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INDUSTRIAL SPILL RESPONSE

INSTRUCTIONAL GOAL

Upon completion of this topic, the student will understand the procedures used in response to releases and spills of hazardous materials in an industrial setting.

ENABLING OBJECTIVES

Based on the information presented in the classroom and in the student guide, the student will be able to:

1. List the factors that affect the behavior of a released hazardous material.
2. Describe the dangers of working with pressurized drums.
3. Describe the purpose and procedures for using an overpack drum.
4. List common absorbents available and their advantages and disadvantages.
5. Describe methods used to reduce the amount of toxic and flammable vapors at a spill.
6. Outline general safety procedures to use around chlorine and chlorine leaks.
7. List and discuss the hazards of several common corrosives common in industry.

OVERVIEW

Spill containment and remediation activities shall be directed in such a way that the protection of human life, health, and safety is paramount. The other priorities to be considered are the prevention of environmental harm and the protection of property. Some of the general guidelines in handling an emergency response includes: use of the Incident Command System, using proper PPE, incorporation of the buddy system, designation of a Safety Officer, following the ten steps to a safe response, and use of appropriate decontamination procedures.

INTRODUCTION

Because of the potential risks of fire, explosion, chemical reactions, and release of gases and vapors, it is imperative that proper methods and procedures are used to handle spills from containers of hazardous materials. This section includes conditions to be alert for and to be considered in approaching and handling containers, as well as information on containing and controlling spills of hazardous materials.

Spill containment and remediation activities shall, by necessity, be determined and directed by the Incident Commander at the scene of the incident. The coordinator will base activities on the circumstances current to the incident. However, these activities will be directed according to the following priorities:

1. The protection of human life, health and safety.
2. The mitigation of environmental harm.
3. The protection of property.

LEVELS OF RESPONSE

A response to a hazardous materials spill should be limited when possible to defensive actions. Defensive actions are actions that do not bring the responder or the responder's PPE into direct contact with the released material.

RESPONSE GUIDANCE

Teams should observe the following general guidelines when handling an emergency response to a spill of a hazardous substance:

- Use the Incident Command system (ICS).
- Identify, to the extent possible, all hazards.
- Get help from specialist employees who can give technical advice or assistance.
- Use proper personal protective equipment.
- If possible, do not come in direct contact with the hazardous substance.
- Use SCBA unless air monitoring shows a decreased level of protection is acceptable.
- Work in teams of two or more: the buddy system.
- Have backup personnel with equipment on standby.
- Designate a safety official.
- Maintain communications with other members of the team through eye contact, hand signals, or voice.
- Maintain contact with the Incident Commander or Site Safety Officer.
- Use appropriate decontamination procedures.

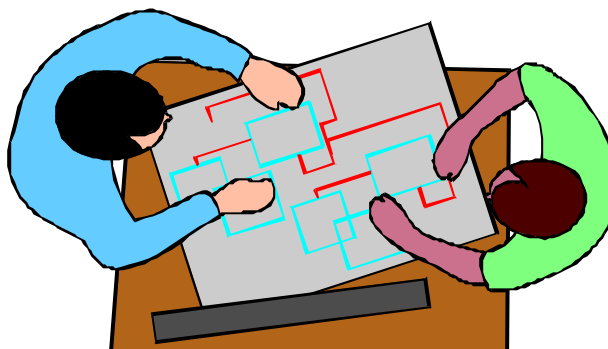
There are four factors that affect the behavior of the released hazardous material:

1. The **quantity** of the hazardous material.
2. **Inherent properties** of the material and of the container.
3. **Natural laws** of physics and chemistry.
4. The **environment**, including the physical surroundings and the conditions (ventilation, sources of ignition, etc.).

Consider each of these factors as the hazards are identified and as a plan of action is prepared in response to spills.

PREPARE A PLAN OF ACTION

In preparing a plan of action, the consequences of additional spills, leakage and other incidents that can aggravate the situation need to be considered. If a drum has failed, it is likely that other drums and containers in the area may have failed or are about to fail. Each step in the response needs to be planned carefully. Accidents are most likely to occur when drums and containers are being handled for the first time in an emergency.



From data obtained during an initial inspection determine:

- The immediate hazards and the response required based on the inherent properties of the spilled material and of the container.
- The potential for additional hazards and the response required.
- The number and size of drums, tanks or containers that have leaked or are broken (total quantity of material released).
- The number of drums or containers that need to be moved to complete the cleanup.
- The environment that the drums, tanks or containers are in, including the physical surroundings and the conditions (ventilation, sources of ignition, etc.).

Develop a plan based on the results of the above to:

- Procedures based on hazards likely to be encountered.
- Equipment and supplies required.
- Number of drums or containers to be moved.
- Methods for moving drums or containers.
- Number of responders required.
- Number and type of support personnel required.
- Levels of protection required by responders and support personnel.
- Rescue plan in event of failure.

HANDLING OF DRUMS OR CONTAINERS

In responding to an emergency, move drums or containers for only these reasons:

- To gain access to other drums or containers that are leaking or failing.
- To prevent injury to responders and support personnel because of the way the drums or containers are stored or located.
- To prevent reaction with spilled or leaking materials.

Before handling drums or containers, consider the consequences of additional spills, leakage or an accident occurring. Salvage or overpack drums and absorbent material should be available and if additional spillage is likely, a dike should be built around the drum or container to contain the liquid.

Carefully plan and consider all information available before moving drums or containers. Consider proper lifting and moving techniques. Moving drums or containers manually in emergency situations is unfortunately a common practice. It puts the worker in close contact with heavy drums or containers that are often contaminated with spilled or leaking chemicals.



Extra precautionary measures need to be taken when drums or containers are not sealed or are damaged. Leaks in drums or containers should be stopped by moving and rotating the drum until the leak is above the level of the liquid. The spilled material can be cleaned up, then the damaged drum can be patched and/or placed into an overpack.

Handling Drums or Containers That Are Pressurized or Bulging

If handling is necessary, exercise extreme caution and use a grapple unit designed for explosive containment. As a minimum a worker must use EPA Level B protection with properly taped seams. These drums or containers are extremely dangerous. If pressure is to be vented, use remote equipment if possible. If not, use the maximum level of protection and loosen the smallest bung above the liquid level with a non-sparking tool.



Handling Open and Deteriorated Drums or Containers Containing Liquids

If the drum cannot be moved without danger of it breaking open, immediately transfer contents to a good drum using a transfer pump. Most pumps, designed for moving flammable liquids, will move a minimum of 55 gallons of any type of liquid. If possible, use pumps designed for the class of liquid to be moved. If the liquid is unknown or highly contaminated, choose a simple pump that can be easily decontaminated or disposed of inexpensively.



Transferring Flammable or Combustible Liquids

Bond the drums together and then ground the drums when transferring flammable or combustible liquids. This is to prevent development of a static charge. An uncontrolled discharge could produce a static spark of sufficient energy to ignite vapors. Always start the bonding/grounding process at the full drum, then to the receiving drum, and then to ground. Remove the bonding/grounding lines in the same order as installing them.

Using Overpack or Salvage Drums

Overpack or salvage drums are heavy-duty, open-ended drums with a capacity of approximately 85 gallons. The purpose of these drums is to contain a damaged or a repaired drum and its contents. There are several types of overpack drums designed to contain different materials. The most common is an epoxy coated 85-gallon steel drum. It has a removable head that contains a bung that can be used to vent a closed drum. The head is secured to the body of the drum with a band and bolt assembly. A leak-proof seal is provided by a gasket. The next most common overpack drum is made of plastic and not harmed by most corrosive materials. This type of drum has a screw-on head that contains a venting bung and gasket to ensure a seal.

There are several methods for putting a 55-gallon drum into an overpack without lifting it. One method is to insert the damaged drum into the overpack turned on its side. This method requires the work of two people. Pieces of lumber and cardboard are helpful in sliding the punctured drum on its side into the overpack. Another method is to lower the overpack over the damaged drum and then invert the two drums together. The picture at the left shows yet another method. Place the damaged barrel and the overpack at a slight angle to each other, rolling both drums so that the damaged barrel rolls into the overpack. With the damaged drum secured inside, the lid is placed on the overpack and sealed.



It is important that the damaged drum be wedged or immobilized inside the overpack with wood, cardboard, or other packing material.

Movement of the damaged drum within the overpack can cause additional ruptures to occur during handling and transport. Absorbent also should be added to soak up spills and leakage that may occur during transport.

Before placing a drum in an overpack, observe the following:

- Record all label information from the damaged drum and other information that could be useful, such as where the drum was located and what its contents are.
- Make certain that the overpack drum is compatible with the contents of the damaged drum.
- Prepare a label for the overpack drum.

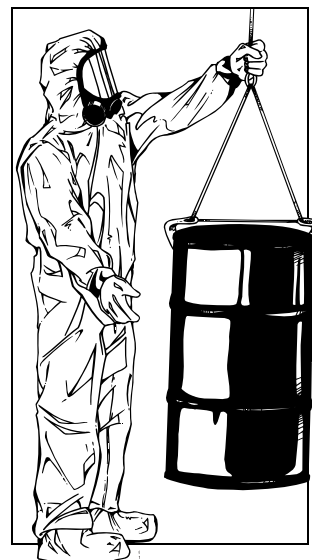
Reduce splashes and spills and stop leaking material using one of the following methods:

- Temporary plugs or patches, and/or
- Place the damaged drum in a heavy-duty plastic bag.

Consider the following methods for getting the damaged drum inside the overpack drum:

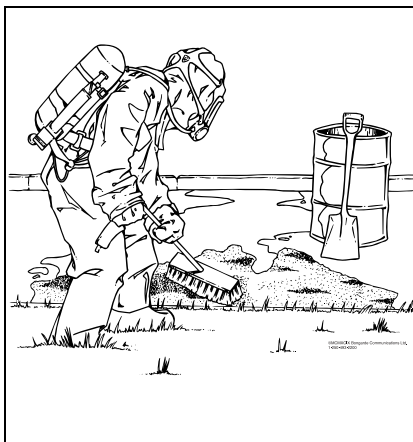
- Slide it into an overpack on a heavy duty plastic bag.
- Roll it into the overpack using a three- to four-inch diameter wood dowel or PVC pipe 2 to 3 feet long.
- Maneuver it into the overpack by rolling the drum onto a wood 2 x 4 and then balancing it on the piece of wood as the overpack is moved over the damaged drum.
- Damaged upright drums can be picked up using a drum sling or other lifting device that grabs onto the chime. This permits removal of the lifting device after insertion into the overpack. Ensure that the chime is not damaged and observe extreme caution if it is.

Be aware that pressure from the lifting device may cause further damage or total failure of the drum.



When raising a drum with a lift, place the overpack under it and then lower the damaged drum into the overpack. Don't swing or rotate the drum into the overpack. Secure the damaged drum inside the overpack and attach a copy of information obtained from the damaged drum to the outside of the overpack.

DRUM AND TANK REPAIR - PLUG AND PATCH OPERATIONS

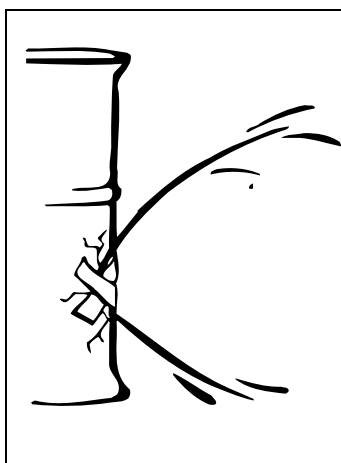


Before proceeding with drum repair make sure that proper protective clothing and equipment are used and that the leak has stopped. If the leak has not stopped, position the drum so that the leak is above the liquid line. Lock the drum in this position with wood blocks. Use a temporary plug or patch to contain the leaking material.

With the drum secured and the leak stopped, clean the immediate work area of the material that has leaked. Use absorbents and place the material in drums for disposal at a later time. This will allow the repair to proceed safely and the contamination to be contained.

The most common leaks come from loose connections, the absence or deterioration of gaskets, damaged threads on fasteners, and the corrosion of fittings. Tightening a nut or bolt can stop many of these leaks. Other leaks are a result of mishandling and improper use of equipment. Punctures in the sides of the drum and leaks in the chime, where the body and head of the drum are joined, are two common areas for leaks to develop because of improper handling.

Plugs and patches and combinations of the two make effective repairs. Plugs can be wooden wedges, screws with washers, tubeless tire plugs, toggle bolts with washers, and expandable plugs. Patches include metal tapes, epoxy sealers, and mastic materials. Patching can be done by wrapping the drum in a banding material such as rubber or neoprene and holding it in place with a metal plate.



Rectangular or round wedges of soft wood are effective for patching large and irregular holes. Wood shingles, door shims and tapered wood dowels all work well. Irregular holes should be lined with lead wool before the wedge is driven into the hole. The lead wool, available from plumbing supply stores, will compress and fill the irregular edges when the wedge is inserted. After the wedge is firmly seated, it is trimmed so that the repair can be sealed or the drum placed inside an overpack. Before sealing, clean the area around the hole of paint and contaminated material. If the material in the drum is flammable, do not use anything that might create a spark. After cleaning, seal the repair with lead, steel, aluminum body tape, or with a self-hardening metalline plastic such as liquid steel or epoxy compound.

Lead wool and an epoxy compound are useful for patching small holes. The procedure for doing this is similar to that used for installing a wedge. The area around the hole is cleaned; the wool is packed into the hole with a plastic or rubber mallet, and the repair coated with epoxy.

Sheet metal screws that are large enough to bite into the metal surrounding the hole can be used with neoprene washers to plug small holes. The flexibility of the

neoprene washer allows this type of plug to fit a variety of contours. If the hole is too large for a sheet metal screw, a toggle bolt can be used with a neoprene washer or ball. The metal washer provides the strength to bridge the hole and the tightening of the nut forces the neoprene to close the hole. Even larger holes may be plugged with a similar toggle bolt assembly and a tapered plug substituted for the neoprene washer.

Several commercially available mastic-type products are very sticky and contain clay, starch, or synthetic polymers. This material is inert and can be molded to plug and patch holes in drums, tanks, or containers. The material will adhere very well to the drum. Disposable gloves should be used when working with this material, as it is difficult to remove. After the patch is made it should be covered with duct tape. The drum can then be placed in an overpack. This type of patch is temporary but will stop leaks as long as the drum is not pressurized. This type of patch also works well on the seams between the drum and the drumhead.

Banding is another type of patch that is very effective and strong. A piece of sheet rubber or neoprene is placed over the hole and backed with a metal plate. The assembly is clamped or held in place by a fabric band or chain that is tightened around the drum. A variation to this method places an air bag between the neoprene and the banding material. The air bag is then slowly inflated forcing the neoprene against an irregularly shaped hole. This is often done when the hole is near or on a rib of the drum or tank.

Air bags must be used with caution as the pressure exerted by the air bag can crush a drum or tank. Air bags must not be pressurized to more than 22 psi of pressure. A safety control with a 22-psi safety relief valve should be used in series with the bag. Input pressure to air bags should be limited to 20 to 40 psi. An air bag cannot be placed directly against sharp or jagged surfaces. Sealing pads or plates can be used to protect the bag; the same pads may be used to protect the bag from chemical attack. Air bags should be put in place and banded to the leak before they are pressurized. Once banded or belted in place, the air bag can contour to 90° square corners.

ABSORPTION METHODS

Dry absorbents commonly used at spill sites include vermiculite, expanded clay, diatomaceous earth, sand, ground corncobs, polypropylene fibers, Hazorb sawdust, and granular activated carbon. There are many other specialized absorbents and variations of these materials. All of these materials absorb liquids. Granular activated carbon absorbs gas vapors as well. Absorption is the process in which materials hold liquids through the process of wetting. Absorption is accompanied by an increase in the volume to sorbate/sorbent system through the process of swelling.

Floor Dry

The most common and economical among dry absorbent is a commercial product known as Floor Dry, commonly used in automotive repair centers. Floor Dry is clay made up of hydrous aluminum and iron magnesium silicates. The absorbent will soak up to 50 percent of its weight in liquids and oils. It has a density of 40 pounds per cubic foot. Although economical to use, it is very heavy and generally cannot be incinerated. This product can be very dusty. It is most commonly packaged in 50-pound bags that will absorb about 5.5 gallons of fluid.

Sand

Sand is a common and economical dry absorbent. The absorbent will soak up to 10% percent of its weight in liquids and oils. It has a density of 50 pounds per cubic foot. Although economical to use, it is very heavy and cannot be incinerated. It is not commonly packaged in bags but delivered by the cubic yard via dump trucks. Sand is best used to control large spills of oil and other viscous materials.

Diatomaceous Earth (Solid-A-Sorb)

Diatomaceous earth is made of a fine, granular, calcium-based material. It is much lighter than the clay-based materials but can be used in much the same way. It has a density of 25 pounds per cubic foot. It is available in 25-pound bags that will absorb about 5 gallons of liquid. A disadvantage of this material is that liquid will tend to drain from the material after one to four hours.

Polypropylene

Polypropylene fibers are a lightweight material that can be used on most liquids. It can be incinerated. It consists of shredded polypropylene fibers and comes in two forms, universal sorbent for water and organic-based chemicals and hydrophobic sorbent for hydrocarbons. The hydrophobic sorbent repels water and will float on water. The density of both sorbents is 5 pounds per cubic foot. A 5-pound bag will absorb about 4 gallons of water or organic-based liquid or 6 to 10 gallons of a hydrocarbon-based liquid.

Hazorb

Hazorb is a proprietary product made of highly expanded silicates. The material is very lightweight and can be used on most liquids except for hydrofluoric acid. Density is 2.2 pounds per cubic foot. One cubic foot will absorb 2 to 3 gallons of liquid. A 10-pound bag will absorb 10 to 15 gallons of liquid.

Vermiculite

Vermiculite is a common lightweight granular material often used in shipping containers and as insulation. It can be used on most chemicals and noncombustible liquids. Density is 4.5 pounds per cubic foot. An 18-pound bag will absorb 4 to 5 gallons of liquid.

Activated Carbon

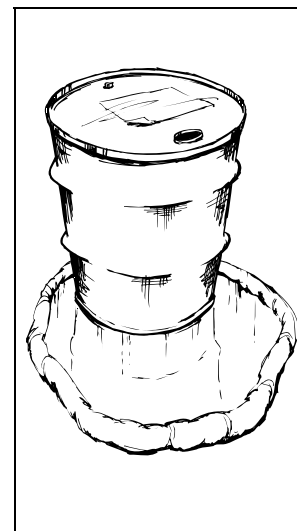
Activated carbon is a granular substance that absorbs vapors and liquids. It is very effective on flammable solvents and suppresses the formation of dangerous vapors. Density is 16 pounds per cubic foot. A five-gallon pail of activated carbon will absorb 1.5 gallons of liquid and suppress the vapors associated with that amount of liquid. Activated carbon can be used over other absorbents to absorb vapors but not liquids.

Spill Pillows

Spill pillows are absorbent products that most commonly contain amorphous silicate particles or polypropylene. Pillows may contain any of the dry absorbents. The pillows can be used for acids, caustics, and organic solvents. They should not be used for solutions containing hydrofluoric acid unless specifically labeled as acceptable for this use. The pillows also are effective for absorption of hazardous biological spills that cannot be chemically inactivated in place. The pillows generally are packaged in four different sizes with a capacity for absorbing a pint, quart, gallon or 2 gallons of liquid. There is no limit on shelf life.

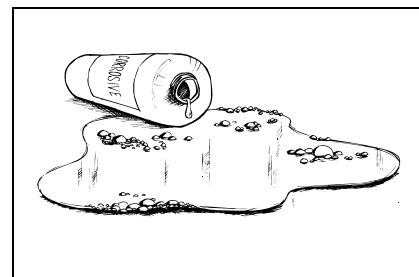
Control pillows are also known as control pigs, dikes, and socks. A different control pillow should be used for each spill as chemicals from different spills may react violently with each other. No attempt should be made to dry out and reuse pillows because chemical residues may remain. It is difficult but possible to use pillows on heavy oils and viscous materials. The material may need to be diluted to facilitate absorption.

Special hydrophobic spill control pillows, socks, booms and rugs are available that will absorb oil and other petroleum based solvents but not water. Most are filled with polypropylene or treated cellulose. They are most suitable for use in wet areas or on water. Most of the products can be wrung out and reused on the same spill. They should not be used for other spills because chemicals from the different spills may react violently with each other. Be careful when working with flammable spills, as the hydrophobic materials will burn.



NEUTRALIZATION

Most corrosives can be neutralized by applying another material to the spilled corrosive acid or base which will react chemically with it to form a less harmful substance. Neutralization reactions generally give off heat and are subject to splattering. Full Level B protection is needed by personnel attempting to neutralize a corrosive material. Spills should be covered by shoveling from the outermost edge inward. Avoid walking through non-neutralized material.



Neutralization Agents

Soda ash in 50-pound bags is the most common neutralizing agent for strong acids. Other common agents include sodium bicarbonate and lime. All are used in a dry form and generally applied in excess. Some spill guns are available that dispense neutralizing agents just like a dry powder fire extinguisher. Neutralization agents for bases tend to be liquids like citric acid or dilute hydrochloric. After the base is neutralized, the liquid is absorbed with floor dry, Solid-A-Sorb, or another available dry absorbent.

GEL-FORMING AGENTS

Gels forming agents or bonding agents are dry granular materials specifically designed to gel or coagulate aqueous or petroleum-based liquids. Unlike absorbents that soak up the liquid through physical actions, gel forming agents chemically bond to the liquid. The chemical bond keeps the liquid from separating from the absorbent.



Gelling agents for petroleum based liquids can be used to separate the petroleum from water, as the gel forming product reacts only with the petroleum product. Thus a floating liquid can be changed to a floating solid much easier for containment and removal. On land-based spills, the gel forming agents immobilize the spilled material to reduce ground contamination. The gel forming agents also reduce but do not eliminate volatility of the spill material.

Gelling agents for petroleum-based liquids do not work well on oil/water emulsions. Gelling agents designed for water are effective when used in moderation. The gelling agent must be applied to the floating emulsion. Allowing the gelling agent to reach water uncontaminated by the emulsion will only compound the clean-up problem.

On water spills, gelling agents have been used to increase the effectiveness of booms, underflow dams, and filter fences. As gel-forming agents do not have EPA approval, permission to apply them to surface waters must be obtained from state and federal authorities at the time of response. Solidified material must be evaluated as a possible hazardous waste and disposed of accordingly.

VAPOR SUPPRESSION

Foam Blanketing Methods

Vapor from hazardous spills is suppressed by applying a foam blanket over a spill in a contained area. It is less effective if the liquid is not contained and is not effective if the liquid is flowing.

Vapor suppressing foams vary in effectiveness. The type of chemicals in the spill, size of spill, topography of the spill area, type of foam, and the rate and density of application all affect the successfulness of this technique. Foams presently being used are mechanical agents produced by mixing diluted foam concentrate with air and water. Foams can be broken down into categories by chemical composition and by expansion ratio. They break down chemically into fluoroprotein foams and synthetic aqueous film-forming foams (AFFF). Both the protein-based and AFFF type foams have good vapor suppressing characteristics. The AFFF types flow and cover hydrocarbon fuels better than the protein-based foams. The protein-based foams are more fire resistant.



Both types of foam are available in forms that act on water soluble or polar solvents such as alcohols, ketones and ethers. Common examples are acetone, ethanol, MEK, and diethyl ether. (Unless specially formulated with polysaccharides, traditional foams cannot be used on water soluble or polar solvents.) These multipurpose foams are the most commonly used as they can be used on all types of flammable chemicals. The normal dilution rates for foams used

on water soluble fuels is 6 percent and for non-water soluble fuels, 3 percent. Some foams specify a uniform 3 percent dilution rate.

Vapor Barrier Sorbent (VBS) Blankets

These fabric blankets made of polypropylene microfibers provide high absorbency for liquids and suppress or trap vapors under a polyethylene film attached to the top of the fabric blanket.

Activated Carbon

Activated carbon, a granular absorbent, will absorb vapors and liquids. It is very effective on flammable solvents and suppresses the formation of dangerous vapors. Activated carbon also can be used over other absorbents to absorb vapors. Granular activated carbon must not be confused with powdered activated carbon. The powdered material will not absorb liquids and is dusty. The dust can be a fire hazard.

Water Spray or Fog

The use of water as spray or fog patterns to control hazardous vapors is effective in controlling some gases. Various techniques involving the use of water spray have proven successful in actual incidents. For example, air entrained in water spray has been shown to dilute, ventilate, and move hazardous vapors. Water droplets in spray will absorb soluble vapors under certain conditions.

WARNING:

Use of water or fog on flammable gases to prevent ignition is seldom successful and may result in a more severe fire or explosion than would have occurred otherwise (NIOSH July 1985 Request for Assistance in Preventing or Controlling Ignition of Flammable Atmospheres).

Water used for vapor dispersion or absorption will be contaminated and must be contained for later treatment or disposal. The effects of the water and gas on the leaking container also must be considered. For example, both chlorine and sulfur dioxide will form strong acids that will react with the leaking container and increase the rate of discharge. If water is used near leaking chlorine or sulfur dioxide containers, the leak on the container must be kept dry.

SAFETY CONSIDERATIONS FOR RESPONSE AND SPILL CLEANUP

Chlorine

Chlorine is a greenish yellow gas shipped under pressure as a liquid. It can be found in 100 and 150 pound compressed gas type cylinders, ton cylinders and rail tank cars. Any release of liquid chlorine will result in the generation of large quantities of heavier than air gas. The gas is highly corrosive and toxic and may persist in pits, hollows, and depressions. Although chlorine is not itself flammable, the product is a strong oxidizer and most combustible materials will ignite and burn in chlorine gas.

Downwind evacuation should be considered if chlorine is leaking. A minimum distance of 900 feet should be considered for any release of liquid material in all directions, 1500 feet might be necessary. The downwind evacuation distance may

be three to five miles dependent upon the rate of release, location, and weather conditions. Sulfur dioxide recommendations and response is similar to that for chlorine.

Facilities using chlorine in ton or larger sized containers should have an emergency plan. Refer to your plan in any chlorine emergency. The following general safety procedures should be used around chlorine:

- Use EPA Level B or A protective equipment. Use Level A for all but the smallest leaks.
- Use standard response procedures, buddy system, back-up team, and safety person.
- Never weld or flame cut on pipe or equipment filled with chlorine. Iron and steel will ignite at about 500° F when in contact with chlorine.
- Never allow liquid chlorine to be trapped between two closed valves. Liquid chlorine expands as temperature increases, creating hydrostatic pressure.
- Liquid chlorine evaporates into gas at -29° F and can generate enough pressure to rupture pipes. One part of liquid chlorine expands to 460 parts of chlorine gas.
- Never spray water or ammonia water on leaking chlorine. It will generate an acid that will eat through the metal around the leak and increase the rate of leakage.
- Locate chlorine leaks by spraying ammonia gas from a squeeze bottle partially filled with strong ammonia water solution. The leak will show up as a white fog.
- Position a leak from a 150# or 1 ton cylinder to the top of the cylinder. In this position chlorine gas will escape instead of liquid chlorine.
- A chlorine leak of 10 pounds or greater will require notification of local, state government, and the National Response Center.

SOURCES OF CHLORINE LEAKS

	SOURCE OF LEAK	150# CYL	TON CYL	RAIL CAR
1	VALVE SEAT	X	X	X
2	VALVE PACKING GLAND	X	X	X
3	FUSIBLE PLUG METAL FAILURE	X	X	
4	SAFETY VALVE			X
5	VALVE GASKET			X
6	VALVE INLET THREADS	X	X	
7	FUSIBLE PLUG THREADS		X	
8	BROKEN OFF VALVE	X	X	
9	VALVE BLOWN OFF	X	X	
10	FUSIBLE PLUG BLOWN OFF		X	
11	VALVE STEM BLOWN OUT	X	X	
12	SIDE WALL OF CONTAINER	X	X	X

Corrosives

Corrosive agents present special problems for response personnel. These types of materials can damage metals, gasket materials and, of course, human tissue. Many

corrosives will react with metals to give off hydrogen gas, creating a flammable gas hazard. The hazards to response personnel from splashes and incidental contact with the substance can be extreme. Response personnel must pay particular attention to selection of the proper level of protection (EPA Level B) and the correct assembly of the clothing and equipment.

Danger comes from splashes, mists, and fumes. Splashes of acid to an SCBA can cause malfunction. None of the PPE in use is designed to protect from immersion into an acid or caustic. Decontamination of personnel should be thorough. Decontamination of tools and equipment, if possible, must be thorough to prevent further corrosion.

Corrosives of Concern

Sodium hydroxide

Sodium hydroxide liquid is the water solution of sodium hydroxide. The concentrated solutions will dissolve in additional water with the evolution of heat. It is corrosive to metals and tissue. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Recover spilled material whenever possible. Neutralize unrecoverable material with citric acid, vinegar, or other dilute acid. Land spill: Dig a pit, pond, lagoon, or holding area to contain liquid or solid material. Dike surface flow using soil or sandbags. Absorb bulk liquid with fly ash or cement powder. Neutralize with citric acid, vinegar, or other dilute acid. Water spill: Neutralize with dilute acid or removable strong acid. Air spill: Apply water spray or mist to knock down vapors.

Anhydrous ammonia

Anhydrous ammonia is a clear colorless gas with a characteristic odor. Although it is classed as a nonflammable gas, it will burn within certain vapor concentration limits, and the fire hazard will increase in the presence of oil or other combustible materials. Its "combustibility" should be considered but is not a common problem in the event of leakage. It is shipped as a liquid under pressure. Contact with the liquid can cause frostbite. It is soluble in water forming a corrosive liquid. Although ammonia is lighter than air, the vapors from a leak initially hug the ground. Keep material out of water sources and sewers. Attempt to stop the leak if exposure can be prevented. Use water spray to knock down vapors. Vapor knockdown water is corrosive, toxic, and should be diked for containment.

Sulfuric acid

Sulfuric acid is a colorless oily liquid. It is soluble in water with release of heat. It is corrosive to metals and tissue. It will char wood and most other organic matter on contact, but is unlikely to cause a fire.

Hydrochloric acid

Hydrochloric acid is a colorless to yellow liquid with a pungent odor. Its fumes are irritating to the eyes and mucous membranes. It is soluble in water with release of heat. It is corrosive to metals and tissue.

Nitric acid

Nitric acid is a colorless to yellow or red liquid sometimes fuming reddish brown vapors with a suffocating odor. It is soluble in water with release of heat. It is corrosive to metals and tissue. It will accelerate the burning of combustible materials and it may even cause ignition of combustible materials by contact.

Any Acid

For any acid that is fuming, isolate the area 150 feet in all directions. Keep concentrated material out of water sources and sewers. Build dikes to contain flow, as necessary. Recover spilled material whenever possible. Neutralize unrecoverable spilled material with crushed limestone, soda ash, or lime.

Land Spill

Dig a pit, pond, lagoon, or holding area to contain liquid or solid material. Dike surface flow using soil or sandbags. Absorb bulk liquid with fly ash or cement powder. Neutralize with soda ash, agricultural lime (slaked lime), crushed limestone, or sodium bicarbonate.

Water Spill

Neutralize with crushed limestone, or sodium bicarbonate.

Air Release

Apply water spray or mist to knock down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment.

FLAMMABLE LIQUIDS

Where flammable liquid spills have occurred, vapor concentrations should be monitored before and while workers are in the area. Priority should be given to providing increased ventilation and absorbing vapors from the liquid. Activated carbon is a granular substance that absorbs vapors and liquids. It is very effective on flammable solvents and suppresses the formation of dangerous vapors. Density is 16 pounds per cubic foot. A five-gallon pail of activated carbon will absorb 1.5 gallons of liquid and suppress the vapors associated with that amount of liquid.

Hexane is a clear colorless liquid with a petroleum-like odor. It has a flash point of -9° F. It is lighter than water and insoluble in water. Its vapors are heavier than air. Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Cover diked material with foam and pump to recovery tank or truck. Thin layers of spilled material may be absorbed with mixtures of granular activated carbon and dry absorbents. Alternatively, gel-forming products may be used. Attempt to stop the leak if exposure can be prevented. Use water spray to knock down vapors.

Response teams should limit actions to absorbing spills and removing absorbed material from the building. Call for fire department assistance in all but the smallest spills. Do not enter atmospheres having greater than 10 percent of Lower Explosive Limit (LEL). Monitor LEL throughout the response. Slight changes in outdoor wind can greatly change indoor concentrations of gas or vapor.

RCRA (HAZARDOUS WASTE)

Regulations under the Resource Conservation and Recovery Act (RCRA) require specific control over the disposal of certain materials covered by the regulations. These would include, for example, spilled or discarded acids, caustics, gasoline, paints, perchloroethylene, solvents, and thinners.

With the exception of oils and organic materials disposed of through the sewer system, the assumption should be made that clean-up material and residue from all liquid products used are RCRA hazardous materials and require special handling, labeling, and disposal. In the event of a spill of a covered material, the material and residue (contaminated soils, clothing, etc.) should be cleaned up using the appropriate procedures.

The cleaned-up product is to be put into approved containers, labeled, and sent to the hazardous waste storage area for log-in and proper disposal. For large cleanups, bulk trucks or tankers of approved design and from EPA permitted transporters may be used. All RCRA hazardous wastes must be disposed of in a permitted RCRA hazardous waste disposal facility.

TOXINS AND PESTICIDES

Toxic substances and pesticides, like corrosives, present special problems for responders. This class of compounds includes substances that are serious dermal, respiratory, and ingestion hazards. The selection of the proper level of protection is critical, as is the selection of the proper suit and glove materials (check permeation references). Often multiple layers of different suit and glove materials is prudent, depending on the toxicity and characteristics of the substances. Upon exit from the spill area, thorough decontamination of the outer layer of clothing should be followed by thorough decontamination or disposal of the inner suit and subsequent showering by personnel.

COMPRESSED GASES AND CRYOGENIC LIQUIDS

Over 100 different gases and gas mixtures are shipped and stored in compressed gas cylinders. Industrial gases such as nitrogen, acetylene, hydrogen, and methane are very common as are breathing air and refrigerants. Most cylinders contain gases under high pressure. Some contain liquefied gases under their vapor pressure.

The principal hazards to personnel are:

- Innate characteristics of the particular gas involved.
- Contents being under extreme pressure.

Leaks from cylinders are from attachments or cylinder wall breaches. Leaks from attachments are generally the result of attachment failure, loose connections, or open valves and can be corrected by tightening connections and closing valves. If the cylinder contains a liquefied gas such as carbon dioxide, the cylinder should be uprighted first so that gas is escaping, not liquid. Leaks from cylinder walls require the use of specialized equipment not normally available to response teams. For leaks of this type, contact a local industrial or medical gas supplier for expert assistance.

AIR BAG DEPLOYMENT

1. Following the "Ten Steps to a Safe Response," initiate the described procedure to contain and control the release.
2. Extend one of the cinching straps around the tank and through one set of retainers on one side of the air bag. Repeat this process for the other strap. Be sure to remain clear of the leak while performing these functions. Additional straps or chains may be required depending upon the circumference of the tank.

3. Once the straps are in position, place the backing pad between the air bag and the tank to protect the air bag from possible puncture. Slide the air bag and backing pad into position over the breach in the tank. A method of marking the opening on the tank may be needed to ensure proper placement or centering of the bag over the breach.
4. Attach the airline coupling to the air bag.
5. Slowly open the air valve charging the air bag. Slowly inflate the air bag until the flow of material is stopped. Do not exceed the rated inflation pressure as stated by the manufacturer.
6. If the escape of material is not sufficiently stopped or reduced, deflate the air bag and reposition. Repeat step 4.
7. Once the leak has been successfully stopped, transfer of material can now be effectively initiated.
8. When material transfer is completed remove the air bag and follow SOP for cleanup and decontamination of the area and equipment.

DRUM TRANSFER PROCEDURE

Following the "[Ten Steps to a Safe Response](#)," initiate the described procedure to contain and control the potential release.

1. Use a non-ferrous (brass) wire brush to remove rust and paint from the drums to ensure good bonding and grounding contact (if drums are metal).
2. Connect the bonding wire to the damaged drum.
3. Connect the other end of the bonding wire to the receiving drum.
4. Connect the grounding wire to the receiving drum.
5. Connect the other end of the grounding wire to the grounding rod. (Do not transfer flammable or combustible liquids to non-metal drums.)
6. Remove both bungs from the receiving drum.
7. Carefully remove the large bung from the damaged drum and insert the transfer pump through the adapter collar.
8. Secure the transfer pump in the adapter collar by tightening the thumbscrew.
9. Place the discharge nozzle of the 5# carbon dioxide fire extinguisher into the large bung opening of the receiving drum and release the carbon dioxide into the drum displacing the air in the drum.
10. Attach the threaded end of the transfer hose connector to the receiving drum large bung opening.
11. Attach one end of the vent tube to the small bung opening of the damaged drum.
12. Attach the transfer hose to the transfer pump and then connect the vent tube to the receiving drum.
13. Transfer may now begin.

14. When transfer is complete, remove the transfer pump, hose, tube, attachments, and place in a bag for proper decontamination. Replace all bungs securely.
15. Finally, remove the bonding clamps and grounding clamps in the same order as that of attachment (see steps 2-5)
16. Follow established SOP for cleanup, disposal, and decontamination of drums and equipment.

As the liquid is moved from the damaged drum to the receiving drum, the liquid displaces the carbon dioxide that is then vented into the damaged drum. This process reduces the risk of explosion/fire by lowering the oxygen concentration within each drum and by decreasing the amount of vapors released to the ambient atmosphere.

REVIEW QUESTIONS

1. What factors affect the behavior of a released hazardous material?
2. What is the purpose of overpacking a drum?
3. If an open or deteriorated drum containing liquid cannot be moved without danger of breaking open, what should be done?
4. When are accidents most likely to occur when handling a drum during a spill response?
5. When should the immediate work area around a drum be cleaned?
6. What type of material may require expert assistance when responding to a leak?
7. Identify three methods or materials used to suppress vapors during a spill.
8. Suggest several types of absorbents that could be used in the cleanup of 30 gallons of lightweight oil.