It is known that Carbon Tetrachloride is present in a number of barrels that were washed down the river. There is also a possibility that fluorine could be present

It is known that some of the drums have ruptured. Since the work plan calls for workers to overpack ruptured barrels, it is expected that the worker's PPE in the exclusion zone will be highly contaminated.

GROUP TWO

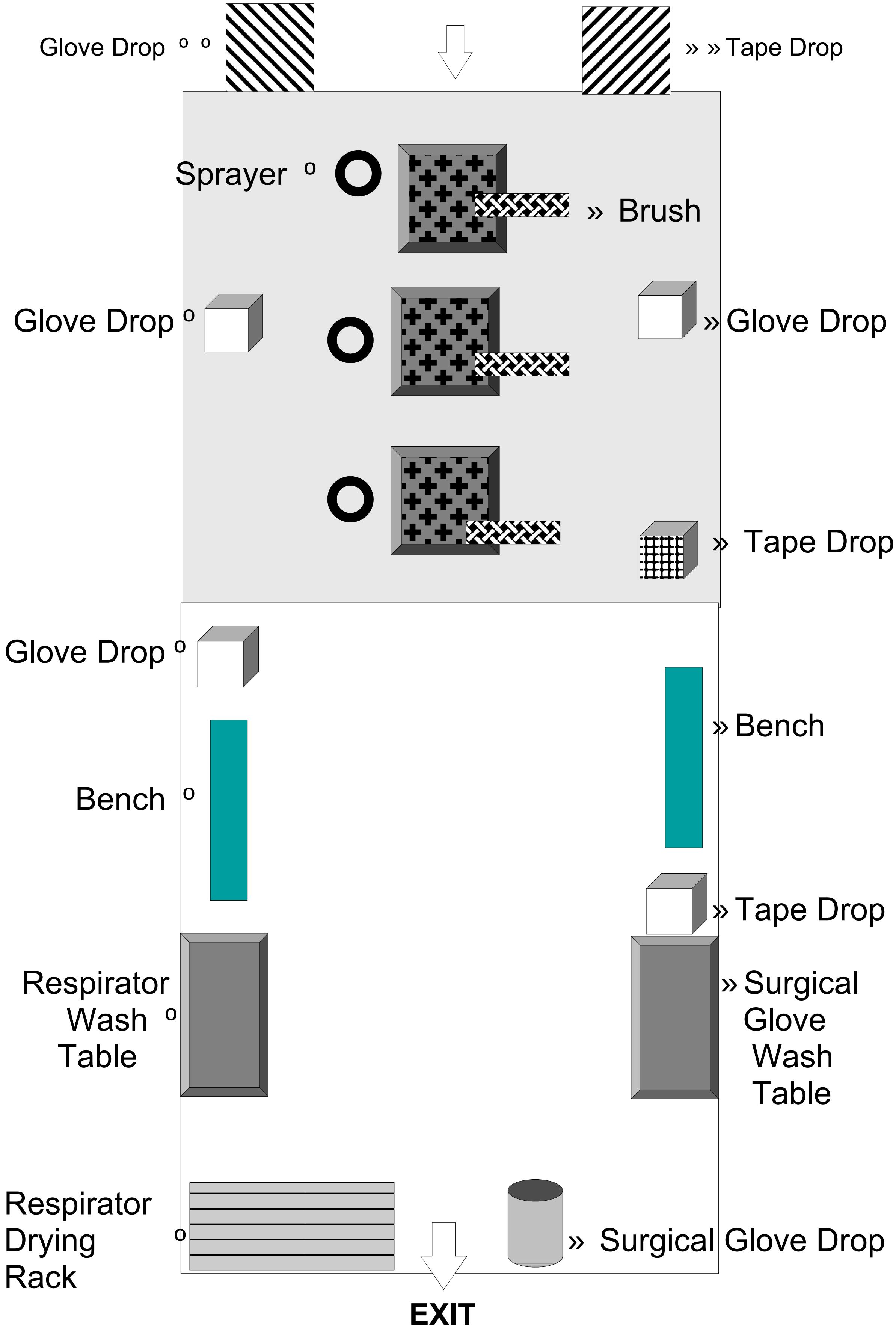
It is known that Benzene is present in a number of barrels that were washed down the river. There is a possibility that some of the barrels may have ruptured. It is expected that the worker's PPE will be moderately contaminated

GROUP THREE

It is known that Boron Oxide is present in a number of barrels that were washed down the river. Monitoring reveals that there is less than 50 mg/m^3 in the air. It is doubtful if any of the barrels are ruptured and it is not expected that the worker's PPE will be even moderately contaminated.

GROUP FOUR

It is known that Diacetone alcohol is present in a number of barrels that have washed down the river. Air monitoring indicates that there is less than 200ppm of diacetone alcohol vapor in the atmosphere. It is expected that the work practices will prevent serious contamination to the worker's PPE.


Glove Drop
Tape Drop
Sprayer
Brush
Glove Drop
Glove Drop
Tape Drop
Glove Drop
Bench
Bench
Tape Drop
Respirator Wash Table
Surgical Glove Wash Table
Respirator Drying Rack
Surgical Glove Drop
EXIT

NOTES & SCRIBBLES

CHAPTER 8: AIR AND MEDICAL MONITORING

The concentration of hazardous substances can be detected with monitoring instruments including oxygen meters, combustible-gas meters, and detector tubes. Medical monitoring programs keep track of possible health effects caused by exposure to hazardous substances.

Chapter Objectives

After this training, you will be able to:

- Determine in what situations monitoring is needed.
- Determine the correct instrument to be used.
- Interpret and use air monitoring information.
- Identify OSHA's requirements for medical surveillance.

Union health & safety trainer factory calibrating a personal air sampling pump.

CASE STUDY
Construction workers lowered a gas meter into an underground vault and the readings came back normal. A worker climbed into the vault with a gas meter, but his readings came up high. What happened?

A gas meter will not work right unless there is enough oxygen in the air. Methane from an old dump had filled up the vault and pushed oxygen out. By opening the vault, oxygen began to mix into the methane. The workers forgot to test for oxygen first. In this chapter you will learn about how to use different kinds of gas testers and what some of their limits are to prevent this kind of problem.

WHAT IS MONITORING?

At a hazardous waste site you need to be able to answer questions such as ...

What is in that barrel?

How much lead is in this soil?

How much gas is in the air where Jim is working?

After a chlorine gas leak, how far did the gas cloud spread?

All of these questions can be answered by **chemical monitoring**. Monitoring is very important because it tells you ...

The kind of suit and respirator you need to protect yourself.

The kinds of special equipment and tools you need to use (like fans).

The kinds of special work methods you need to use (like water sprays).

Where dangers are on the hazardous waste site.

The Importance of Air Monitoring

There are many different ways to measure chemicals. Each way of measuring answers a different question. Each way of measuring has serious limits and many are not accurate.

Monitoring provides important information about the presence of hazardous substances. No single instrument can detect all hazards, but proper use of air sampling equipment can provide information to help protect workers' health. Using the wrong type of instrument may expose workers to an unsafe work environment.

Monitoring must be performed whenever employees may be exposed to hazardous substances, monitoring results are one criteria in selecting PPE.

Airborne exposures are very complex and can change a lot. A monitoring plan must be set up by a knowledgeable person in charge of site safety. The frequency of monitoring will be determined in the plan.

Monitoring can:

- **detect** potential hazardous conditions; and
- **measure** concentrations of hazardous substances.

Airborne concentrations of hazardous substances should be measured to:

- determine worker exposure level and the location and extent of hazardous worker exposures;
- assist in selection of PPE and planning work activities;
- determine community exposure;
- create records of exposure; and
- determine whether employees need medical attention.

Monitoring during initial entry:

- Identifies oxygen-deficient atmospheres;
- Notes presence of flammable gases;
- Identifies chemicals present; and
- Measures concentrations of contaminants to identify IDLH situations and potential over exposures to hazardous chemicals.

Periodic monitoring must be conducted when there are IDLH conditions, flammable atmospheres, or signs that exposures may have risen over acceptable limits since the last monitoring. The employer must monitor those employees likely to have the highest exposure. When workers are found to be overexposed, the monitoring program should be expanded to identify all overexposed workers. Monitoring must be repeated if there is a change in work activities or the materials that are handled.

Exposures can change when --

- work begins in a different area of the site
- new contaminants are found
- work tasks change
- obvious liquid contamination is in the work area
- weather conditions change

What Can Be Monitored in The Air?

Oxygen-Deficient Atmospheres

Normal breathing air contains **20.9%** oxygen. Air which contains less than **19.5%** oxygen is **oxygen-deficient.** The oxygen in confined spaces such as tanks, pits, silos, pipelines, vaults and sewers is often oxygen-deficient. OSHA requires SAR (with escape) or SCBA respiratory protection in atmospheres with less than 19.5% oxygen.

Oxygen-Enriched Atmospheres

The atmosphere **is oxygen-enriched** if it contains **more than 23.5%** oxygen. If flammable substances are present, oxygen enrichment increases the risk of fire or explosion by providing extra oxygen.

Fire and Explosion Hazards

Flammable and explosive chemicals are detected by combustible gas meters. Oxygen content must be measured before you test for the presence of flammable materials. If the oxygen content is too low, combustible-gas meters will not register correctly.

Toxic Chemical

Instruments that give immediate results can identify only certain chemicals. If a substance cannot be identified immediately, samples are taken and sent to a lab for analysis.

Biological Hazards

The presence of bacteria, viruses, and certain parasites will affect PPE selection, as well as decontamination and disposal procedures. Specialists must be brought in to investigate biological hazards.

Radioactivity

Detection of radiation usually requires special technicians (Radiation Safety Officers) to conduct monitoring. No single instrument can measure all forms of radiation accurately.

Types of Air Sampling

There are several types of air sampling --

Personal sampling - the monitor is worn by the worker and samples collected from his or her breathing zone

Area sampling - the monitor is placed in the work area

Real-time/direct- reading sampling - area monitoring equipment that provides an immediate reading of air contamination

Indirect monitors - collect samples to be analyzed in a lab

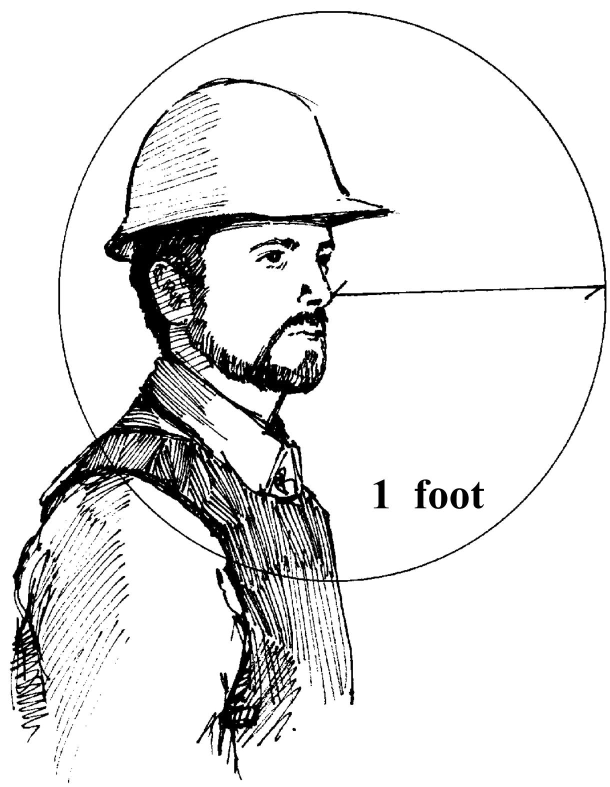
Personal Sampling

Personal samples are usually collected by placing a **battery-operated air pump** on the person's belt and clipping a collection tube or filter in their **breathing zone**, usually on the collar. Air from the breathing zone is pulled into the collection device. The contaminants are trapped, and the sample is sent to a laboratory for analysis. **Passive dosimeters** are badges clipped to the collar which collect samples without using a pump.

Strengths of personal sampling ...

It is the most accurate measurement of your exposure, because the sampling device goes where you go and collects air from your breathing zone.

Results can be converted to a TWA or STEL and compared with the published exposure limits.



An Air Monitor Needs to be in your Breathing Zone

Weaknesses of personal sampling ...

Laboratory analysis of the sample may take 1–14 days.

If collected over several hours, samples provide no information about ceiling exposures.

Generally you need to know what chemical you are sampling for before you sample.

If you are requested to wear a sampling device:

Be sure the monitor is positioned properly within your breathing zone;

Notify safety or sampling personnel if any problems occur;

Use the OSHA Access to Employee Exposure and Medical Records Standard (1926.33) to request the results of tests in writing;

Compare the results with OSHA PELs and recommended exposure limits - (RELs) and TLVs;

Keep the results. If you become ill the information may be helpful to your doctor; and

Ask for assistance if you do not know what the results mean.

Personal sampling pump with a particulate filter or cassette.

Real-Time or Direct-Read Sampling

Real-time monitoring with direct-reading instruments provides an immediate measurement of exposure. The equipment used depends upon the potential hazards present.

Advantages of real-time monitoring--

Results are immediate

Detects high levels of toxic and flammable materials

Used to ensure safe entry to confined space

Disadvantages of real-time monitoring:

Instruments may not be sensitive enough to detect low but possibly harmful levels of a contaminant;

Most monitors cannot identify a specific unknown contaminant or distinguish one from another; and

Background levels and other chemicals can give false readings (cross-sensitivity).

Environmental Sampling

Environmental sampling includes water sampling, soil testing, wipe testing, compatibility testing, and drum sampling.

Water Sampling
Sampling and analysis of groundwater and water from wells, ponds, and streams helps determine whether wastes are present.

Soil Testing
Soil testing indicates how much area contamination there is, how deep it is, and the boundaries of the contaminated area.

Wipe Testing (Swipe Testing)

Wipe testing shows which surfaces are contaminated. A piece of cloth or other material is swiped across a surface and then submitted to a laboratory for analysis.

Drum Sampling

Drum sampling identifies the contents of drums and tanks. A glass rod called a "thief" or a "coliwasa" is inserted into the drum. The captured sample is then bottled and sent away for analysis.

Compatibility Testing

Tests performed by a laboratory can determine whether the hazardous materials can be mixed safely. Compatibility software programs have been developed by the U.S. EPA, Army Corp of Engineers, and other groups.

SAMPLING INSTRUMENTS

Oxygen Meter - **Measures concentration of oxygen in the air.**

Keep in mind:

Temperature, pressure and carbon dioxide can all effect readings;

Calibrate meter regularly; and

User must be trained.

Combustible-Gas Indicator (CGI) - measures concentrations of flammable gas/vapors. Useful for confined space entry. Also called LEL meters.

CGI's measure the percent of the LEL that is in the air.

Above 10% of the LEL indicates there is a potentially dangerous atmosphere for fire/explosion.

You must test for oxygen content **before** you test for flammable vapors. CGI's need enough oxygen to work properly.

Keep in mind --

CGI's require periodic factory calibrations.

CGI's do not respond the same to all vapors.

Old models with a needle indicator require constant observation during use, as the needle may peg out (swing far to the right and back to 0 and then be misread as 0).

User must be trained.

Must be **field-calibrated** (**bump checked**) by trained personnel before each shift, and

Enough time must be allowed for contaminants to reach the instrument through the length of tubing used.

Colorimetric Detector Tubes (Drager, MSA, Sensidine) - Measure gas/vapor concentrations by color change of the material in tube.

A **colorimetric detector tube** is a glass tube filled with a solid material or gel that contains an indicator chemical. As air is pulled through the pump, the contaminant reacts with the chemical in the tube and produces a stain proportional in length to the concentration of the contaminant.

Keep in mind --

- Each tube is specific to a small range of chemicals. Even very similar chemicals will give different readings.
- Accuracy is +/- (plus or minus) **25% at best**.
- Pump must be checked for leaks and calibrated.
- Tubes have a limited lifetime, always check expiration date.
- Results may be affected by **temperature and humidity**.
- User must be trained in reading the scales on the tubes used.
- User must follow specific **pump-stroke requirements**.

Other Monitoring Instruments

Use of photo-ionization detectors (PID), flame ionization detectors (FID), and other more complicated monitors require special training.

Radiation Sampling

No single instrument can measure all forms of radiation. On sites where radiation sources are present, a specific monitoring program should be in place which describes monitoring devices, the type of hazard, and control methods.

Noise Monitoring

Sound Level Meter (SLM) - Direct reading monitor measures sound levels in **decibels (dB)**. Most instruments use the A scale which mimics how the ear responds to noise.

Keep in mind:

Requires calibration before and after each use

Battery must be checked before each use

Dial must be viewed constantly while using instrument

Personnel must be trained to use instrument

NOTE: Personal noise dosimeters are also available. These instruments are worn by the employee during the entire shift and give a time-weighted average exposure.

SELECTING MONITORING EQUIPMENT

Site management is responsible for selecting appropriate monitoring equipment. Manufacturers should provide information about equipment uses and its limitations. NIOSH and the EPA can also provide information about equipment. Some general considerations when selecting monitoring equipment follow:

All instruments must be electrically safe (**called intrinsically safe**) if used in flammable areas.

Most direct-reading instruments are designed to sample only one contaminant or group of contaminants.

No instrument can sample **all** toxic substances.

Make sure instruments are designed for use at the temperatures they will be exposed to.

Users must be trained in and allowed to practice monitoring procedures.

SUMMARY: AIR MONITORING

Air testing or monitoring tells you what levels of chemicals workers are exposed to. Your employer will use monitoring results to choose the right personal protective equipment.

Oxygen-deficient and oxygen enriched atmospheres, fire and explosion hazards, toxic chemicals, biological hazards, and radioactivity can all be monitored at the site.

Personal and area sampling is used to measure the amount of a toxic chemical in the air that a worker is exposed to. These samples must usually be sent away to a lab.

Real-time sampling gives you a direct reading of the air at the moment you use the equipment. Direct-reading instruments are used for flammable vapors, oxygen, and toxic materials. Real time sampling may be used for personal or area monitoring.

Full-shift air samples are averaged out over an 8-hour work day. Full-shift sampling is called a time-weighted average (TWA). This type of monitoring gives no information on high (peak) exposure unless many samples are taken during this 8-hour period.

OSHA requires employers to do everything they can to keep air contaminants below the Permissible Exposure Limits (PELs). Results of personal monitoring can be compared with PELs or other recommended limits (such as the Threshold Limit Values set by the American Council of Governmental Industrial Hygienists).

Personal sampling, when the worker wears a small pump all day and the sample is taken in the breathing zone, gives most accurate information on a worker's exposure. It takes a few days to get the results back.

The air in a confined space must be tested with direct-reading instruments in this order: oxygen (19.5%-23.5%), flammable (less than 10% LEL), and then known toxic substances (below PEL) before you enter and periodically while workers are inside.

If the oxygen level is low or high, or if the meter is not properly calibrated, combustible gas levels will not be accurate. If the combustible gas indicator reads above 10% of the LEL, leave the area immediately and alert your supervisor.

MEDICAL SURVEILLANCE PROGRAM

Medical surveillance (**29CFR1926.33**) is a required part of the safety and health program. Workers' health must be monitored before, during employment, and at the end of employment (if the last exam was more than 6 months before the job ends). The medical surveillance program must be provided by the employer for the following employees:

- All employees who are or may be exposed to hazardous substances or health hazards at or above the PEL or another published exposure level (if no PEL) for 30 days or more a year;
- All employees who wear a respirator for 30 days or more a year;
- All employees who are injured, become ill, or show symptoms due to overexposure to hazardous substances from an emergency response or clean-up; and
- Members of hazardous materials response teams.

NOTE: Medical clearance must be obtained before using a respirator.

Medical examinations must be made available by the employer to each employee who falls into one or more of the above categories. Medical exams must be conducted:

- before a new job assignment;
- at least once every year unless a physician determines that a longer period, up to two years, is appropriate;
- more than once each year if the doctor decides it is necessary;
- when a job ends; and
- if an employee has symptoms which may have been caused by exposure to hazardous substances or if the employee has been injured or exposed above the PEL or published exposure levels in an emergency situation.

All medical examinations and procedures must be performed by or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine. The exam is provided without cost to the employee, without loss of pay, and at a reasonable time and place.

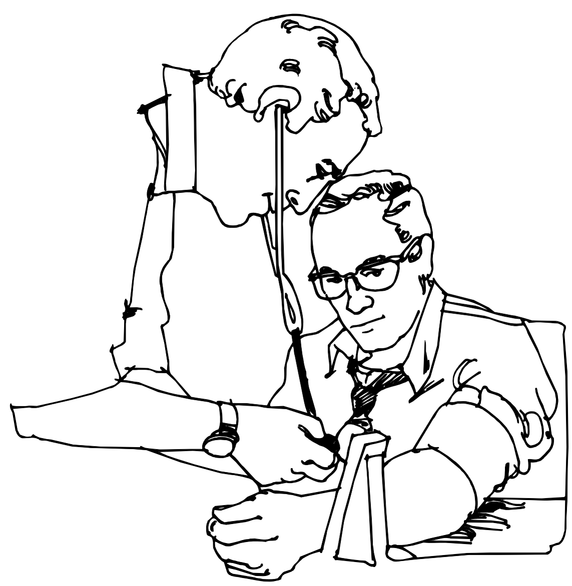
A physician will decide on the content of the examination. You should explain to the physician the type of work you do, the potential health risks, and the type of protective equipment which you wear on the job. At a minimum medical exams must include a medical and work history. They should also include a complete physical, lung function, hearing test, and an EKG for your heart.

Your employer must give the physician:

- a copy of **29CFR1926.33**;
- your job description and exposures;
- your current or anticipated exposure levels;
- a description of personal protective equipment used or to be used;
- information from previous examinations that the physician may not have; and
- information required by the respirator standard **29CFR1926.103**.

Your employer has to give you a copy of the physicians written opinion, including:

- medical conditions that would make hazardous waste work or respirator use particularly risky to you;
- recommended limitations on your assigned work;
- results of the exam and tests, if you request them; and
- a statement that the doctor has told you about the exam results and any conditions which require further examination or treatment.



The opinion your employer gets from the physician can discuss only findings related to your work. **Any other medical conditions must not be revealed to the employer.** You have the right to request and be given a copy of the physician's full report. Your employer must keep medical and exposure records for as long as you are **employed plus another 30 years**. If you work for your employer for less than a year, he does not have to keep your records provided that he gives them to you when you leave.

SUMMARY:
MEDICAL SURVEILLANCE

Regular medical exams or **medical surveillance** tell you if chemicals are damaging your health. The employer may use medical surveillance results to change the way work is done.

You must have a hazardous waste **medical exam**:

- Before you begin work;
- At least every two years after that;
- Any time you are involved in an emergency or a serious spill;
- Any time you feel sick because of work; and
- When you leave a job.

The medical exam **must include** --

- Your health history
- Your work history
- A doctor's physical exam (usually heart, lungs, abdomen, ears, eyes, reflexes) based on the chemicals you will work with. The physical often includes:
    - lung tests (Pulmonary Function Test or PFT);
    - heart tests (Electrocardiogram or EKG);
    - hearing test (audiogram); and
    - blood tests (for lead and some other chemicals).

The doctor will write a **report** to your employer about any health problems related to your work. This report must not contain any unrelated findings. Your employer must give you a copy.

BACKGROUND READING MATERIAL: MONITORING

Hazardous Waste Operations and Emergency Response Standard
Final Rule, March 6, 1990 (29CFR1926.65) (h) Monitoring

Occupational Safety and Health Guidance Manual for Waste Site Activities
October 1985. (NIOSH # 85-115)

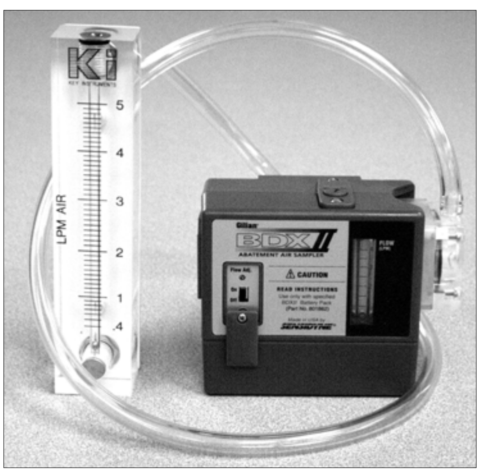
Chapter 7	Air Monitoring, p. 1-7

EPA's Standard Operating Safety Guides, July 1988

Part 8	Air Surveillance p. 1-8 and Annex 5 and 6
Appendix I	Characteristics of HNU Photoionizer and Organic Vapor Analyzer, p. 1-4
Appendix II	Rationale for Relating Total Atmospheric Vapor/Gas Concentrations to the Selection of the Level of Protection

NIOSH Pocket Guide to Chemical Hazards, (2005).

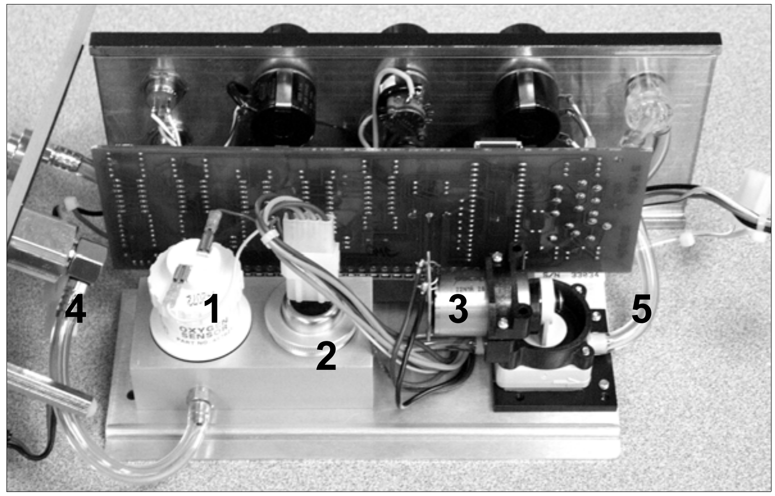
Column 8	Measurement method
Table 1 (p. xix)	Codes for measurement methods



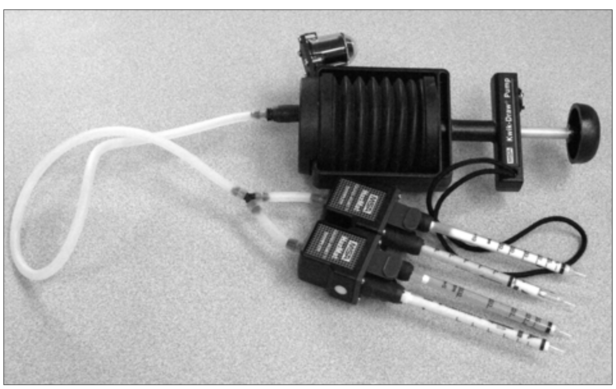
Personal Sampling Pump
w/rotometer for field-calibration.


Three union health & safety trainers learn from a certified industrial hygienist how to factory calibrate a personal sampling pump. Arrow points to calibrating device.

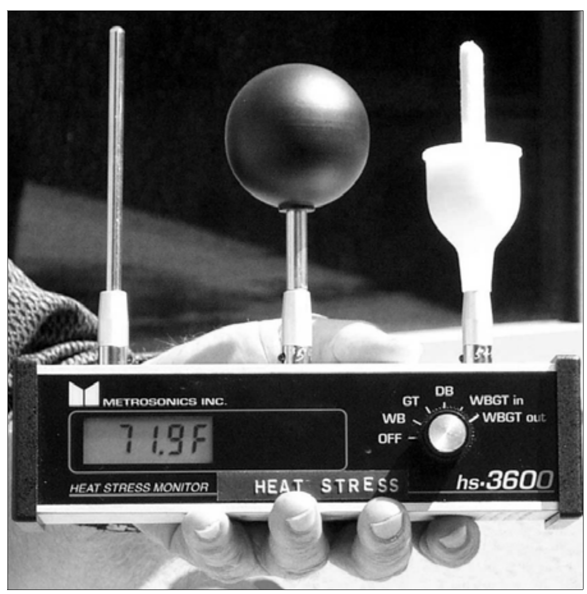
Calibration gas
with valve and hose



Inside a direct reading two-gas sensor monitor shown on page 8-8. #1 = O_2 sensor #2 = Combustible sensor #3 = pump #4 Air intake line #5 Air out line



Multi-tube adapter for colormetric tube pump



Heat stress monitor indicating
a temperature of 71.9°F

CHAPTER 9: EMERGENCY RESPONSE

Site management must provide a detailed SOP for emergency procedures in case of fire, explosion, spills, or other situations that cannot be handled by workers on site. The site safety and health plan required by **OSHA 29CFR1926.65** requires a section on Emergency Response. Knowing what to do during an emergency helps workers protect their safety and health.

Chapter Objectives

After this training you will be able to:

- Discuss OSHA's requirements for a written, site-specific ERP
- Identify the important parts of an ERP

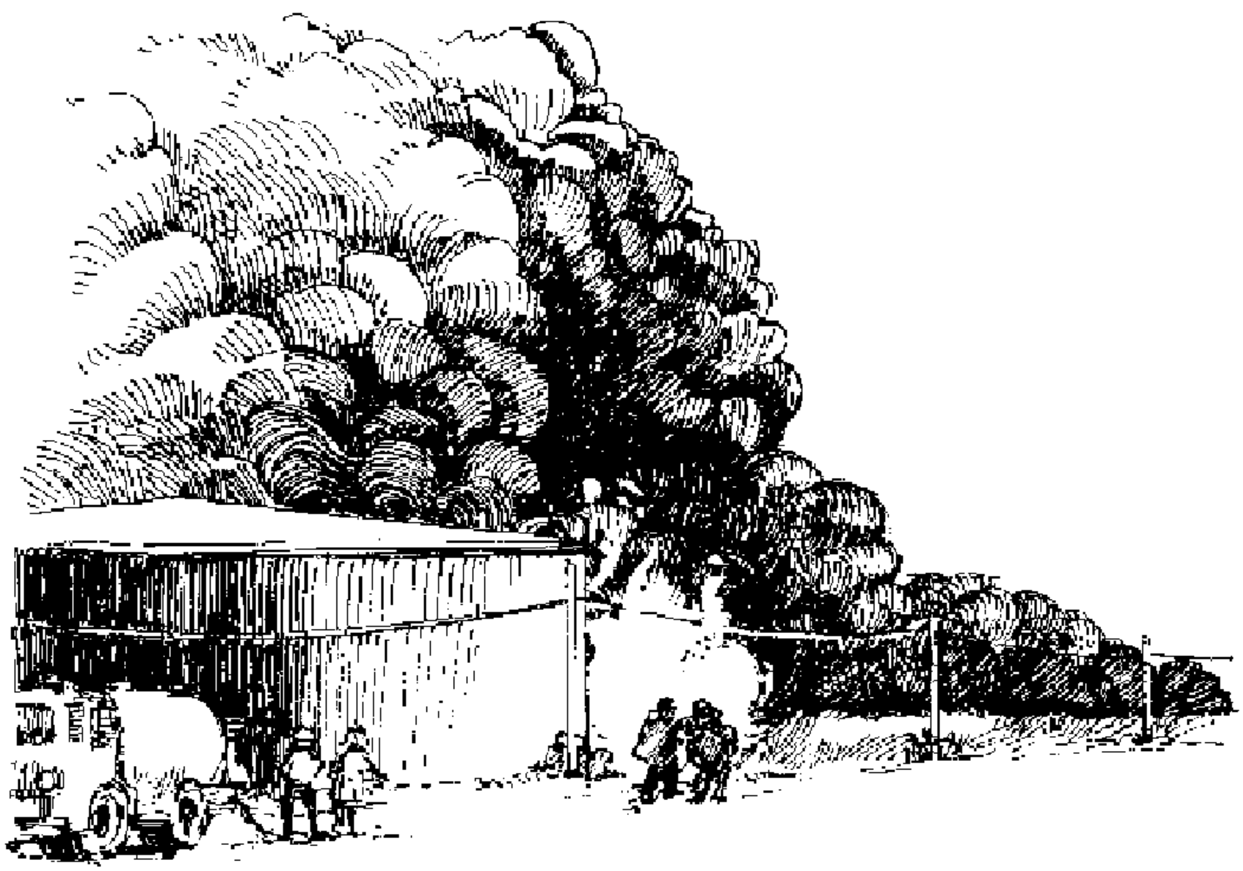
CASE STUDY
Workers were cleaning out an old factory in Brooklyn that used potassium cyanide and many different acids. During cleanup two leaking drums were put next to each other by accident. The chemicals combined to form highly toxic hydrogen cyanide gas. Workers left the building, but it was hard to see because of the gas in the air. Once they got outside there were not enough showers to hose the chemicals off everyone quickly. Finally, the first worker who finished decon called the fire department. What happened?

No one thought ahead about what kinds of emergencies could happen on this job. They did not plan ahead with exit signs, extra showers, and SOPs for notifying the fire department. In this chapter you will learn about planning for emergency response to prevent this kind of problem.

HAZWASTE EMERGENCIES

A hazardous materials emergency is a spill or release that cannot be controlled without outside help. **OSHA defines "outside help" as anyone other than employees working in the immediate area or maintenance personnel.** The most common emergencies at waste sites are spills, fires, and explosions.

Notify your supervisor whenever a spill or release is detected. The supervisor will decide whether outside help is required.



EMERGENCY RESPONSE PLAN (ERP)

Employers **must** develop and put in practice an **emergency response plan (ERP)** in accordance with **OSHA 1926.65(q)(1)** to handle emergencies before work starts at the hazardous waste site. This written emergency response plan is a required part of the safety and health plan. It must be in writing and available for review and copying by employees, their representatives, personnel from OSHA, and other relevant agencies. The ERP must be consistent with the disaster, fire, local, state, and/or federal response plans.

Emergency Response Plans must contain:

- Emergency escape procedures and escape route assignments, Including safe distances and places of refuge
- Coordination and roles including procedures for employees who remain to perform critical operations such as machine shut-down
- Lines of authority and communication
- Site security and control
- Rescue and medical duty assignment for employees
- Decontamination, PPE, and emergency equipment
- Procedures for reporting emergencies to other responders and incidents to governmental agencies
- Follow-up procedures

To be exempt from the requirement for a written emergency response plan employers must:

- evacuate workers when an emergency occurs;
- not permit workers to help handle the emergency; and
- have an emergency action plan in place, consistent with OSHA **1910.38** and **1926.65**.

The ERP must be reviewed periodically. If site conditions have changed or new information is available concerning hazards, the employer must update the ERP.

The overall training program in site operations requires regular ERP drills.

First Aid Caution

It is not possible to include complete first aid training in the basic 40-hour Site Worker or the 24 hour awareness program mandated by 1926.65. However, first aid considerations and emergency medical treatment are required components of the Site Safety Plan. Personnel designated to conduct first aid activities require additional training.

In a medical emergency, get the victim out of the hot zone, decon as completely as you can, wipe off and remove PPE, and tell medical personnel what has happened.

Employee Alerting Systems

In order to alert all employees to an emergency situation, an alarm system must be in place that meets **OSHA 29CFR1910.165.** The alarm system must:

be heard over background noise;

notify all employees of an emergency;

result in work being stopped if necessary;

result in lowering background noise to speed communication; and

signal the start of emergency procedures.

The alarm system must produce a signal (noise, light, etc.) that can be perceived by all affected employees. All alarms must be distinct and recognized as signaling a specific action. The employer shall assure that all components of the alarm system are approved for the work site and operating properly.

During site-specific training, the employer must explain how to report an emergency. Emergency telephone numbers must be posted near the telephone or in obvious locations.

The system must be tested at least every two months. The system must be operational at all times, unless undergoing repairs or maintenance, but a back-up system must be operational. Maintenance work must be done by trained personnel only.

Your Responsibilities in an Emergency

If you observe a life-threatening event:

activate the alarm system;

notify the supervisor/emergency coordinator; and

carry out your designated activities.

Make sure you know where to go and what to do before an emergency occurs.

When it happens, it is too late to read the plan!

INCIDENT COMMAND SYSTEM (ICS)

The **Incident Command System (ICS**) is the chain-of-command system at an emergency. The number of people involved and the roles of each person depend on the types of emergencies that could occur at a site. Planning, training, and practice are required to make sure that each team member knows his or her role. **Site-specific training is required for effective response to an emergency situation.**

The ERP must include --

- chain-of-command
- lines of communication
- responsibilities

Priority of Protection --

- Life
- Environment
- Property

SUMMARY: EMERGENCY RESPONSE

An **emergency** is any sudden or unexpected event requiring outside help. Emergency response workers need more training before they may respond to an emergency incident. **This course does not qualify you as an emergency response worker**.

The **emergency response plan** is a written plan that is put into action before cleanup work begins. The plan must be site specific and it must be available for employees to copy or read.

You will be able to clean up small spills on site without outside help. For **large spills** or medical emergencies, you will need to get out and call for trained help. In a medical emergency, get the victim out of the hot zone, decon as completely as you can, wipe off and remove PPE, and tell medical personnel what has happened.

Work sites must be **equipped to respond** to unplanned emergencies. Telephones, horns, fire extinguishers, spill control equipment, and hand signals are effective when responding to accidents and alerting employees.

Part of planning for emergencies is deciding who is in charge. The **incident command system** is a pre-planned chain of command which specifies lines of authority, communication, and responsibilities.

BACKGROUND READING MATERIAL: EMERGENCY RESPONSE

Hazardous Waste Operations and Emergency Response
(29CFR1926.65) (l) Emergency Response

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities
October 1985. (NIOSH #85-115)

EPA's Standard Operating Safety Guides. July, 1988.
Part 9 Site Safety Plan, p.2-3, 7-8
Annex 7 Emergency Operations Color Codes

NIOSH Pocket Guide to Chemical Hazards.
(2005). DHHS (NIOSH) Publication No. 97-140.

Activity 10
Buried Drum Recovery Exercise

prepared by:

Behavioral Research Aspects of Safety and Health Group
Institute for Mining and Minerals Research
University of Kentucky

Read the background material on the next page. Then study the problem and the site map on the following pages. After you think about the problem, you will answer a series of questions. Each question is followed by four or more choices.

Read the questions <u>one</u> <u>at</u> <u>a</u> <u>time</u>. <u>Don't</u> <u>jump</u> <u>ahead</u>. ; However, <u>you</u> <u>may</u> <u>look</u> <u>back</u> <u>at</u> <u>previous</u> <u>questions</u> and your answers at anytime you wish. (

Now, turn the page and begin the exercise.

Background

You are working at an inactive toxic waste storage dump in a rural region. Earlier work at the site included sampling and labeling of wastes. This survey determined the sole chemical contaminant to be **organochlorides (DDT)**. DDT irritates the skin and eyes and produces toxic fumes. **Level A suits are required in the waste hot zone. Level A suits at this site are not equipped with portable two way radios.** The crew had coffee and donuts at 8:00 a.m. today. **You and one of the Level C crew members at this site have recently completed a basic first aid course**.

Problem

It is 11:30 a.m. and 90º F, with a relative humidity of 86%. You and your partner Moe are in Level A suits with one-hour SCBAs. You are working in a trench dug by an earlier crew. You have been working about 25 minutes overpacking 55-gallon drums of DDT which have been unearthed by an earlier crew. You are tired, hot, and thirsty. Your face-plate is fogged and your visibility is poor .

The six other members of your crew are 25 yards away at the suit-up and decontamination area. A small hill obscures the view between you and the other crew members. (**See Figures l and 2 on the following pages.**) The other members of the crew include: the site supervisor (Larry), a Level A back-up man (Curly),and two Level B and two Level C workers. (**See Figures l and 2 for their locations.**) Your partner Moe, and Larry and Curly, are hung over because they were bar hopping until 2:00 a.m. last night .

As you and Moe work to move a drum, you notice that it is leaking onto your suits and is forming a puddle around your feet. Using hand signals, you let Moe know that you want to push the drum to an upright position to try to slow the leak. You get the drum upright, but your suits are now highly contaminated with organochlorides. You begin to feel dizzy, like you may pass out.

Study the map on the next page and then answer the first question.

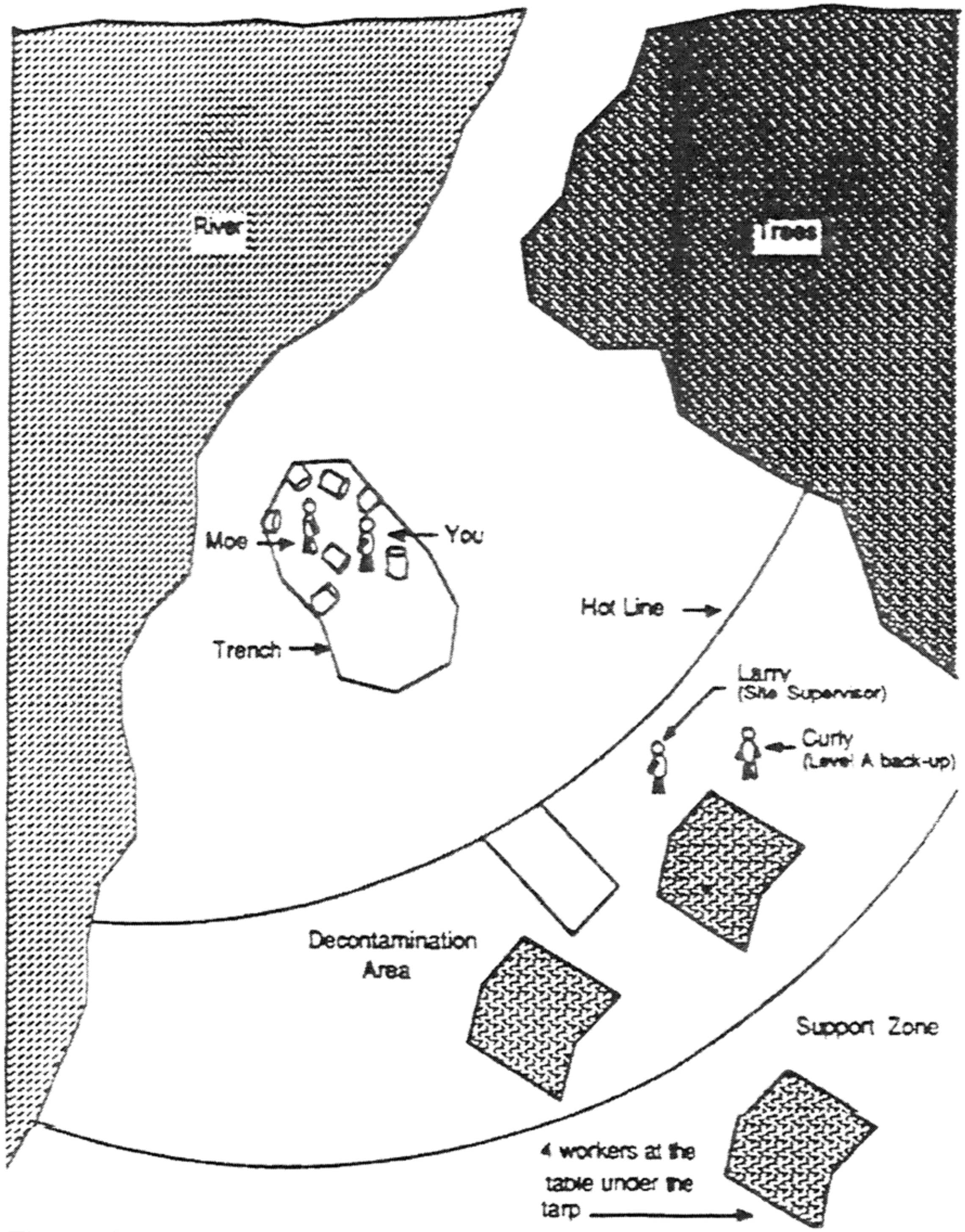

River
Trees
Moe
You
Trench
Hot Line
Larry
(Site Supervisor)
Curly
(Level A back-up)
Decontamination
Area
Support Zone
4 workers at the
table under the
tarp

Figure 1.

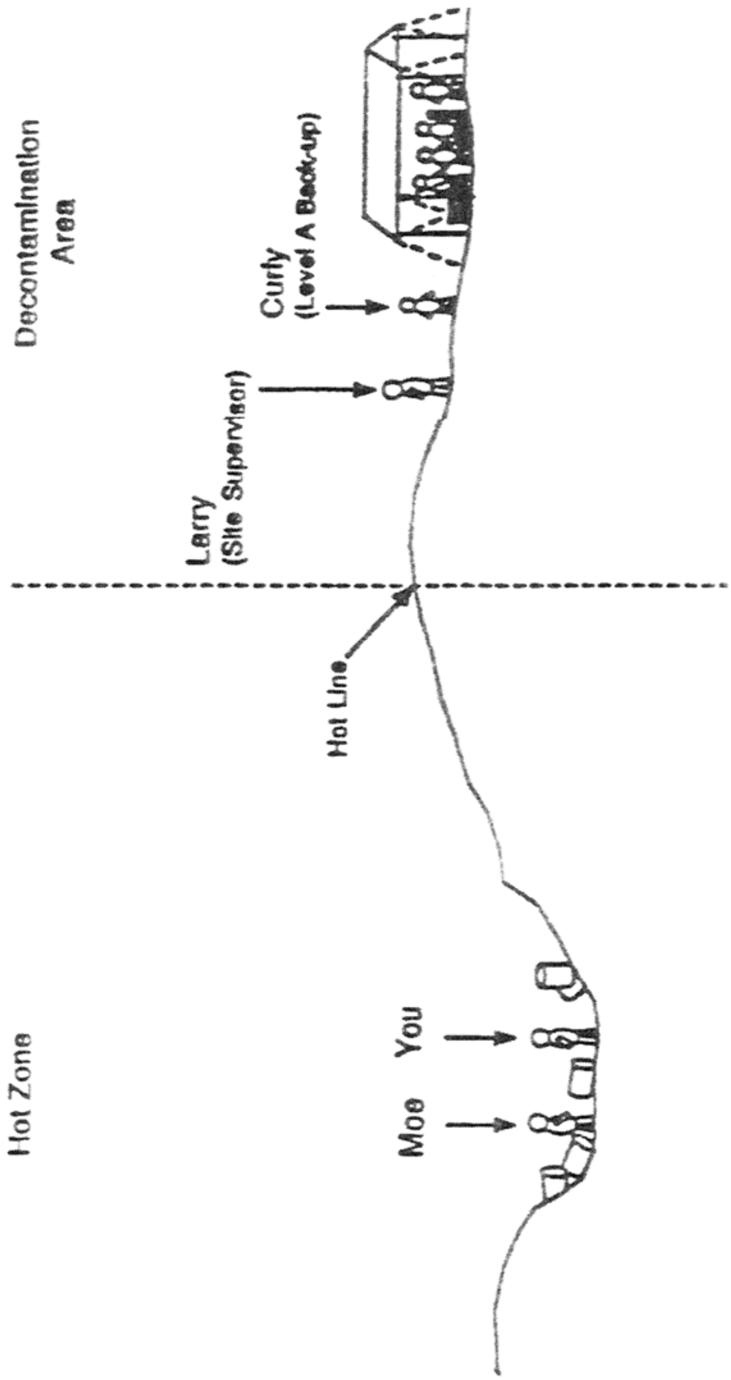

Decontamination Area
Curly (Level A Back-up)
Larry (Site Supervisor)
Hot Line
Hot Zone
Moe
You

Figure 2.

Question A: You and Moe are standing next to a slow leaking drum. You notice that your are breathing faster and that the visibility through your face-plate is getting worse because of the fogging. You are hot, tired, dizzy, and very thirsty. You would like to get out of the pit and out of your suit, but Moe wants to place the drum in an overpack and he needs your help. What should you do? (Choose only one answer.)

☐ 1. Quickly help Moe place the leaking drum into the overpack. Your symptoms will pass.

☐ 2. Signal to Moe to hurry because you feel sick.

☐ 3. Sit down before you fall down.

☐ 4. Immediately leave the pit and head for the decontamination station.

■ 5. Immediately communicate to Moe, by using hand signals, that you need help.

Having two persons working together greatly increases their safety, but to maximize their safety, good communication must be maintained between both workers. It is also important to have communication between the workers and the site coordinator.

Question B: You use hand signals to tell Moe that you need to go to the decontamination station. Moe signals that he wants you to help overpack the drum first. Reluctantly, you help him overpack the drum and then turn to leave the pit . As you leave, you look back and see Moe lying on the ground of the pit. He is not moving. What should you do? (Choose only one answer.)

☐ 6. Look at the gauge inside Moe's suit to see if his air supply is still operating.

☐ 7. Bend down and hold your breath to listen for sounds which can tell you if Moe's air supply is operating.

☐ 8. Signal to the decontamination team that Moe is down.

☐ 9. Shake Moe and see if he responds to you.

☐ 10. Drag Moe out of the pit.

☐ 11. Watch Moe for awhile to see if he recovers.

■ 12. Climb to the top of the trench and signal the back-up man for help.

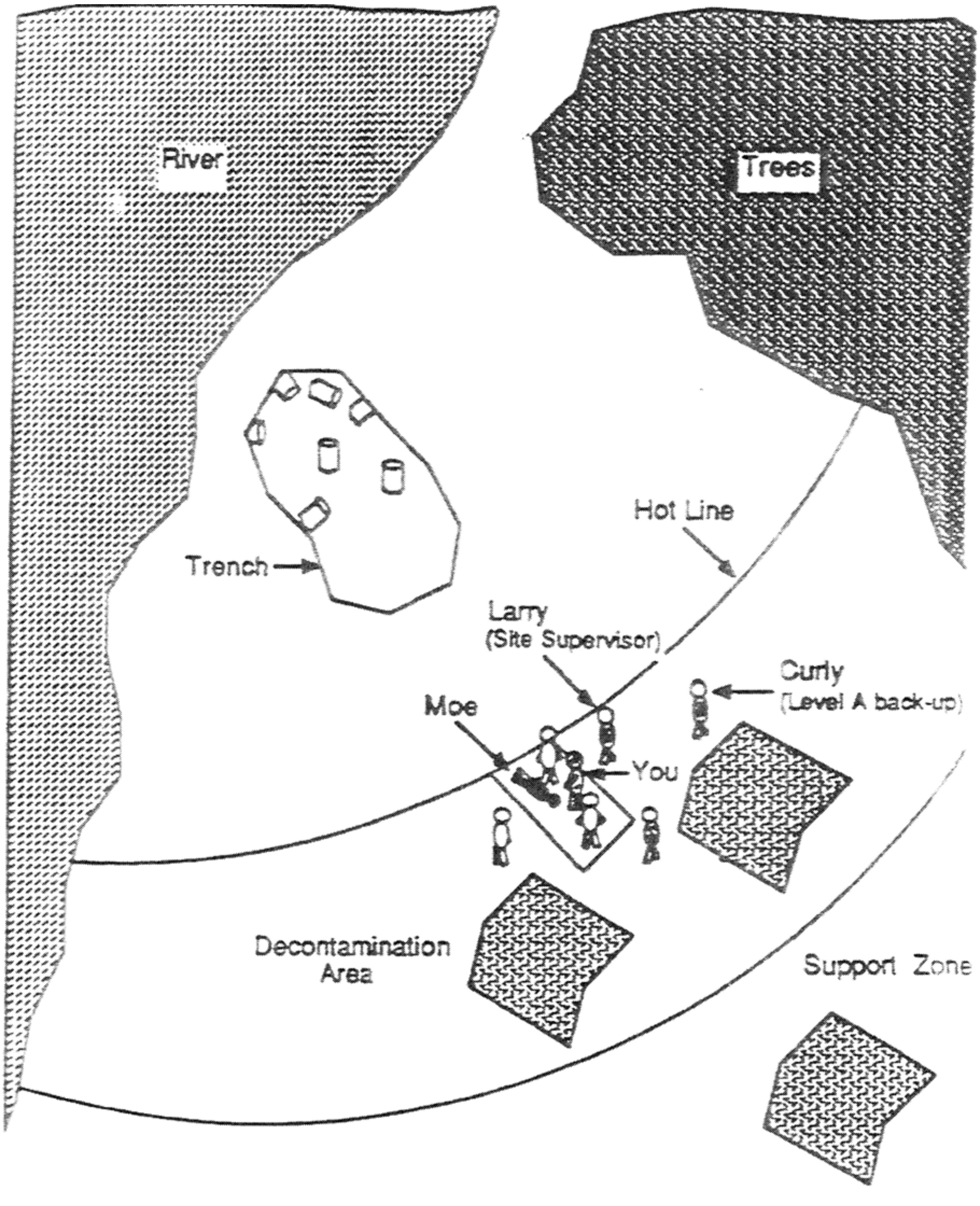

River
Trees
Trench
Hot Line
Larry
(Site Supervisor)
Curly
(Level A back-up)
Moe
You
Decontamination
Area
Support Zone

Figure 3.

Question C: You climb out of the pit and to the top of the hill. You are now in the direct view of your crew. You signal to your crew that you are in trouble. You expect to see the Level A back-up man Curly coming to help you. But he seems to be having trouble with his suit and he doesn't come. You are feeling hot and very weak. What should you do? (Choose only one answer.)

☐ 13. Sit down and wait for help to arrive.

■ 14. Return to the trench and open Moe's suit so you can check his breathing.

☐ 15. Return to the pit and try to drag Moe to the decontamination station.

☐ 16. Go to the decontamination station and get help.

The correct answer may be #14 – go to the pit and open Moe's suit to make sure he has air. However, this decision to return to the pit and risk one's own life to save Moe is a moral predicament. Something in the pit may have breached Moe's suit. Returning to the pit could cost you your life. Yet, if Moe is out of air, he may die in three minutes inside his closed suit. If a rescue is attempted, Moe's suit must be opened to see if he is breathing, and then provide him with air if his tank is empty. His SCBA should not be removed if it is working because this would only serve to contaminate his lungs. Some experts would say the best answer is #16 – to go to the decontamination station and get help, and not return to the pit. Choices #13 and #15 have no merit.

Question D: As, you begin working to open Moe's suit, two Level B crew members arrive. They take over and get Moe's suit open just enough to check him. Moe is unconscious. His air-pressure gauge reads 1200 psi. They can hear Moe's demand regulator working, but his breathing sounds irregular. They leave Moe's SCBA on, zip his suit closed, and drag him back to the decontamination station. When the four of you reach the decontamination station, Moe's suit is quickly rinsed down. Then his suit is opened to expose his head and shoulders and his SCBA is removed. (See figure 3 on the previous page for the locations of Moe, you, and the other crew members.)
A clean Level C worker is ready to give first aid to Moe in the decontamination area. This worker is wearing thin surgical rubber gloves. Now, what should this clean Level C worker do for Moe? (Select as <u>many</u> answers as you think are correct.)

☐ 17. Immediately decontaminate him.

■ 18. Check his breathing.

■ 19. Check his heart rate by taking his neck pulse.

■ 20. Feel his skin.

■ 21. Check his level of consciousness by shaking him and asking him to respond.

■ 22. Look at his skin.

■ 23. Examine his suit for a cut, rip, or other breach that could have contaminated him and caused his symptoms.

The basics of first aid and the ABCs which only take a minute: A (checking and opening the victim's airway so that breathing is not obstructed, B (making sure the victim is breathing, and providing CPR if he or she is not), and C (checking the victim's circulation, making sure there is an adequate pulse). Moe's airway is clear, he is breathing, and his heart is beating. The next step is to look for and control bleeding with direct pressure if there is a problem. (In this case, there isn't any bleeding.) The next step is to carefully examine the victim to find anything else that can give clues to the person's problem, in this case unconsciousness. This includes quickly looking and feeling for injuries to the victim's head, spine, chest, abdomen, arms, and legs. (In Moe's case, there are no apparent injuries.) Checking a victim's level of consciousness (21) can be done at the same time as the other first aid diagnostic procedures are being carried out. Feeling (20) and looking (22) at Moe's skin are important actions that give strong clues that he is seriously overheated and in danger of dying (heat stroke). Your symptoms, the enclosure of the Level A suits, the heavy work which you and Moe were doing, and the weather conditions all suggest that heat stroke is Moe's major problem. It is also important that Moe's suit be checked for rips or cuts (23). Moe's symptoms could be caused by material in the pit that has contaminated him. If his Level A suit is intact, this situation is unlikely

and can probably be ruled out. Since adequate first aid cannot be completed while wearing heavy gloves like those needed to protect from chemical contamination, the Level C first aider is wearing only thin surgical gloves. Therefore, he should delegate the task of inspecting Moe's suit for cuts or rips to another person who is wearing proper PPE and who can safely handle the suit which may not be fully decontaminated.

Question E: A crew member has quickly decontaminated you and helped you out of your Level A suit. With your suit off, you begin to cool off and fell better. You find out that Curly's Level A suit failed (the zipper stuck), and that is why he could not come help when you signaled for him.
The decon crew has also quickly decontaminated Moe and removed his Level A suit. Moe's body has now become stiff and is shaking all over. You still don't know what is wrong with him. What should you and the others do to help Moe? (Choose only one answer.)

☐ 24. Immediately begin CPR on Moe.

☐ 25. Continue to try to arouse Moe by shaking and yelling at him.

☐ 26. Go to the decontamination station, get the first aid kit, and return to treat Moe.

☐ 27. Prop Moe up and give him some cool water to drink.

■ 28. Check to see if someone has called for an ambulance.

☐ 29. Treat Moe for shock by wrapping him in a blanket or jacket.

Checking to see if someone had called for an ambulance and alerted the emergency medical system. This action should have been done much earlier at the first sign of a serious problem. A common mistake at accident sites is the failure to immediate call for help. Time wasted by not calling for help can result in death. All other responses are wrong. Choices 24, 27, and 29 might even kill Moe. Choice #26 is out of the question.

Question F: Curly has gone to call for an ambulance. You and the Level C first aider must now determine what is wrong with Moe and what emergency treatment to begin. Moe is still barely conscious, his breathing is deep and fast, and his pulse is very rapid. Before you started to decontaminate him, his skin was hot and dry and he appeared not to be sweating. What should you suspect is wrong with Moe and what should you do to help him? (Choose only one answer.)

☐ 30. Moe's oxygen supply was cut off or the air inside his SCBA was contaminated. Give him plenty of fresh air by moving the crew members away from him.

☐ 31. Back in the pit Moe may have slipped and hit his head on one of the exposed drums. Don't handle him because he may have a head or neck injury.

☐ 32. Moe may be having an allergic reaction to something. There is not much that can be done for him until he gets to the hospital.

☐ 33. Moe's suit failed. His symptoms are due to his exposure to the organochlorides. Continue decontaminating him and wait for help.

☐ 34. Moe is suffering from heat exhaustion. He should recover in a few minutes.

■ 35. Moe is suffering from heat stroke. You must get him into the shade, remove his clothes, and cool him down.

None of the other choices work because they have been eliminated earlier. Do not confuse heat exhaustion from choice #34 with heat stroke in the answer, #35. The dry skin diagnosis may be difficult to make if there is a great deal of moisture in Moe's Level A suit, giving the appearance that he is still sweating. Sometimes heat exhaustion precedes heat stroke. Heat stroke is a medical emergency, not a first aid case.

Question G: The ambulance has been called and will be arriving in about 10 minutes. You think that Moe is suffering from heat stroke. You have removed his clothes, placed him in the shade under the tarp in the decon zone, and covered him with clean, wet towels. Curly is fanning him with another towel and your first aid helper is sponging cool water on Moe's head. Every few minutes Moe continues to convulse for 20 seconds or so. His skin is still very hot and red. What should you do now before the ambulance and EMTs arrive? (Select as <u>many</u> answers as you think are correct.)

■ 36. Continue to monitor Moe's vital signs.

■ 37. Keep talking to Moe calmly and reassure him.

■ 38. Make sure the crew fully decontaminates the two Level B men who dragged Moe out of the pit.

■ 39. Do another check on Moe to make sure you have not missed any other injuries.

☐ 40. Keep trying to arouse Moe by vigorously shaking him.

Unconscious victims should be continually monitored (36) to make sure their airway remains open, that they are breathing, and that the have a pulse. These are the ABC vital signs of first aid. First aiders should always talk calmly and reassure victims (37). Apparently unconscious victims can often hear what is being said to them or around them, and what they hear can influence how well they respond to their crisis. The EMTs are not equipped to decontaminate Moe or other workers. When they arrive, they must promptly examine Moe and others for injury. Decontaminating Moe, you, and the other workers (38) who were in the pit and exposed to the toxic material before the EMTs arrive will save time and help everyone. While waiting for the EMTs and caring for Moe, it takes little effort and is a good idea to check him for other injuries (39).

Question H: When the EMTs arrive, Moe's condition is unchanged. You, Moe, and the two Level B workers who rescued Moe all have been properly decontaminated. When the EMTs arrive, they need to obtain information from you so they can assist Moe and the other team members properly. What information should they ask you, or should you be sure to tell them? (Select as many answers as you think are correct.)

■ 41. Moe's vital signs: breathing, pulse, skin color, and the fact that he was hot and red and not sweating.

■ 42. A description of what Moe was doing and wearing when he passed out.

■ 43. The amount of time Moe has been unconscious.

■ 44. The fact that Moe's suit was heavily contaminated with organochlorides, that his suit was opened in the pit, and that he may have had skin exposure.

■ 45. A description of the symptoms you experienced when you were in the pit with Moe, e.g. being hot, dizzy, rapid breathing, and feeling like you might pass out.

■ 46. What you believe Moe's problem is and why you think so.

■ 47. How you and the other Level B back-up persons who were in the pit are feeling now.

☐ 48. Moe's religious preference in case he needs the last rites.

■ 49. Anything you know about Moe's medical history, such as allergies or any medications he might be taking.

The EMTs need to know what happened. It is up to you to give them all the important facts you can. If they don't ask for this information, you should volunteer it. Your symptoms (45), the lack of symptoms for the Level B persons who rescued Moe, and how you and the rescuers are feeling now is important information. The fact that you now feel okay and that the Level B team had no symptoms further suggest's Moe's problem is heat stroke, not chemical poisoning. Choice #48 is not essential for treatment.

Question I: The EMTs think your diagnosis of heat stroke is correct. They decide to transport Moe to the hospital immediately. You wisely request treatment and also are taken to the local hospital emergency room. As you ride in the air-conditioned ambulance and drink some cool water you feel much better. An EMT compliments you on your rescue and treatment of Moe, but he also says that this accident could have been prevented or at least lessened in severity.
In what ways might this accident have been prevented? (Select as many answers as you think are correct.)

■ 50. You and Moe could have paid closer attention to the early warning signals of heat exhaustion and quit working before the accident.

■ 51. You, Moe, and the others should have drunk a lot of fluids, and stayed away from the coffee.

■ 52. You should have maintained closer communication with Moe, regularly checking on each other, and each asking how your partner was doing.

■ 53. You should have demanded an electronic two-way communication system in your Level A suits.

■ 54. Larry and Moe should have skipped the drinking last night and got a good night's sleep before tackling a difficult job the next day.

■ 55. Larry (the site supervisor) should have had a man stationed on top of the hill overlooking the trench you and Moe were working in.

■ 56. Curly's suit should have been checked and tested before you and Moe went into the trench.

☐ 57. You should have been using one-half hour SCBAs. This would have reduced the amount of working time in the Level A suits.

■ 58. This type of work should have been done earlier in the day when it was cool.

■ 59 . You should have refused to work in the pit unless someone was stationed on top to the hill to watch you and Moe.

If all of these standard safe work practices had been followed, the accident could have been prevented. Notice that some of these safe work practices depended on the site supervisor and those who designed the site safety plan (55 & 58). Others depended upon the workers knowing how to take care of themselves (e.g. not to drink alcohol and become dehydrated before doing hot and heavy work – 54), knowing that caffeine-containing drinks also contribute to dehydration and risk of

heat stroke (51), paying attention to and reporting the early signs of heat stress (50), and knowing their right to demand safe working conditions at the site (32 & 59). Other factors under the control of those who planned and managed the work at this site also contributed to this accident. These include poor site management, lack of equipment checkout and insufficient communication among all members of the crew, working at the wrong time of the day, and failure of the site supervisor and backup team to maintain direct line-of-sight with the workers in the pit. Can you think of others?

NOTES & SCRIBBLES

Glossary

ABBREVIATIONS and ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ACM	Asbestos Containing Material
ANSI	American National Standards Institute
APR	Air-Purifying Respirator
atm	Atmosphere, a measure of pressure.
BP	Boiling Point
°C	Celsius, Centigrade; International temperature scale in which boiling is 100 °C and freezing is 0 °C.
CAS	Chemical Abstracts Service
cfm	Cubic Feet per Minute
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
C	Ceiling Limit
cm	Centimeter (measure of length, 1 cm = 0.394 in)
cm^2	Square Centimeter
cm^3 or cc	Cubic Centimeter
CNS	Central Nervous System
CPC	Chemical-Protective Clothing
CPR	Cardiopulmonary Resuscitation
CRC	Contamination Reduction Corridor
CRZ	Contamination Reduction Zone
dB	Decibels (measure of sound intensity)

DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EL	Excursion Limit
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
f	Fiber
FID	Flame Ionization Detector
Fl. P. or FP	Flash Point
FRZ	Freezing Point for liquids and gases
g	Gram
GFI or GFCI	Ground Fault (Circuit) Interrupter
HEPA	High Efficiency Particulate Air
IARC	International Agency for Research on Cancer
IDLH	Immediately Dangerous to Life or Health
IP	Ionization Potential
l	Liter
LEL	Lower Explosive Limit
LFL	Lower Flammable Limit
m	Meter
m^2	Square Meter
m^3	Cubic Meter
mg	Milligram

mil	a measure of thickness
ml	Milliliter
mm	Millimeter
mmHg	Millimeters of mercury
MP or MLT	Melting Point
MSDS	Material Safety Data Sheet
MW	Molecular Weight
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priority List
ORM	Other Regulated Material
OSHA	Occupational Safety and Health Administration
PAPR	Powered Air-Purifying Respirator
PCB	Polychlorinated Biphenyl
PEL	Permissible Exposure Limit (OSHA)
PF	Protection Factor
PID	Photoionization Detector (monitor)
PPE	Personal Protective Equipment
ppm	Parts Per Million
PRCS	Permit-Required Confined Space
psi	Pounds Per Square Inch
REL	Recommended Exposure Limit (NIOSH)
SAR	Supplied-air Respirator (Type C System)

SCBA	Self-Contained Breathing Apparatus
SG	Specific Gravity
SOL	Solubility in Water
SOP	Standard Operating Procedure
Sp. Gr. or SG	Specific Gravity
STEL	Short-Term Exposure Limit
TLV	Threshold Limit Value
TLV-C	Threshold Limit Value—Ceiling
TLV-STEL	Threshold Limit Value—Short-Term Exposure Limit
TSDF	Treatment, Storage, and Disposal Facility
TWA	Time-Weighted Average
UEL	Upper Explosive Limit
UFL	Upper Flammable Limit
µg	Microgram (millionth of a gram)
µm	Micron or Micrometer (1/1000 mm or 0.001 mm)
USCG	U.S. Coast Guard
VOC	Volatile Organic Compound
VD	Vapor Density (air = 1)
VP	Vapor Pressure (air = 760 mmHg)

GLOSSARY

A

Absorption—a route of entry into the body by which chemicals are absorbed through the skin.

Acid—a chemical with a pH between 1 and 6.9 with the strongest acids having the lowest pH. Acids are sour, turn litmus red and can cause skin or tissue damage (pH goes from 1-14).

Acute effect—an adverse health effect which develops rapidly. Common acute effects include dizziness, headache, difficulty breathing, eye and throat irritation.

Additive effect—one in which the combined effect of two chemicals is equal to the sum of the agents acting alone.

Administrative controls—work and personnel practices that reduce exposure to chemical and physical hazards.

Adsorbent—a substance that holds other substances. Adsorbents such as activated carbon are used to remove odors and vapors.

Air-purifying respirator—protective mask with absorbent filters that remove toxic materials form the air.

Alkali—a base: any chemical with a pH above 7 and up to 14. Alkalis are bitter and turn litmus paper blue.

Alpha particle—positively charged radioactive particle capable of traveling only a few inches in air. Although it cannot penetrate the skin it does a lot of damage if it gets into the body.

Alveoli—the small air spaces deep in the lung where oxygen goes into the blood.

American Conference of Governmental Industrial Hygienists (ACGIH)—A private organization that develops and publishes recommended occupational exposure limits (see TLV).

Anhydrous—inorganic compound that does not contain water.

Asphyxiant—a vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Asphyxiation is a major hazard of confined spaces.

B

Base—see alkali

Beta particle—a radiation particle which can cause skin burns and harm if inside the body. Beta particles can be stopped by a thin sheet of metal.

Boiling point—temperature at which a liquid changes to a vapor.

Buddy system—a safety measure where workers, especially those exposed to hazards work in pairs.

C

Carcinogen—a substance which can cause cancer.

CAS Number—a unique number assigned to a chemical by the Chemical Abstract Service.

Catalyst—a substance that speeds up a chemical reaction.

cm^3 (cc)—cubic centimeter, a metric measurement (cm x cm x cm) about the size of a sugar cube.

Ceiling (C)—the maximum allowable exposure limit for an airborne substance, not to be exceeded during the shift.

Central Nervous System (CNS)—The brain and the spinal cord.

Chemical cartridge—a filtering device which is attached to an air-purifying respirator.

Chemical-resistant material—prevents chemicals from penetrating through your clothes to your skin.

Chronic effect—an adverse health effect which develops slowly over a long period of time.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)—The "Superfund" law administered by the EPA, regulates clean-up of hazardous waste.

Concentration—the amount of one material in another, i.e. the amount of a chemical vapor in air.

Confined space—space with limited access, poor natural ventilation and not intended for continuous human occupancy.

Corrosive—a liquid or solid that eats away another material or skin. Both acids and bases (alkalis) are corrosive.

D

Decibels—a unit of measurement of noise levels.

Decomposition—the breakdown of a material by heat, chemical reaction, decay, or other processes.

Decontamination—the chemical or physical process of reducing and preventing the spread of contamination from persons and equipment.

Decontamination line—a line set up with stations for decontamination procedures between the Hot Zone and the Cold Zone.

Degradation—process which diminishes or destroys protective properties of chemical protective clothing.

Department of Transportation (DOT)—Government agency that regulates shipments and transfer of hazardous materials.

Dermatitis—redness or irritation of the skin often caused by chemical exposures.

Dilution—method of reducing the concentration of a contaminant, generally in air or water by adding more air or water.

Dose—the quantity of a chemical taken into the body.

Dose response—the relationship between the amount of the chemical and the severity of response in humans or animals.

E

Emergency response plan—A written plan detailing actions and personnel responsibilities during chemical emergencies.

Engineering control—substitution, isolation, and ventilation methods used to reduce the level of the contaminant at the source.

Environmental Protection Agency (EPA)—federal agency concerned with the quality of the air, water, and land.

Evaporation rate—how fast a liquid becomes a vapor

Exclusion zone —The Hot Zone or contaminated area.

Exposure—the concentration of a material in the air to which a worker can come into contact. Usually, exposure is measured within the worker's breathing zone.

F

Flammable—The ability of a material to ignite and burn. According to OSHA, flammable liquids have flashpoints below 140^{o} F.

Flash Point—the temperature at which a liquid will give off enough vapors that they will burn if ignited.

G

Gram (g)—a metric unit of weight. 454g = 1 pound.

H

Hazardous material—A chemical which is either flammable, corrosive, reactive or toxic.

Hazardous Waste Operations and Emergency Response (HAZWOPER)—OSHA standard which was developed to protect hazardous waste personnel and emergency responders.

Hazards—the properties of a material that may cause injury, or death by contact, inhalation, or ingestion.

HAZCOM—OSHA Hazard Communication Standard (1910.1200).

Heat exhaustion—prolonged exposure to intense heat exceeds the body's ability to cool down, causing excessive sweating and sodium deficiency.

Heat stroke—a life-threatening condition requiring medical attention in which the body is unable to sweat; skin is hot and dry.

Heavy metals—the major toxic metals, for example; mercury and arsenic.

Hematotoxin—toxic to the blood or organs where blood is made. "Hem-" or "Hema-" or "Hemo-" has to do with blood, as on "**hemo**lysis," which means bursting blood cells.

Hepatotoxin—toxic to the liver. "Hep-" or "Hepat-" has to do with the liver, as in "**hepat**itis," which means swelling of the liver, usually caused by a germ (virus or bacteria), but can also caused by some chemicals.

I

Immediately Dangerous to Life or Health (IDLH)—According to the OSHA respiratory Protection Standard, "an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere."

Incident Command System (ICS)—an organized system of personnel and delegation of responsibilities which controls the response to an emergency.

Incident commander—person in charge of on-site management of all activities at a hazardous materials emergency.

Incompatible chemicals—chemicals which produce a negative reaction when mixed.

Ingestion—taking a substance in through the mouth.

Inhalation—Breathing in substances (usually as gas, vapor, fume, mist, or dust). The most common route of entry for workplace chemical exposures.

Irritant—a substance which causes an inflammatory response when brought into contact with the eyes, skin, or respiratory system.

Isolation—method of decontamination in which contaminated equipment and materials are bagged or covered and set aside, usually for subsequent shipment to an approved landfill for disposal.

L

Latency—the time interval between exposure to a substance and the development of a disease.

Lock-out—a procedure to prevent energy from reaching equipment being serviced or repaired. Energy source is locked out and the equipment tagged off.

Lower explosive limit—the lowest concentration (percentage of the substance in air) that will burn when an ignition source is present.

M

M—meter; a metric unit of length equal to about 39 inches

M^3—cubic meter-a measure of volume, close to a yard X a yard X a yard.

Manifest form—required by EPA to track hazardous wastes.

Material Safety Data Sheet (MSDS)—chemical information sheet required by OSHA's Hazard Communication Standard. Lists health effects, chemical properties, emergency response actions, reactivity data, control measures, safe handling procedures, etc.

Melting point—the temperature at which a solid substance changes to a liquid state.

Metabolism—the chemical reactions that go on in the body to maintain life.

Milligrams per cubic meter (mg/$m^{3)}$—unit of measurement which is a weight per unit volume of air.

Monitoring—measuring concentrations of substances in the workplace.

Mutagen—a substance which can change the genetic material (DNA) in a living cell.

N

National Fire Protection Association (NFPA)—produces fire standards, and the four-color diamond used on labels to indicate hazard.

National Institute for Environmental Health Sciences (NIEHS)—a federal agency responsible for issues related to the environment.

National Institute for Occupational Safety and Health (NIOSH)—The federal occupational health and safety research agency.

Neurotoxin—a substance which is toxic to the brain and nerves.

Neutralization—method of decontamination in which a chemical is mixed with another chemical to lessen the hazards.

Nuclear Regulatory Commission—a federal agency responsible for community and worker protection from radiation hazards.

O

Occupational Safety and Health Administration (OSHA)—a federal unit responsible for creating and enforcing occupational safety and health regulations.

Oxidation—a reaction in which a substance combines with oxygen, rusting is an example of oxidation.

Oxidizer—a substance that gives up oxygen readily.

Oxygen-deficient—air which contains less than 19.5% oxygen.

Oxygen-enriched—air containing more than 23.5% oxygen.

P

Parts per million (ppm)—a volume measure of chemical concentration. For example one part of chemical in a million parts of air.

Penetration—the flow of a chemical through zippers, stitched seams, pores, or imperfections in the material.

Permeation—process by which a chemical dissolves in or moves through a protective clothing material on a molecular level.

Permissible Exposure Limit (**PEL)**— set and enforced by OSHA is the highest concentration of a substance to which a person can be legally exposed during a typical weekday.

pH—measures acidity/alkalinity of substances and ranges from 1 to 14. Strong bases are closer to 14, strong acids closer to 1 water, pH 7, is neutral.

Physical agent—light, heat, cold, noise, radiation, vibration, etc. which affect health and safety.

Pulmonary toxin—a substance which is toxic to the lungs.

Q

Qualitative fit-test—measures effectiveness of a respirator by exposing wearer to a test atmosphere containing an irritating or smelly substance. Wearer should not be able to detect the substance.

Quantitative fit test—measures effectiveness of a respirator in preventing substance from entering the facepiece while wearer is in a test chamber. Concentration of substance is measured inside the facepiece of the respirator.

R

Rad—A measure of radiation energy absorbed by the body.

Reactivity—tendency of a substance to undergo chemical reaction with the release of energy.

REM—Roentgen Equivalent Man, a measure of radiation dose.

Renal—pertaining to the kidney.

Residual volume (RV)—the amount of air remaining in the lung after breathing out.

Risk—the chance of injury or loss.

Route of Entry—how material gets into the body: inhaled, ingested, through skin or eye contact absorption.

S

Self-Contained Breathing Apparatus (SCBA)—a supplied-air respirator with an air tank carried on wearer's back.

Sensitizer—a substance which on first exposure causes little or no reaction but which on repeated exposure may cause a marked serious allergic response.

Short-Term Exposure Limit (STEL)—the maximum concentration of a chemical a worker can be exposed to during a 15-minute period, set by OSHA.

Solubility (in water)—a measure of how much of a material will dissolve in water.

Stability—ability of a material to remain unchanged. A material is considered stable if it remains in the same form under expected and reasonable conditions of storage or use.

Standard Operating Procedures (SOP)—written descriptions of tasks and activities to be followed during work.

Support zone (cold zone)—area where administrative and support functions not requiring respiratory protective equipment are performed.

Synergistic Effect—a combined effect of two or more substances which is greater than the sum of the effect of each.

Systemic—relating to the whole body

T

Teratogen—a substance which can cause birth defects in a developing fetus.

Threshold—the lowest dose or exposure to a chemical at which a specific effect is observed.

Threshold Limit Value (TLV)—A concentration limit similar to the OSHA PEL TLVs are set by ACGIH and not legally enforceable.

Time-Weighted Average (TWA)—measurement to determine the worker's average exposure to a substance over a typical 8-hour work shift. OSHA PELs are time weighted averages.

Toxicity—Ability of a chemical to cause health damage.

U

United Nations Identification Number (UN Number)—A number used internationally to identify a hazardous material.

United States Coast Guard (USCG)—concerned with the transportation of hazardous materials on navigable waterways.

Upper Explosive Limit or Upper Flammable Limit (UEL/UFL)—The highest concentration (percentage of the substance in air) that will burn when an ignition source is present. At higher concentration, the mixture is too "rich" to burn. Also see "LEL."

V

Vapor—gaseous form of a substance normally in the liquid or solid state at room temperature.

Vapor density—the weight of a vapor or gas compared to air. Materials lighter than air have vapor densities less than 1.0. Materials heavier than air have vapor densities greater than 1.0. Also called Relative Gas Density or RGasD.

Vapor pressure—indicates the tendency of a liquid to evaporate into the air. Normal air has a vapor pressure of 760 mmHg at sea level (less at higher elevations).

Ventilation—Fans: a form of engineering control that removes (or dilutes) airborne contaminants.

Viscosity—resistance to flow.

OSHA REGIONAL OFFICES

NOTE: In case of a workplace fatality/explosion/emergency call OSHA at 1-800-321-6742

Region 1: CT, ME, MA, NH, RI, VT
U.S. Department of Labor—OSHA
JFK Federal Bldg. Rm. E340
Boston, MA 02203
Phone: (617) 565–9860
Fax: (617) 565–9827

Region 2: NJ, NY, PR
U.S. Department of Labor—OSHA
201 Varick St., Rm. 670
New York, NY 10014
Phone: (212) 337–2378
Fax: (212) 337–2371

Region 3: DE, DC, MD, PA, VA, WV
U.S. Department of Labor—OSHA
The Curtis Center
170 S. Independence Mall West
Suite 740 West
Philadelphia, PA 19106-3309
Phone: (215) 861-4900
Fax: (215) 861-4904

Region 4: AL, FL, GA, KY, MI, NC, SC, TN
U.S. Department of Labor—OSHA
61 Forsyth St., SW
Atlanta, GA 30303
Phone: (404) 562–2300
Fax: (404) 562–2295

Region 5: IN, IL, MI, MN, OH, WI
U.S. Department of Labor—OSHA
230 S. Dearborn St., Rm. 3244
Chicago, IL 60604
Phone: (312) 353–2220
Fax: (312) 353–7774

Region 6: AR, LA, NM, OK, TX
U.S. Department of Labor—OSHA
525 Griffin St., Rm. 602
Dallas, TX 75202
Phone: (214) 767–4731
Fax: (214) 767–4137

Region 7: IA, KS, MO, NE
U.S. Department of Labor—OSHA
City Center Square
1100 Main St., Ste. 800
Kansas City, MO 64105
Phone: (816) 426–5861
Fax: (816) 426–2750

Region 8: CO, MT, ND, SD, UT, WY
U.S. Department of Labor—OSHA
1999 Broadway, Ste. 1690
Denver, CO 80202-5716
Phone: (303) 844–1600
Fax: (303) 844–1616

Region 9: AZ, CA, HI, NV, American Samoa, Guam, Trust Territory of Pacific Islands
U.S. Department of Labor—OSHA
71 Stevenson St., Rm. 420
San Francisco, CA 94105
Phone: (415) 975-4310
Fax: (415) 975-4319

Region 10: AK, ID, OR, WA
U.S. Department of Labor—OSHA
1111 Third Ave., Ste. 715
Seattle, WA 98101–3212
Phone: (206) 553–5930
Fax: (206) 553–6499

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