

DECONTAMINATION

The first step in **DECONTAMINATION** is to **PREVENT CONTAMINATION** as much as possible. Listed below are some basic steps to follow when dealing with a chemical spill or whenever the possibility of contamination exists:

- o **Minimize contact with hazardous substances** Don't taste, touch or sniff hazardous chemicals. Don't walk through areas that are obviously contaminated.
- o **Avoid walking on broken pallets and other objects than could tear your personal protective equipment (PPE).**
- o **Whenever possible use disposable outer protective clothing and equipment.**
- o **USE REMOTE TECHNIQUES** for handling, opening and patching drums. Whenever possible use drum grapplers or pneumatic impact wrenches.
- o **Protect your monitoring equipment and tools from contamination.** Keep equipment bagged and cut openings for the parts that must come in contact with the hazardous substances. It is also possible to cover tools with a strippable coating that can be peeled off.
- o **Be aware of signs that your PPE isn't working** Reddening, swelling or burning of the hands or other body parts are signs that your PPE is not protecting you.
- o **CHECK YOUR BUDDY'S PPE** for rips, tears, swelling and other problems.
- o **ACT FAST.** If you suspect that your PPE is leaking or that you've been contaminated get out of the contaminated area immediately and get decontaminated.
- o Remember, PPE is a way of preventing serious contamination. It is not a license to go wading into chemicals.

WHAT IS DECONTAMINATION?

DECONTAMINATION is the process of getting rid of the hazardous substances which have gotten onto your protective clothing, equipment or body.

There are two basic methods of decontamination:

1. Use washes, rinses, scrubbing to physically remove the contaminants.
2. Use chemicals to neutralize or inactivate the contaminants.

How decontamination is carried out and how thorough it needs to be depends upon several factors. The most important factor is the contaminant itself. **The more harmful the contaminant the more thorough decontamination must be.** And even very small amounts of some contaminants can be harmful. **If the chemical is destructive to the skin, decontamination must be as complete as possible.**

Other factors to consider when deciding how to decontaminate include:

- o **Amount of Contamination.** If you can see the contamination on your clothing or equipment, you need to be thoroughly decontaminated.

But remember that not all contamination can be seen!

- o **Concentration of the Contaminant.** The higher the concentration of the hazardous substance, the more likely it is that your PPE has become contaminated. Remember, high concentrations of chemicals are also more likely to have seeped into or through your chemical protective clothing.
- o **Level of Protection Worn.** Decontamination procedures will vary according to the protective clothing and equipment used. For example, the straps and backpack of a Self-Contained Breathing Apparatus may require decontamination. (To avoid having to decontaminate your SCBA wear a butyl rubber apron over it).
- o **Location of the Contamination.** Contamination of the upper part of your Chemical Protective Clothing (CPC) can also contaminate your breathing zone and the breathing zone of the decontamination workers helping you.

Skin contact with contaminated CPC is also more likely if the contamination is on the upper part of the CPC.

HOW CAN YOU TELL IF THE DECONTAMINATION WORKED?

You can't. At least not immediately. Sometimes you will be able to tell by inspecting your protective clothing and equipment for stains, discolorations, swelling, stiffness or corrosive effects. **Always remember to do this before you put on your suit.**

There are, however, two problems with looking for visible effects:

1. **Many chemicals do not leave visible traces**
2. **Visible traces only tell you about surface contamination. They can't tell you if the chemicals have been absorbed or permeated**

LABORATORY TESTING OF DECONTAMINATION

1. **Swipe Testing**
The inner and outer surfaces of Chemical Protective Clothing can be wiped with cloth or paper patches called "swipes" and then sent to a laboratory for analysis. Swipe tests can also be done on the skin.
2. **Permeation Analysis**
To find out if the contaminants have permeated your CPC, a small piece of the clothing can be sent to a lab for analysis.
3. **Analysis of Cleaning Solution**
The final decontamination rinse can be sent to a lab for analysis to find out the amount of toxic chemicals it contains.

PERMEATION OF CHEMICAL PROTECTIVE CLOTHING AND EQUIPMENT

It is almost impossible to decontaminate PPE that has been permeated by hazardous chemicals. If your decontamination procedures haven't worked the **contaminants can keep permeating your Personal Protective Equipment even after direct exposure has stopped**. Remember, the only way to know if your equipment has been permeated is to have it analyzed by a laboratory.

Listed below are the major factors which affect permeation:

- o **TYPE OF MATERIAL.** The kind of material your Protective Clothing is made of. All materials are not protective for all chemicals; to varying degrees all materials are permeable by all industrial chemicals.
- o **CONTACT TIME.** The longer you're in contact with the hazardous substances, the more likely they are to permeate your clothing and equipment
- o **CONCENTRATION OF THE CONTAMINANT.** The higher the concentration of the hazardous chemicals, the more likely it is that they will permeate your CPC.
- o **TEMPERATURE.** Permeation occurs more rapidly in higher temperatures.
- o **SIZE OF THE CONTAMINANT MOLECULES.** The smaller the contaminant's molecules the easier it is for them to pass through the CPC.
- o **PHYSICAL STATE OF THE CONTAMINANT.** Gas, vapors and liquid are more likely to penetrate clothing and equipment than solids are.
- o **MIXTURES OF CHEMICALS.** Some mixtures of different chemicals may be able to permeate protective clothing and equipment very rapidly. It is extremely difficult to predict how chemical mixtures will behave.

EQUIPMENT AND MATERIALS USED FOR DECONTAMINATION

1. DECONTAMINATING SOLUTIONS

Personal Protective Equipment and Clothing are usually decontaminated by scrubbing with a detergent-water mixture, and then rinsing with lots of water.

Although this method may not be completely effective, it is usually safer than using chemicals to detoxify (make harmless) or neutralize the contaminants.

IF YOU DON'T KNOW WHAT THE CONTAMINANT IS YOU CAN'T USE CHEMICAL DETOXIFICATION. You have to know what you are dealing with in order to know which chemicals can neutralize the contaminant.

If you know what the contaminant is you may be able to use one of the following general purpose chemical decon solutions. However, this list is a guideline to general groups of hazardous chemicals only. It is important to check with the manufacturer of the known contaminant before using one of these solutions. **Exposure to more than one contaminant may mean that you cannot use a chemical decon solution.**

Decon Solution A: Solution containing 5% sodium carbonate and 5% trisodium phosphate.

May Be Used For:

- o Inorganic acids
- o Metal processing wastes
- o Solvents and some organic compounds such as Trichloroethylene, Chloroform, Toluene
- o PCBs and PBBs

Decon Solution B: Solution containing 10% calcium hypochlorite.

May Be Used For:

- o Heavy metals (i.e., mercury, lead, cadmium)
- o Pesticides
- o Chlorinated phenols
- o Dioxins
- o PCBs
- o Cyanides, ammonia and other inorganic wastes

Decon Solution C: Solution containing 5% trisodium phosphate.

May Be Used For:

- o Oily, greasy unspecified wastes not suspected to be contaminated with pesticides
- o PCBs and PBBs
- o Solvents and some organic compounds such as Trichloroethylene, Chloroform and Toluene

Decon Solution D: A dilute solution of hydrochloric acid. One pint of hydrochloric acid mixed into TEN GALLONS of water (and stirred with a wooden or plastic stirrer).

May Be Used For:

- o Inorganic bases, alkali and caustic wastes.

2. **DECONTAMINATION EQUIPMENT**

Equipment which is readily available and either disposable or easy to decontaminate is generally used for decontamination.

For example: Large galvanized wash tubs, stock tanks or even children's wading pools can be used for washing and rinsing solutions. Large plastic garbage cans with plastic liners can be used to store contaminated clothing and equipment. The equipment and supplies listed below are all useful for setting up decontamination procedures:

- o **Plastic drop cloths** - contaminated clothing and equipment should be placed

on drop cloths, or in

- o **Collection containers** such as lined plastic garbage cans for holding disposable clothing and equipment
- o **Absorbents**, such as throw-away towels, for rinsing and wiping
- o **Long handled, soft-bristled brushes** for scrubbing
- o **Paper or cloth towels** for drying clothing and equipment
- o **Wash and rinse solutions** applied with hand -pump sprayers
- o **Plastic sheeting** or other method for collecting and containing wash and rinse solutions spilled during decontamination
- o **Metal or plastic containers** to hold the contaminated wash and rinse solutions
- o **Galvanized wash tubs**, stock tanks or wading pools to hold wash and rinse solutions.
- o **SHOWER FACILITIES and soap or wash solutions and towels.**

PROTECTING THE DECONTAMINATION WORKERS

Workers who carry out the decontamination of contaminated workers, clothing and equipment also need to be protected.

The Level of Protection to be worn by decontamination workers should be selected on the basis of the following considerations:

- o What the contaminant is and whether it is a respiratory or skin hazard
- o How contaminated the Chemical Emergency Team workers are or expected to be

- o What the potential for exposure of decon workers is. Decon workers at the end of a decontamination line or procedure may not need the same Level of Protection as decon workers at the beginning of the line.
- o The concentration of vapors or gases in the area where the decon workers are

When selecting the protection to be worn by decon workers, always remember the following:

- o **If the contaminant is unknown** or known to be highly toxic, a skin hazard or very volatile decon workers should wear, at a minimum, Level B protection
- o **Decon workers should wear face shields.** against splashes.
- o If decon workers are wearing APRs, they must have the approved canister for filtering the contaminants involved.

POINTS TO REMEMBER ABOUT DECONTAMINATION OF PPE

- o **Wood and leather absorb chemicals and are therefore impossible to decontaminate.** All contaminated wood and leather objects, including tools and clothing, should be thrown out.
- o Respirators can be very difficult to decontaminate - particularly the harness and all leather or cloth parts. If respirators are heavily contaminated they will have to be discarded.
- o Respirators and reusable Chemical Protective Clothing must be sanitized as well as decontaminated. Respirator cartridges must be thrown away.
- o All equipment and materials used during decontamination procedures must be disposed of properly, along with all other contaminated items.
- o Contaminated clothing, equipment, tools, brushes etc. must be put into containers and labeled.
- o **Contaminated wash and rinse solutions must not be dumped on the ground or poured down drains.** Contaminated solutions must be

transferred to drums, labeled and disposed of.

- o **WHATEVER CANNOT BE DECONTAMINATED MUST BE DISCARDED!!**

Decontamination: SETTING UP WORK ZONES

One way to help prevent spilled chemicals from being carried from the accident site to other areas of the plant is to set up work zones.

There are usually three work zones:

HOT ZONE

WARM ZONE

COLD ZONE

ZONE 1: THE HOT ZONE

This is where the contamination is. **Everyone entering the hot zone must be wearing the proper level of protection of PPE.** The number of pairs of people allowed in the hot zone should always be kept to the necessary minimum.

THE HOTLINE is the line dividing the hot zone from the warm zone.

Obviously, it's not always easy to decide where the hotline is. Monitoring information is very important in setting up the hotline, but there are other considerations also. These include available space, layout of area, wind direction and distance needed to prevent other people from being hurt.

Setting Up Work Zones (continued)

ZONE 2: THE WARM ZONE

The warm zone is the area between the contaminated zone and the clean areas of the plant. Decontamination stations where PPE is removed and washed or disposed of are set up within the warm zone.

The warm zone also acts as a buffer by putting physical distance between the accident and the clean areas and by allowing for further air dilution of the chemicals.

At first, the warm zone is considered uncontaminated. But, as workers leaving the hot zone go through the decontamination stations, the warm zone becomes contaminated.

Contaminated or potentially contaminated PPE must not leave the warm zone until it has been decontaminated.

ZONE 3: THE COLD ZONE

The cold zone is considered clean. Therefore, no contaminated equipment, clothing or personnel can enter the cold zone. Normal work clothes are worn in the cold zone.

Where the cold zone is located depends upon several factors including: amount of space available, physical limitations, wind direction, distance from the hot zone, resources available such as telephones, water, references materials and ease of access for people providing assistance.

DECONTAMINATION STATIONS AND LEVELS OF DECONTAMINATION

The number and kinds of decontamination stations required is determined mainly by the Level of Protection worn by the Chemical Emergency Team Members.

The EPA recommends up to 19 stations, generally spaced about three feet apart, for decontamination of Level A. However, at most chemical facilities there is neither adequate physical space nor an adequate number of trained people assigned to operate so many decontamination stations.

The steps listed below will give you an idea of the general sequence of decontamination - what piece of PPE comes off when and what happens to it. Remember, if the contaminated workers are wearing Level B rather than Level A, some of the decontamination steps would be eliminated.

Decon Steps Which Can Be Done in the Hot Zone

- o Drop-off of equipment used in the Hot Zone. Tools, monitoring equipment, radios, clipboards, etc. would each be dropped onto a separate drop cloth or into a container
- o Washing and rinsing and removal of outer boot covers and outer gloves. **IF WRIST AND ANKLE JOINS WERE TAPED, do the wash and rinse first, then remove the tape and then remove the boot covers and outer gloves.**
- o Put boot covers and gloves in separate plastic containers.

AFTER THIS POINT, DECONTAMINATION MUST BE DONE INSIDE WARM ZONE.

DECON STEPS INSIDE THE WARM ZONE:

- o Thoroughly wash and rinse full-body suit and regular boots. This may take several wash/rinse cycles. Use long-handled soft bristle brushes and high pressure spray units.
- o **REMOVE BOOTS** and deposit in plastic container
- o **REMOVE FULL-BODY SUIT** and hard hat.
Lay suit on drop cloth or hang it up.

- o Leaving facepiece on, remove SCBA backpack and disconnect hose from regulator valve.
- o Wash and rinse inner glove. Use detergent/water or a decon solution that will not harm the skin.
- o **After washing and rinsing inner gloves, but before removing them, remove your facepiece. TRY TO AVOID TOUCHING YOUR FACE WITH YOUR FINGERS.** Deposit facepiece into plastic-lined container.
- o Remove inner gloves.
- o Remove inner clothing. Because some contamination may have gotten onto your inner clothing when you were removing the full-body suit, it's important to remove your inner sweat-soaked clothing as soon as you can after going through the above steps.

AT THIS POINT YOU SHOULD BE DECONTAMINATED ENOUGH TO GO INTO THE COLD ZONE.

- o **SHOWER with soap and water. This is especially important if the chemicals are highly toxic, corrosive to the skin or can be absorbed through the skin.**
- o Put on clean, uncontaminated clothing.

PART TWO: SITE CONTROL

Before clean-up begins at a hazardous waste site, a **SITE CONTROL PROGRAM** needs to be put into effect. The SITE CONTROL PROGRAM sets out how the site should be organized and run so that worker contact with hazardous chemicals is kept to a minimum.

The SITE CONTROL PROGRAM spells out the ways in which worker exposure to hazards will be controlled. **The most important elements of site control are:**

- ! **Engineering controls** to reduce worker exposure to hazards.
- ! Creating **site work zones** with controlled access procedures and specific **personal protective equipment** requirements.
- ! **Standard Operating Procedures** (safe work practices) for each job on site.
- ! **The buddy system**.
- ! **Site communications system**, including emergency alarms

ENGINEERING CONTROLS

In a plant or on a hazardous waste site, **engineering controls are the most effective means of reducing worker exposure to chemical and physical hazards.**

On a hazardous waste site use of the following equipment can help protect workers from direct contact with the chemicals:

- ! Equipment such as cranes and fork- lifts fitted with remote control and/or robotic mechanisms. Equipment can be built with enclosed cabs that have supplied air.
- ! Use of heavy equipment such as front-end loaders, bobcats, backhoes, cranes and fork lifts.
- ! Hydraulic drum handlers

- ! Vacuum pumps and tanks for bulking liquids
- ! Remote drum samplers

Other equipment helps to reduce the risk of chemical spills, leaks and fires:

- ! Ventilation fans for confined spaces.
- ! Non-sparking tools (bung wrenches, socket wrenches and drum cutters).
- ! Grounding for all metal containers.

Common physical hazards found on waste sites can be **minimized** by simple measures such as:

- ! Spraying water to keep dust down.
- ! Adequate lighting.
- ! Good roads and paths, kept clear.
- ! Clearly marking obstacles.
- ! Building soil embankments between the hazardous waste and the workers.
- ! Cutting down weeds and scrubs that conceal hazards or interfere with work.

Simple engineering controls and good work practices can also be used to **protect the environment** from further contamination:

- ! Dikes, ditches, contour grading and drainage pipes should be used to divert rain water from wastes.
- ! Contaminated water must be kept out of clean areas.
- ! All water used for decontamination should be collected and disposed of as hazardous waste.

- ! Proper drum storage reduces the risk of leaks, spills and chemical reactions.

SITE CONTROL USING WORK ZONES

Dividing the site into work zones helps to control worker exposure and the spread of contamination. Work zones are generally organized in the following way:

ZONE 1: HOT (also called the DIRTY OR EXCLUSION) ZONE

This is the most contaminated zone. Access to the **Hot Zone** should be restricted and restrictions need to be enforced. No one should be allowed to enter Zone 1 without the required personal protective clothing and equipment. Entry and exit control points regulate the amount and flow of people and equipment into the Hot Zone.

The boundary of the Hot Zone is the HOTLINE.

ZONE 2: WARM (also called the CONTAMINATION REDUCTION) ZONE

Decontamination of personnel and equipment takes place in the **Warm Zone**. Entry to the Warm Zone needs to be controlled. Proper personal protective equipment should be required for all workers entering the Warm Zone.

ZONE 3: COLD (also called the CLEAN OR SUPPORT) ZONE

Only "clean" personnel and equipment should be permitted in the **Cold Zone**. Any worker or piece of equipment leaving the Hot Zone must first go through decontamination in the Warm Zone before entering the Cold Zone. Normal work clothes are usually worn in this zone.

SITE CONTROL USING PERSONAL PROTECTIVE EQUIPMENT AND THE BUDDY SYSTEM

The least effective way to protect workers is the use of Personal Protective Equipment (PPE). **PPE does nothing to reduce the level of contamination or exposure to chemicals.** However, on hazardous waste sites where it is almost impossible to control all hazards through engineering controls, it is very important that the proper PPE is worn and that workers are trained in the selection and use of personal protective equipment.

Information on respirators and chemical protective clothing can be found in other sections of the Manual.

The Buddy System

It is very important that hazardous waste site workers wearing vision and movement-limiting personal protective clothing carry out their work assignments in the buddy system.

Use of the buddy system assists in site control in the following ways:

- ! there is someone to request assistance or backup in an emergency.
- ! buddies keep on eye on each other's protective clothing to make sure it is intact.
- ! buddies watch each other for symptoms of chemical exposure and heat stress. Symptoms may include lack of coordination, dizziness, intense sweating, coughing, wheezing, teary eyes, weakness.

OTHER WAYS TO CONTROL SITE HAZARDS

1. SITE PREPARATION

Before clean-up can start, most sites require some preparation. Preparation generally includes construction of access routes for heavy equipment, clearing the site of debris, weeds, slip\trip\fall hazards, etc., installing lights. A site which has been well prepared can eliminate or reduce the number of common physical hazards.

2. SITE COMMUNICATIONS

Hazardous waste sites should have two sets of communications. One for use among the site workers, and one for use between on and off-site personnel.

Internal communication systems are used to alert workers to emergencies, control zone access, and to report equipment\tool requests and safety information.

Communication between on and off-site personnel is used mainly to coordinate

emergency response.

3. SITE SECURITY

Site security is needed to prevent the public from wandering onto hazardous waste sites and to prevent further waste dumping. It is also important to prevent stealing from the site so that contaminated materials do not leave the site.

Site security can be maintained by enforcement of restricted access policies and construction of a fence or barrier around the site.

4. SITE SAFETY PLAN

Before clean-up work begins, each site should develop a **Site Safety Plan (SSP)**. The SSP details the safety procedures that will be practiced on the site.

All of the following should be included in a Site Safety Plan:

- ! hazard analysis of each job
- ! employee safety and health training to be conducted
- ! Personal Protective Equipment required for each job and site zone
- ! how, by whom and how often air monitoring, personnel monitoring and sampling will be done
- ! decontamination procedures
- ! confined space entry procedures
- ! site control measures
- ! how the Emergency Response Plan will be implemented
- ! spill containment procedures

5. **SAFETY MEETINGS AND INSPECTIONS**

Safety meetings should be held twice daily. In the morning, the day's activities and the site safety procedures to be used should be discussed. At the end of the work day, discussion should focus on changes in the site safety procedures which might be required and on any problems which arose during the day. Site safety procedures should be evaluated and up-dated on an on-going basis.