



Chapter 7: Decontamination

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

Chapter Objectives:

After completing this module, you will be able to:

1. Demonstrate proper decontamination of your personal protective equipment, yourself, your tools and equipment to protect yourself, your family, and your community.
2. Explain the layout of a decontamination line.



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 soft and sticky. The suits had to be thrown away. **Why did this happen?**

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



Decontamination (decon) is necessary to prevent worker exposure and the spread of hazardous substances beyond the work site. Each hazardous waste site involves different workers, equipment, chemicals, and risks.

Decontamination procedures are described in the employer's site safety and health plan. The site-specific decontamination and safety and health plans should state when, where, and how decontamination will occur.



The decontamination plan must contain the following information:

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

Proper decontamination procedures must:

1. Be communicated to workers and implemented before workers or equipment enter the with hazardous substance
2. Protect workers and the environment from hazardous substances or contaminated equipment
3. Prevent continued permeation of the hazardous substance into PPE, other equipment, and tools and degradation that could result
4. Prevent the mixing of incompatible substances
5. Prevent the uncontrolled transfer of contaminants to the home and community and to workers in clean areas
6. Be monitored by the safety and health supervisor and revised as necessary



It is important to reduce the need for decontamination by minimizing contamination and contact with hazardous substances. SOPs should establish practices that minimize exposure and maximize worker protection.

For example, these PPE practices can minimize worker exposure:

1. Inspect PPE before each use to ensure it is in good condition
2. Close zippers, buttons, and snaps fully
3. Tuck inner gloves under the suit's sleeves and outer gloves over suit's sleeves
4. Wear a third pair of tough outer gloves over the sleeves
5. Tuck boots under the legs of outer clothing
6. Wear hoods over the respirator harness
7. Tape and tab all joints (if tape adhesive is compatible with suit materials) to help prevent contaminants from getting inside gloves, boots, and jackets





Proper work practices can help reduce the amount of contamination and the need for decontamination. Examples of good work practices include:

1. Follow SOPs that minimize contact with hazardous substances
2. Do not kneel or walk through puddles or areas of obvious contamination
3. Properly dispose of decontamination equipment and solvents
4. Use remotely controlled equipment, such as drum grapplers, to sample, handle, and open drums
5. Cover monitoring and sampling instruments with plastic bags
6. Wear disposable outer garments and use disposable equipment whenever possible

Protective clothing and equipment must be decontaminated, cleaned, maintained, or replaced as often as necessary to protect the workers. You must remove and discard contaminated clothing and PPE that cannot be decontaminated because it is permeable and/or not chemically resistant.

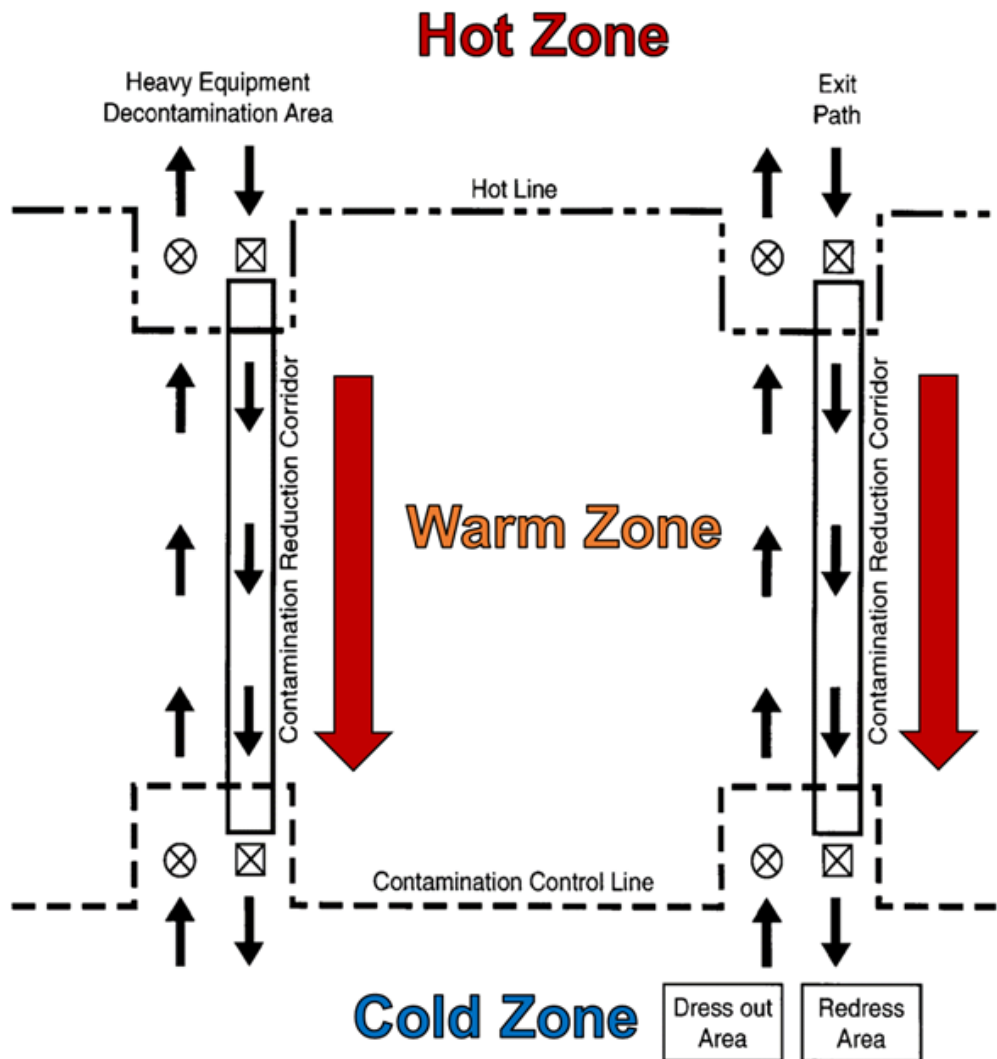
The decon line must be set up and operational before anyone starts work in the Hot Zone or Exclusion Zone.

Decontamination must occur:

- When PPE or clothing becomes contaminated;
- Before personnel go from a hot zone to a cold zone;
- Before workers eat, drink, smoke, or use restroom facilities; and
- Before equipment or vehicles leave the site.



Decontamination takes place as you leave the hot zone and pass through a series of wash stations in the Warm Zone. This area is called the decontamination line or the decon line. 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.** Most decontamination activities take place in the Warm Zone (also known as the Contamination Reduction Corridor Zone) but gross decontamination may take place in the Hot Zone. The only way out of the Hot Zone should be through the decon line.



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



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

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

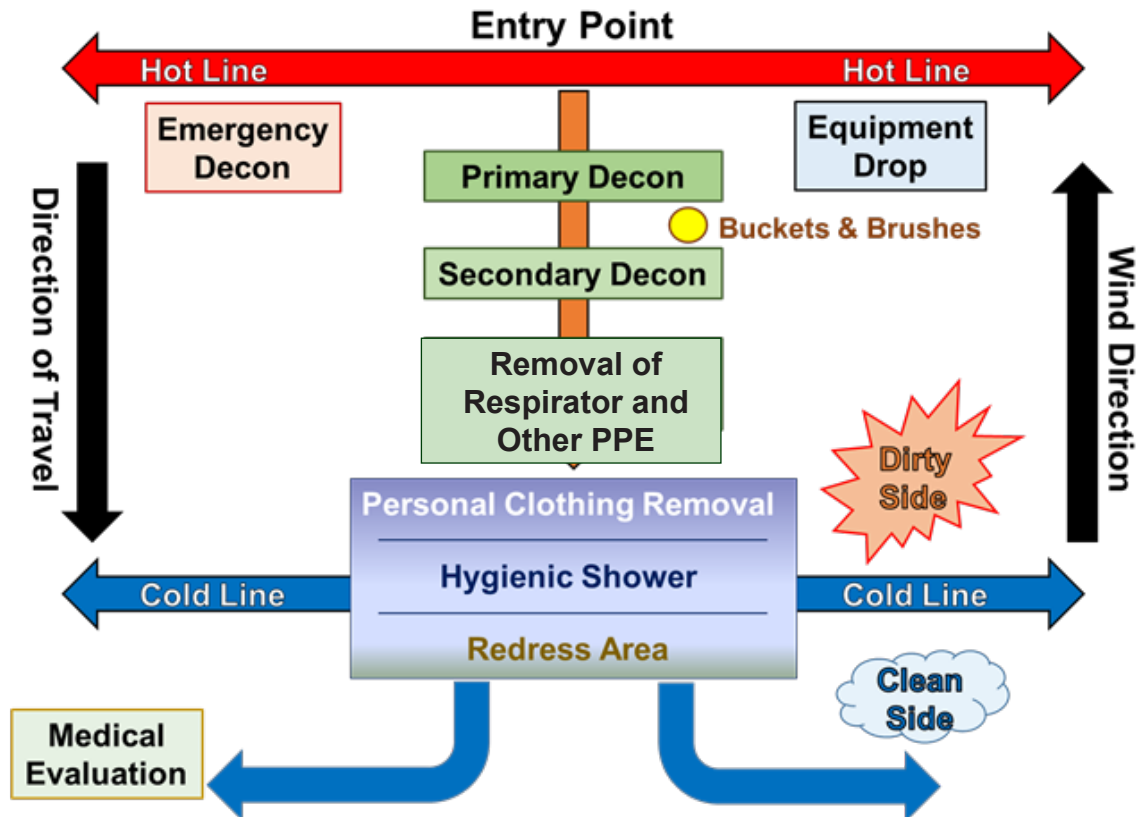
The Cold Zone is free of contamination. If necessary, workers who have been in the Hot Zone receive a medical exam in the Cold Zone. The Cold Zone contains the administrative and other support personnel who keep the zones running smoothly.

Personnel decontamination must occur before workers enter clean areas.

Workers in suits and respirators may be assigned to the decon line to scrub and rinse personal protective equipment and help you take it off. 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. You must go through decon every time you leave the Hot Zone.

The number of stations, their configuration, and the procedures at each station is site-specific and will vary with the nature (type of chemicals) and extent (amount or concentration) of the contamination. On most decon lines you will stand in a tub and your suit gloves and outer boots will be scrubbed with brushes and a 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. 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 and some are short but the basic idea is always the same.

See the sample decontamination line diagram shown below.



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

All personnel, clothing, equipment, and sample containers leaving contaminated areas must be decontaminated.



The process of decontamination uses one or more methods to remove or neutralize hazardous substances. The decon methods must be site-specific. Just as no one pair of gloves will protect you from every chemical, no single decon method will remove all types of contamination.

- Contaminants may be removed by washing and rinsing, dissolving contaminants in a solvent (water, alcohol, dilute acid, etc.), wiping, scrubbing, scraping, evaporating, heating, freezing, melting, or adsorption/adsorption (with powdered lime or kitty litter).
- Contaminants may be neutralized or inactivated by using a weak acid or base, chemical detoxification (making the hazardous substance less toxic), disinfecting or sterilizing equipment with chemical disinfectants, heat, or steam,

Particulate (dust) that cling to PPE and machinery may become trapped in small openings, such as the weave of the fabric, can be removed with water or a liquid rinse. Surfactants, such as detergent, improve the effectiveness of washing and rinsing by making the contaminants dissolve more readily into a solvent and reducing the ability of contaminants to stick to surfaces. Multiple rinses with clean solutions will remove more contaminants than a single rinse with the same volume of solution.

Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Make sure that you wear an appropriate respirator or use other protection from the vaporized chemicals.

Chemicals, heat, and radiation may be used as disinfectants to kill some microorganisms such as bacteria and viruses. Disposable PPE is recommended for use with infectious agents. All equipment that cannot be decontaminated, such as wooden handles, and any contaminated cleaning solutions must be properly disposed.

It is important to select and follow proper decon procedures. The methods used must be compatible with the clothing and equipment being cleaned and capable of removing the contaminant without creating hazardous byproducts. Decontamination through chemical neutralization requires careful planning and training.

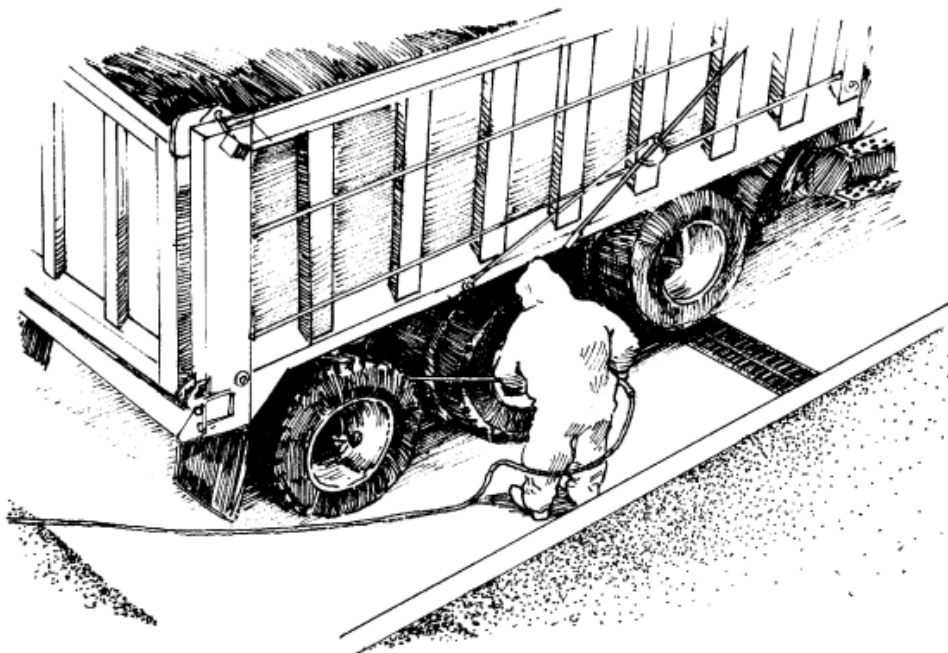


Decontamination of equipment prevents deterioration of the equipment and controls the spread of hazardous substances. The specific decontamination procedure depends on the equipment and the hazardous substance.

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

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.

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.



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



Contaminated wash and rinse solutions must be contained and properly disposed of to prevent pollution and the spread contamination. Tools used in the Hot Zone must not be removed from the Hot Zone unless they have been 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.

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 should wear the same level of PPE as Hot Zone workers or no more than one level of protection lower. Decon workers must never wear less than Level C protection.** The safety and health plan should specify the level of PPE to be worn by workers at all positions on the decon line.

- **Level A workers entering decon are met by level A or B;**
- **Level B workers entering decon are met level B or C;**
- **Level C workers entering decon are met by level C.**

While it is intended to protect workers, the community, and the environment, **decontamination can result in health and safety hazards if not done properly.**



To reduce health and safety risks during 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
- Use “gripper” decals or other methods of increasing traction to reduce the likelihood of slips on plastic sheeting and slippery surfaces
- Provide benches or chairs (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 work areas are adequately decontaminated and cleaned
- Prevent unauthorized employees from removing protective clothing or equipment from change rooms

How do you know if decontamination was effective?

You can inspect decontaminated items to make sure there are no visible signs of contamination. In most cases there will not be an on-the-spot test to assure total decontamination. Wipe samples can be collected from decontaminated equipment and sent to a lab for analysis. 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 worker exposure and the spread of hazardous substances beyond the site. Proper procedures must be developed before a clean-up job begins. Remove contamination from personnel and expensive equipment such as SCBAs and air monitors. Properly dispose of PPE and less expensive equipment that cannot be decontaminated.

The decontamination line is a series of station organized in a specific sequence. The stations are arranged in order of decreasing contamination and to result in the most efficient decontamination. Decontamination reduces levels of contamination on personnel, PPE, and equipment until acceptable levels of the contaminant are present. Anything that cannot be decontaminated or packaged for reuse must be disposed of. The decon line must be set up and ready to go before anyone enters the Hot Zone.

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 proper PPE should be in the Hot 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.



Methods for decontamination depend on the PPE or equipment and the hazardous substances at the site and include:

- Rinsing or dissolving
- Scraping, brushing, and wiping
- Evaporation, then rinsing
- Washing with soap and water
- Chemical disinfection or neutralization
- A combination of the above.

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

*Occupational Safety and Health Administration Hazardous Waste
Decontamination Training.*
<https://www.osha.gov/SLTC/hazardouswaste/training/decon.html>



Activity 9: Decon

Your group has been given the identity of a chemical 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 Hot Zone (Exclusion Zone) and all areas of the decon line will be wearing. Another consideration is what materials will be used in the decon line.

Chemical: _____

1. What level of protection will the Hot Zone (Exclusion Zone) workers be wearing and why? _____

2. What level of protection will the Warm Zone (Contamination Reduction Zone) workers who meet the Hot Zone workers be wearing and why? _____

3. What level of protection will your Warm Zone (Contamination Reduction Zone) workers who help the Hot Zone workers remove their PPE be wearing and why? _____



4. List any special hazards that this chemical might present. _____
