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Decontamination

Introduction

Decontamination - the process of removing or neutralizing contaminants that have accumulated on personnel and equipment - is critical to health and safety at hazardous waste sites. Decontamination protects workers from hazardous substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, tools, vehicles, and other equipment used on site; it protects all site personnel by minimizing the transfer of harmful materials into clean areas; it helps prevent mixing of incompatible chemicals; and it protects the community by preventing uncontrolled transportation of contaminants from the site.

This chapter describes the types of contamination that workers may encounter at a waste site, the factors that influence the extent of contamination, and methods for preventing or reducing contamination. In addition, this chapter provides general guidelines for designing and selecting decontamination procedures at a site, and it presents a decision aid for evaluating the health and safety aspects of decontamination methods. The chapter does not cover decontamination of radioactively contaminated personnel or equipment. A health physicist should be consulted if this situation arises.

Decontamination Plan

A decontamination plan should be developed (as part of the Site Safety Plan) and set up before any personnel or equipment may enter areas where the potential for exposure to hazardous substances exists. The decontamination plan should:

- Determine the number and layout of decontamination stations.
- Determine the decontamination equipment needed.
- Determine appropriate decontamination methods.
- Establish procedures to prevent contamination of clean areas.
- Establish methods and procedures to minimize worker contact with contaminants during removal of personal protective clothing and equipment (PPE).
- Establish methods for disposing of clothing and equipment that are not completely decontaminated.

The plan should be revised whenever the type of personal protective clothing or equipment changes, the site conditions change, or the site hazards are reassessed based on new information.

Prevention of Contamination

The first step in decontamination is to establish Standard Operating Procedures that minimize contact with waste and thus the potential for contamination. For example:

- Stress work practices that minimize contact with hazardous substances (e.g., do not walk through areas of obvious contamination, do not directly touch potentially hazardous substances).
- Use remote sampling, handling, and container-opening techniques (e.g., drum grapplers, pneumatic impact wrenches).
- Protect monitoring and sampling instruments by bagging. Make openings in the bags for sample ports and sensors that must contact site materials.
- Wear disposable outer garments and use disposable equipment where appropriate.
- Cover equipment and tools with a strippable coating which can be removed during decontamination.
- Encase the source of contaminants, e.g., with plastic sheeting or overpacks.

In addition, Standard Operating Procedures should be established that maximize worker protection. For example, proper procedures for dressing prior to entering the Exclusion Zone will minimize the potential for contaminants to bypass the protective clothing and escape decontamination. In general, all fasteners should be used (i.e., zippers fully closed, all buttons used, all snaps closed, etc.) Gloves and boots should be tucked under the sleeves and legs of outer clothing, and hoods (if not attached) should be worn outside the collar. Another pair of tough outer gloves is often worn over the sleeves. All junctures should be taped to prevent contaminants from funning inside the gloves, boots, and jackets (or suits, if one-piece construction).

Prior to each use, the personal protective equipment (PPE) should be checked to ensure that it contains no cuts or punctures that could expose workers to wastes. Similarly, any injuries to the skin surface, such as cuts and scratches, may enhance the potential for chemicals or infectious agents that directly contact the worker's skin to penetrate into the body. Particular care should be taken to protect these areas. Workers with large areas of damaged skin should be kept from working on site until the skin heals.

All personnel should be trained in the Standard Operating Procedures for minimizing contact and maximizing worker protection, and these procedures should be enforced throughout site operations.

Types of Contamination

Contaminants can be located either on the surface of personal protective equipment or permeated into the PPE material. Surface contaminants may be easy to detect and remove; however, contaminants that have permeated a material are difficult or impossible to detect and remove. If contaminants that have permeated a material are not removed by decontamination, they may continue to permeate to either surface of the material where they can cause an unexpected exposure.

Five major factors affect the extent of permeation:

- Contact time. The longer a contaminant is in contact with an object, the greater the probability and extent of permeation. For this reason, minimizing contact time is one of the most important objectives of a decontamination program.
- Concentration. Molecules flow from areas of high concentration to areas of low concentration. As concentrations of wastes increase, the potential for permeation of personal protective clothing increases.
- Temperature. An increase in temperature generally increases the permeation rate of contaminants.
- Size of contaminant molecules and pore space. Permeation increases as the contaminant molecule becomes smaller, and as the pore space of the material to be permeated increases.
- Physical state of wastes. As a rule, gases, vapors, and low-viscosity liquids tend to permeate more readily than high-viscosity liquids or solids.

Decontamination Methods

All personnel, clothing, equipment, and samples leaving the contaminated area of a site (generally referred to as the Exclusion Zone) must be decontaminated to remove any harmful chemicals or infectious organisms that may have adhered to them. Decontamination methods either (1) physically remove contaminants, (2) inactivate contaminants by chemical detoxification or disinfection/sterilization, or (3) remove contaminants by a combination of both physical and chemical means. Various decontamination methods are listed in Table 1.

Physical Removal

In many cases, gross contamination can be removed by physical means involving dislodging/displacement, rinsing, wiping off, and evaporation. Physical methods involving high pressure and/or heat should be used only as necessary and with caution since they can spread contamination and cause burns. Contaminants that can be removed by physical means can be categorized as follows:

- Loose contaminants. Dusts and vapors that cling to equipment and workers or become trapped in small openings, such as the weave of the clothing fabrics, can be removed with water or a liquid rinse. Removal of electrostatically attached materials can be enhanced by coating the clothing or equipment with anti-static solutions. These are available commercially as wash additives or anti-static sprays.
- Adhering contaminants. Some contaminants adhere by forces other than electrostatic attraction. Adhesive qualities vary greatly with the specific contaminants and the temperature. For example, contaminants such as glues, cements, resins, and muds have much greater adhesive properties than elemental mercury and consequently, are difficult to remove by physical means. Physical removal methods for gross contaminants include scraping, brushing, and wiping. Removal of adhesive contaminants can be enhanced through certain methods such as solidifying, freezing (e.g., using dry ice or ice water), adsorption or absorption (e.g., with powdered lime or kitty litter), or melting.
- Volatile liquids. Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Evaporation of volatile liquids can be enhanced by using steam jets. With any evaporation or vaporization process, care must be taken to prevent worker inhalation of the vaporized chemicals.

Table 1. Some Decontamination Methods

REMOVAL

- Contaminant Removal
 - Water rinse, using pressurized or gravity flow.
 - Chemical leaching and extraction.
 - Evaporation/vaporization.
 - Pressurized air jets.
 - Scrubbing/scraping. Commonly done using brushes, scrapers, or sponges and water compatible solvent cleaning solutions.
 - Steam jets.
- Removal of Contaminated Surfaces Disposal of deeply permeated materials, e.g., clothing, floor mats, and seats. Disposal of protective coverings/coatings.

INACTIVATION

- Chemical Detoxification
 - Halogen stripping
 - Neutralization
 - Oxidation/reduction.
 - Thermal degradation.
- Disinfection/Sterilization
 - Chemical disinfection
 - Dry heat sterilization
 - Gas/vapor sterilization

- Irradiation.
- Steam sterilization.

Chemical Removal

Physical removal of gross contamination should be followed by a wash/rinse process using cleaning solutions. These cleaning solutions normally utilize one or more of the following methods:

- Dissolving contaminants.** Chemical removal of surface contaminants can be accomplished by dissolving them in a solvent. The solvent must be chemically compatible with the equipment being cleaned. This is particularly important when decontaminating personal protective clothing constructed of organic materials that could be damaged or dissolved by organic solvents. In addition, (care must be taken in selecting, using, and disposing of any organic solvents that may be flammable or potentially toxic. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products.

Halogenated solvents generally are incompatible with personal protective equipment and are toxic. They should only be used for decontamination in extreme cases where other cleaning agents will not remove the contaminant.

Table 2 provides a general guide to the solubility of several contaminant categories in four types of solvents: water, dilute acids, dilute bases, and organic solvents. Because of the potential hazards, decontamination using chemicals should be done only if recommended by an industrial hygienist or other qualified health professional.
- Surfactants.** Surfactants augment physical cleaning methods by reducing adhesion forces between contaminants and the surface being cleaned, and by preventing redeposit of the contaminants. Household detergents are among the most common surfactants. Some detergents can be used with organic solvents to improve the dissolving and dispersal of contaminants into the solvent.
- Solidification.** Solidifying liquid or gel contaminants can enhance their physical removal. The mechanisms of solidification are: (1) moisture removal through the use of absorbents such as grounded clay or powdered lime; (2) chemical reactions via polymerization catalysts and chemical reagents; and (3) freezing using ice water.

Table 2. General Guide to Solubility of Contaminants In Four Solvent Types

SOLVENT	SOLUBLE CONTAMINANTS
Water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Basic (caustic) compounds. Amines Hydrazines
Dilute Bases For example: -detergent -soap	Acid compounds Phenols Thiols Some nitro and sulfonic compounds.
Organic Solvents* For example -alcohols -ethers -ketones -aromatics -straight-chain alkanes (e.g., hexane) -common petroleum products (e.g., fuel oil, kerosene)	Nonpolar compounds (e.g., some organic compounds).

*WARNING: Some organic solvents can permeate and/or degrade the protective clothing.

- Rinsing.** Rinsing removes contaminants through dilution, physical attraction, and solubilization. Multiple rinses with clean solutions remove more contaminants than a single rinse with the same volume of solution. Continuous rinsing with large volumes will remove even more contaminants than multiple rinsings with a lesser total volume.
- Disinfection/Sterilization.** Chemical disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization techniques are generally impractical for large equipment and for personal protective clothing equipment. For this reason, disposable PPE is recommended for use with infectious agents.

Many factors, such as cost, availability, and ease of implementation, influence the selection of a decontamination method. From a health and safety standpoint, two key questions must be addressed:

- Is the decontamination method effective for the specific substances present?

- Does the method itself pose any health or safety hazards?

Testing for the Effectiveness of Decontamination

Decontamination methods vary in their effectiveness for removing different substances. The effectiveness of any decontamination method should be assessed at the beginning of a program and periodically throughout the lifetime of the program. If contaminated materials are not being removed or are penetrating protective clothing, the decontamination program must be revised. The following methods may be useful in assessing the effectiveness of decontamination.

Visual Observation

There is no reliable test to immediately determine how effective decontamination is. In some cases, effectiveness can be estimated by visual observation.

- Natural light. Discolorations, stains, corrosive effects, visible dirt, or alterations in clothing fabric may indicate that contaminants have not been removed. However, not all contaminants leave visible traces; many contaminants can permeate clothing and are not easily observed.
- Ultraviolet light. Certain contaminants, such as polycyclic aromatic hydrocarbons, which are common in many refined oils and solvent wastes, fluoresce and can be visually detected when exposed to ultraviolet light. Ultraviolet light can be used to observe contamination of skin, clothing, and equipment; however, certain areas of the skin may fluoresce naturally, thereby introducing an uncertainty into the test. In addition, use of ultraviolet light can increase the risk of skin cancer and eye damage; therefore, a qualified health professional should assess the benefits and risks associated with ultraviolet light prior to its use at a waste site.

Wipe Sampling

Wipe testing provides after-the-fact information on the effectiveness of decontamination. In this procedure, a dry or wet cloth, glass fiber filter paper, or swab is wiped over the surface of the potentially contaminated object and then analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be tested. Skin may also be tested using wipe samples.

Cleaning Solution Analysis

Another way to test the effectiveness of decontamination procedures is to analyze for contaminants left in the cleaning solutions. Elevated levels of contaminants in the final rinse solution may suggest that additional cleaning and rinsing are needed.

Testing for Permeation

Testing for the presence of permeated chemical contaminants requires that pieces of the protective garments be sent to a laboratory for analysis.

Health and Safety Hazards

While decontamination is performed to protect health and safety, it can pose hazards under certain circumstances. Decontamination methods may:

- Be incompatible with the hazardous substances being removed (Le., a decontamination method may react with contaminants to produce an explosion, heat, or toxic products). Be incompatible with the clothing or equipment being decontaminated (e.g., some organic solvents can permeate and/or degrade protective clothing).
- Pose a direct health hazard to workers (e.g., vapors from chemical decontamination solutions may be hazardous if inhaled, or they may be flammable).

The chemical and physical compatibility of the decontamination solutions or other decontamination materials must be determined before they are used. Any decontamination method that permeates, degrades, damages, or otherwise impairs the safe functioning of the PPE is incompatible with such PPE and should not be used. If a decontamination method does pose a direct health hazard, measures must be taken to protect both decontamination personnel and the workers being decontaminated.

Decontamination Facility Design

At a hazardous waste site, decontamination facilities should be located in the Contamination Reduction Zone (CRZ), i.e., the area between the Exclusion Zone (the contaminated area) and the Support Zone (the clean area) as shown in 3.

The level and types of decontamination procedures required depend on several sitespecific factors including:

- The chemical, physical, and toxicological properties of the wastes.
- The pathogenicity of infectious wastes.
- The amount, location, and containment of contaminants. the potential for, and location of, exposure based on assigned worker duties, activities, and functions.
- The potential for wastes to permeate, degrade, or penetrate materials used for personal protective clothing and equipment, vehicles, tools, buildings, and structures.
- The proximity of incompatible wastes.
- The movement of personnel and/or equipment among different zones.
- Emergencies
- The methods available for protecting workers during decontamination.
- The impact of the decontamination process and compounds on worker safety and health.

Decontamination procedures must provide an organized process by which levels of contamination are reduced. The decontamination process should consist of a series of procedures performed in a specific sequence. For example, outer, more heavily contaminated items (e.g., outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g., jackets and pants). Each procedure should be performed at a separate station in order to prevent cross contamination. The sequence of stations is called the decontamination line.

Stations should be separated physically to prevent cross contamination and should be arranged in order of decreasing contamination, preferably in a straight line. Separate flow patterns and stations should be provided to isolate workers from different contamination zones containing incompatible wastes. Entry and exit points should be conspicuously marked, and the entry to the Contamination Reduction Zone (CRZ) from the Exclusion Zone should be separate from the entry to the

Exclusion Zone from the CRZ. Dressing stations for entry to the CRZ should be separate from redressing areas for exit from the CRZ. Personnel who wish to enter clean areas of the decontamination facility, such as locker rooms, should be completely decontaminated.

Examples of decontamination lines and procedures for personnel wearing various levels of protection are provided in an appendix to this section.

Disposal Methods

All equipment used for decontamination must be decontaminated and/or disposed of properly. Buckets, brushes, clothing, tools, and other contaminated equipment should be collected, placed in containers, and labeled. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags, pending further decontamination and/or disposal.

Table 3. Some Recommended Equipment for Decontamination of Personnel and Personal Protective Clothing and Equipment

- Drop cloths of plastic or other suitable materials on which heavily contaminated equipment and outer protective clothing may be deposited.
- Collection containers, such as drums or suitably lined trash cans, for storing disposable clothing and heavily contaminated personal protective clothing or equipment that must be discarded.
- Lined box with absorbents for wiping or rinsing off gross contaminants and liquid contaminants.
- Large galvanized tubs, stock tanks, or children's wading pools to hold wash and rinse solutions. These should be at least large enough for a worker to place a booted foot in, and should have either no drain or a drain connected to a collection tank or appropriate treatment system.
- Wash solutions selected to wash off and reduce the hazards associated with the contaminants.
- Rinse solutions selected to wash off and reduce the hazards associated with the contaminants.
- Long-handled, soft-bristled brushes to help wash and rinse off contaminants.
- Paper or cloth towels for drying protective clothing and equipment
- Lockers and cabinets for storage of decontaminated clothing and equipment.
- Metal or plastic cans or drums for contaminated wash and rinse solutions.
- Plastic sheeting, sealed pads with drains, or other appropriate methods for containing and -collecting contaminated wash and rinse solutions spilled during decontamination.
- Shower facilities for full body wash or, at a minimum, personal wash sinks (with drains connected to a collection tank or appropriate treatment system).
- Soap or wash solution, wash cloths, and towels for personnel.
- Lockers or closets for clean clothing and personal item storage.

Personal Protection

Decontamination workers who initially come in contact with personnel and equipment leaving the Exclusion Zone will require more protection from contaminants than decontamination workers who are assigned to the last station in the decontamination line. In some cases, decontamination personnel should wear the same levels of PPE as workers in the Exclusion Zone. In other cases, decontamination personnel may be sufficiently protected by wearing one level lower protection (e.g., wearing Level C protection while decontaminating workers who are wearing Level B).

The level of protection required will vary with the type of decontamination equipment used. For example, workers using a steam jet may need a different type of respiratory protection than other decontamination personnel because of the high moisture levels produced by steam jets. In some situations, the cleaning solutions used and wastes removed during decontamination may generate harmful vapors. Appropriate equipment and clothing for protecting decontamination personnel should be selected by a qualified health and safety expert.

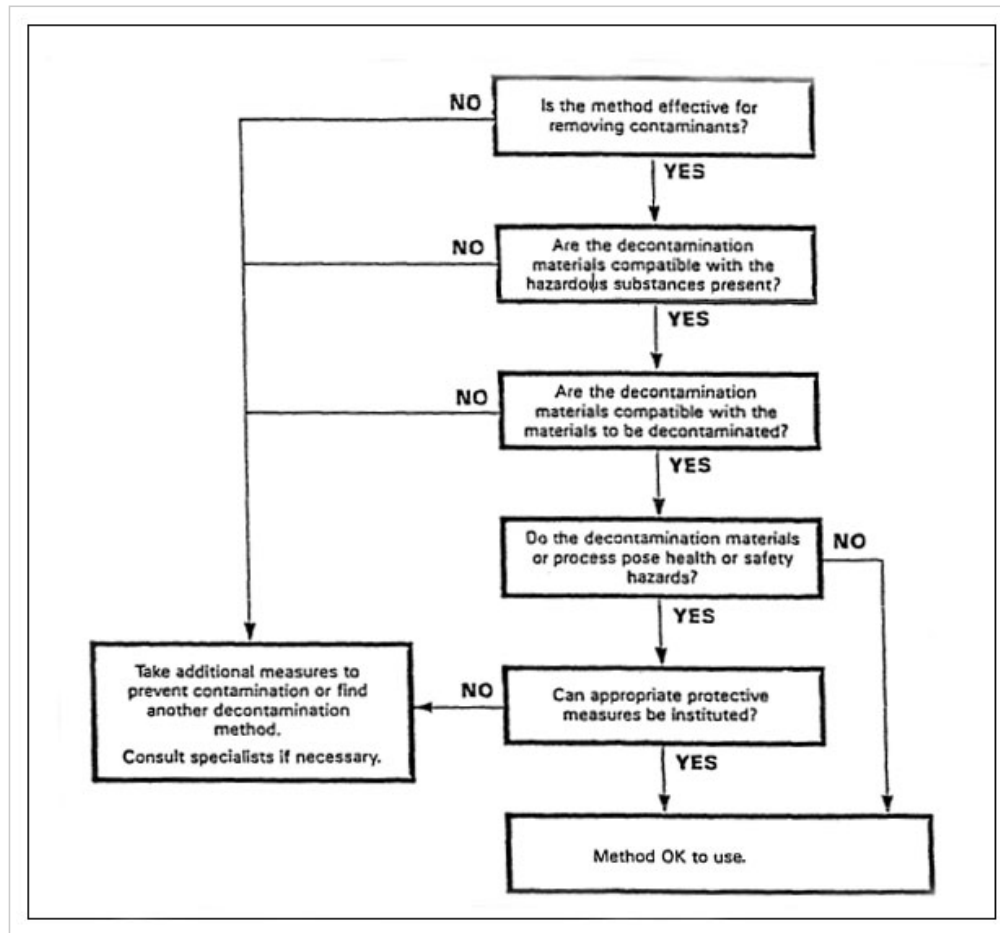
Table 4. Some Recommended Equipment for Heavy Equipment and Vehicle Decontamination

- Storage tanks of appropriate treatment systems for temporary storage and/or treatment of contaminated wash and rinse solutions.
- Drains or pumps for collection of contaminated wash and rinse solutions.
- Long-handled brushes for general exterior cleaning.
- Wash solutions selected to remove and reduce the hazards associated with the contamination.
- Rinse solutions selected to remove contaminants and contaminated wash solutions.
- Pressurized sprayers for washing and rinsing, particularly hard-to-reach areas.
- Curtains, enclosures, or spray booths to contain splashes from pressurized sprays.
- Long handled brushes, rods, and shovels for dislodging contaminants and contaminated soil caught in tires and the undersides of vehicles and equipment.
- Containers to hold contaminants and contaminated soil removed from tires and the undersides of vehicles and equipment.
- Wash and rinse buckets for use in the decontamination of operator areas inside vehicles and equipment.
- Brooms and brushes for cleaning operator areas inside vehicles and equipment.
- Containers for storage and disposal of contaminated wash and rinse solutions, damaged or heavily contaminated parts, and equipment to be discarded.

An decontamination workers are in a contaminated area and must themselves be decontaminated before entering the clean Support Zone. The extent of their decontamination should be determined by the types of contaminants they may have contacted and the type of work they performed.

Emergency Decontamination

In addition to routine decontamination procedures, emergency decontamination procedures must be established. In an emergency, the primary concern is to prevent the loss of life or severe injury to site personnel. If immediate medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. If decontamination can be performed without interfering with essential life-saving techniques or first aid, or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life, decontamination must be performed immediately. If an emergency due to a heat-related illness develops, protective clothing should be removed from the victim as soon as possible to reduce the heat stress. During an emergency, provisions must also be made for protecting medical personnel and disposing of contaminated clothing and equipment.



Decision Aid for Evaluating Health and Safety Aspects of Decontamination Methods.

TEXT VERSION

(Initial box on right side). Is the method effective for removing contaminants?

If No, (Arrow to box on left side below) Take additional measures to prevent contamination or find another decontamination method. Consult specialists if necessary. (End)

If Yes, (Arrow to second box below) Are the decontamination materials compatible with the hazardous substances present?

If No, (Arrow to box on left side below) Take additional measures to prevent contamination or find another decontamination method. Consult specialists if necessary.(End)

If Yes, (Arrow to third box below) Are the decontamination materials compatible with the materials to be decontaminated?

If No, (Arrow to box on left side below) Take additional measures to prevent contamination or find another decontamination method. Consult specialists if necessary. (End)

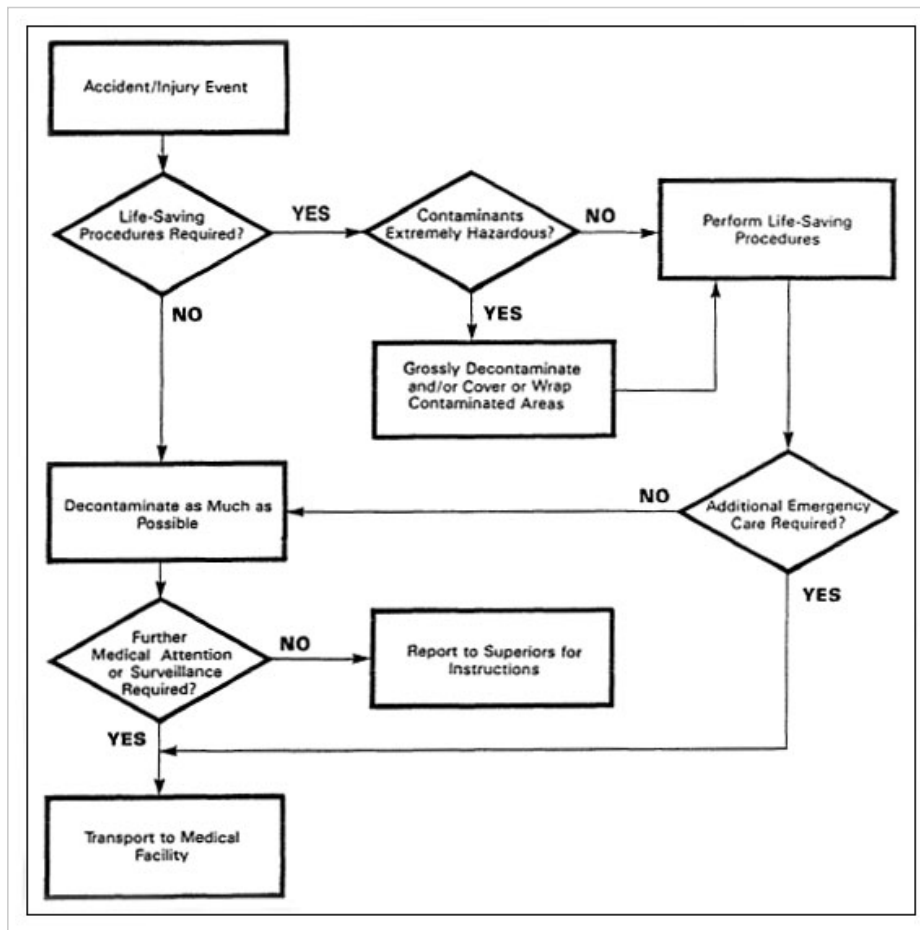
If Yes, (Arrow to fourth box below) Can appropriate decontamination materials or process pose health or safety hazards?

If No, (Arrow to sixth box below) Method OK to use.(End)

If Yes, (Arrow to fifth box below) Can appropriate protective measures be institution

If No, (Arrow to box on left side below) Take additional measures to prevent contamination or find another decontamination method. Consult specialists if necessary.

If Yes, (Arrow to sixth box on right side) Method OK to use.(End)



Decision Aid for Emergency Decontamination

TEXT VERSION

(Initial box on left side) Accident/Injury Event

(Arrow to first decision diamond) Life-Saving Procedures Required?

If No, (Arrow to box below) Decontaminate as much as possible

(Continue to decision diamond below) Further Medical Attention or Surveillance Required?

If No, (Arrow to box to the right) Report to Superiors for Instructions. (End)

If Yes, (Arrow to box below) Transport to Medical Facility (End)

If Yes, (Arrow to second decision diamond to the right) Contaminants Extremely Hazardous?

If No, (Arrow to box on right side) Perform Life-Saving Procedures

(Continue to decision arrow below) Additional Emergency Care Required?

If No, (Arrow to box on left) Decontaminate as Much as Possible

(Continue to decision arrow below) Further Medical Attention or Surveillance Required?

If No, (Arrow to box to the right) Report to Superiors for Instructions. (End)

If Yes, (Arrow to box below) Transport to Medical Facility (End)

If Yes, (Continue to box below) Grossly Decontaminate and/or Cover or Wrap Contaminated Areas (End)

Sample Decontamination Procedures for Three Typical Levels of Protection^a

F.S.O.P. No. 7

Process: DECONTAMINATION PROCEDURES

INTRODUCTION

1.1 The objective of these procedures is to minimize the risk of exposure to hazardous substances. These procedures were derived from the U.S. Environmental Protection Agency, Office of Emergency and Remedial Response's (OERR), "Interim Standard Operating Safety Guides (revised Sep. 82)". This version of the guides is in a format that is more appropriate for use in the field.

1.2 Protective equipment must be worn by personnel when response activities involve known or suspected hazardous substances. The procedures for decontaminating personnel upon leaving the contaminated area are addressed for each of the EPA, OERR designated levels of protection. The procedures given are for the maximum and minimum amount of decontamination used for each level of protection.

1.3 The maximum decontamination procedures for all levels of protection consist of specific activities at nineteen stations. Each station emphasizes an important aspect of decontamination. When establishing a decontamination line, each aspect should be incorporated separately or combined with other aspects into a procedure with fewer steps (such as the Minimum Decontamination Procedures).

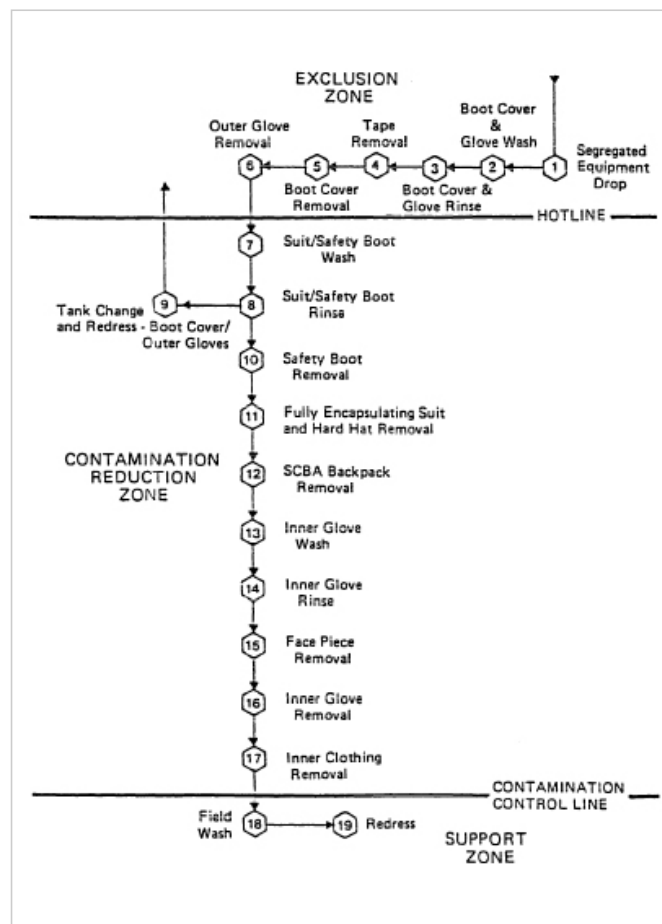
1.4 Decontamination lines are site specific since they are dependent upon the types of contamination and the type of work activities on site. A cooling station is sometimes necessary within the decontamination line during hot weather. It is usually a location in a shaded area in which the wind can help to cool personnel. In addition, site conditions may permit the use of cooling devices such as cool water hose, ice packs, cool towels, etc. When the decontamination line is no longer required, contaminated wash and rinse solutions and contaminated articles must be contained and disposed of as hazardous wastes in compliance with state and federal regulations.

F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL A PROTECTION



Maximum Decontamination Layout - Level A Protection

TEXT VERSION

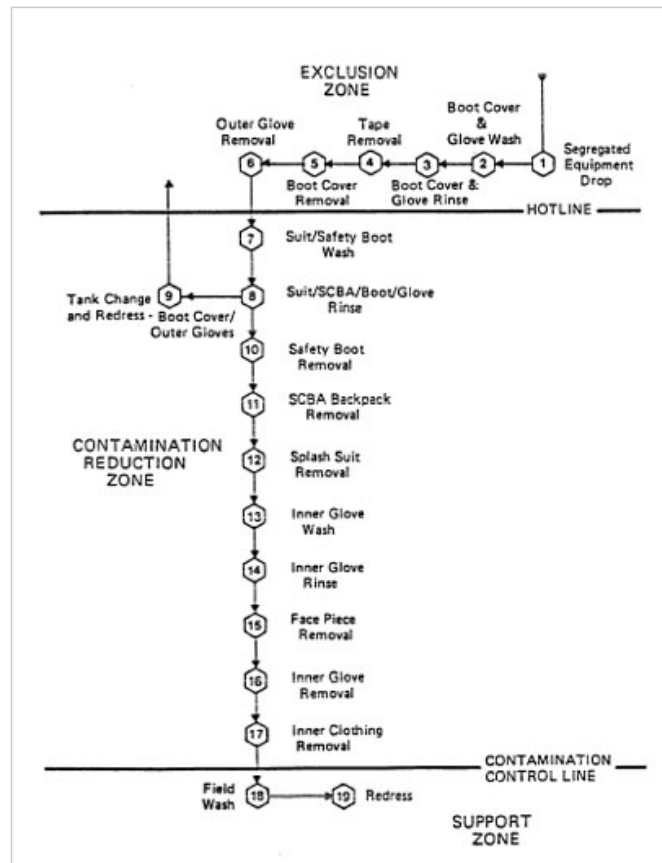
EXCLUSION ZONE (Each station has a numbered hexagon and arrow pointing to next station in a line above the HOTLINE) A flow chart from Station 1: Segregated Equipment Drop, to Station 2: Boot Cover & Glove Wash, to Station 3: Boot Cover & Glove Rinse, to Station 4: Tape Removal, to Station 5: Boot Cover Removal, to Station 6: Outer Glove Removal (The arrow at Station 6 points downward across the HOTLINE into the CONTAMINATION REDUCTION ZONE. A series of numbered hexagons point downward toward the CONTAMINATION CONTROL LINE.) Station 7: Suit/Safety Boot Wash (within the CONTAMINATION REDUCTION ZONE), to Station 8: Suit/SCBA/Boot/Glove Rinse. The Station 8 numbered hexagon has two arrows, the first arrow points to Station 9: Tank Change and Redress - Boot Cover/Outer Gloves, which has an upward arrow that crosses the HOTLINE reentering the EXCLUSION ZONE, and the second arrow, continuing downward to Station 10: Safety Boot Removal, to Station 11: SCBA Backpack Removal, to Station 12: Splash Suit Removal, to Station 13: Inner Glove Wash, to Station 14: Inner Glove Rinse, to Station 15: Face Piece Removal, to Station 16: Inner Glove Removal, to Station 17: Inner Clothing Removal which has an arrow crossing downward past the CONTAMINATION CONTROL LINE, to Station 18: Field Wash (within the SUPPORT ZONE), which has an arrow across to Station 19: Redress, the final station.

F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL B PROTECTION



Maximum Decontamination Layout - Level B Protection

TEXT VERSION

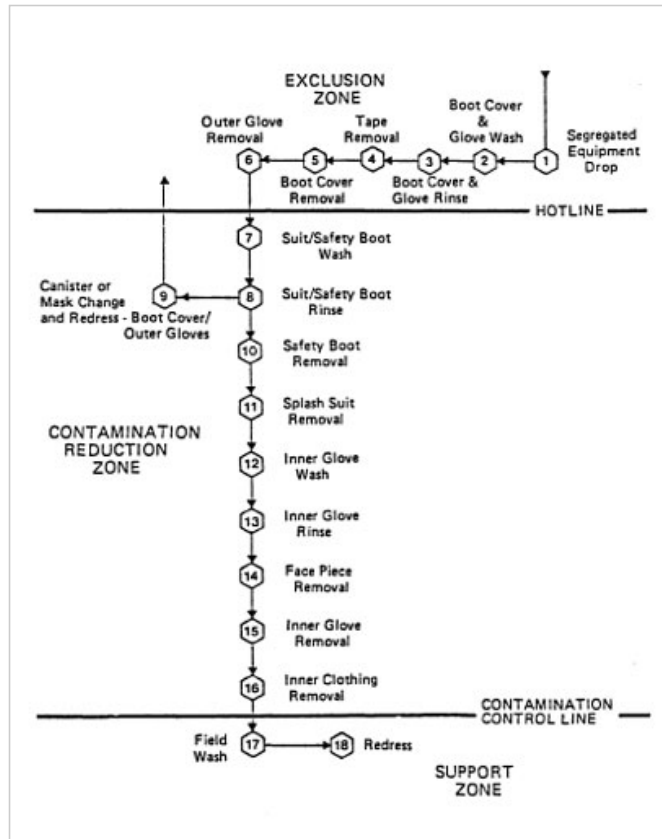
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F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL C PROTECTION



Maximum Decontamination Layout - Level C Protection

TEXT VERSION

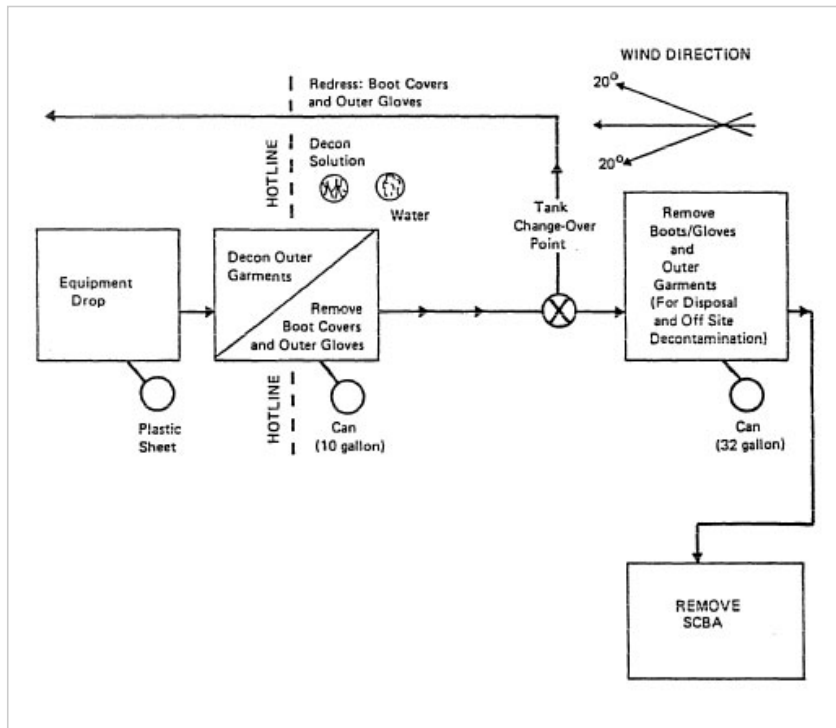
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F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MINIMUM DECONTAMINATION LAYOUT

LEVEL A & B PROTECTION



Minimum Decontamination Layout - Level A & B Protection

TEXT VERSION

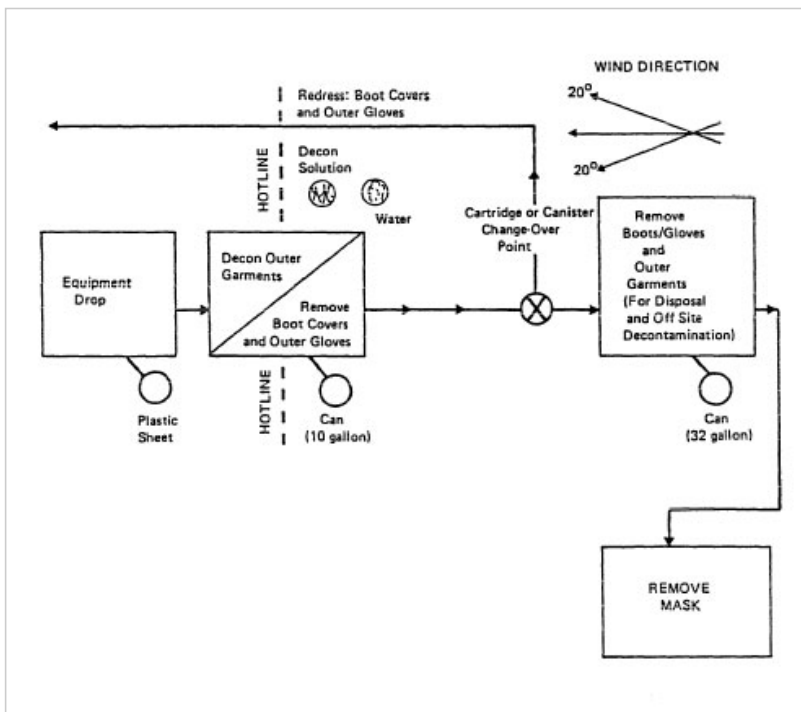
(A series of three arrows in the upper right, one arrow 20 degrees above and the other arrow 20 degrees below the central arrow, indicate wind direction toward the HOTLINE.) The Equipment Drop Area (from left to right) is indicated by a rectangle with a circle below indicating the location of the Plastic sheet and a right pointing arrow to another rectangle divided by a diagonal line into the Decon Outer Garments area and the Remove Boot Covers and Outer Gloves area with a circle below indicating the location of a 10 gallon can. A dashed line cutting vertically through this rectangle indicates the HOTLINE. To the right of the HOTLINE, above the rectangle, two circles indicate the location of the Decon Solution and Water. Two arrows continue from the second divided Decon rectangle to a circle marked with an X that has an upward pointing arrow, that turns back toward the dashed HOTLINE to an area labelled Redress: Boot Covers and Outer Gloves, and crosses the dashed HOTLINE. Another arrow from the circle marked with an X continues to a rectangle indicating the area to Remove Boots/Gloves and Outer Garments (For Disposal and Off Site Decontamination) with a circle below indicating the location of a 32 gallon can. Another series of arrows pointing downward go to another rectangle, the Remove SCBA final decon area.

F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MINIMUM DECONTAMINATION LAYOUT

LEVEL C PROTECTION



Minimum Decontamination Layout - Level C Protection

TEXT VERSION

(A series of three arrows in the upper right, one arrow 20 degrees above and the other arrow 20 degrees below the central arrow, indicate wind direction toward the HOTLINE.) The Equipment Drop Area (from left to right) is indicated by a rectangle with a circle below indicating the location of the Plastic sheet and a right pointing arrow to another rectangle divided by a diagonal line into the Decon Outer Garments area and the Remove Boot Covers and Outer Gloves area with a circle below indicating the location of a 10 gallon can. A dashed line cutting vertically through this rectangle indicates the HOTLINE. To the right of the HOTLINE, above the rectangle, two circles indicate the location of the Decon Solution and Water. Two arrows continue from the second divided Decon rectangle to a circle marked with an X that has an upward pointing arrow, that turns back toward the dashed HOTLINE to an area labelled Redress: Boot Covers and Outer Gloves, and crosses the dashed HOTLINE. Another arrow from the circle marked with an X continues to a rectangle indicating the area to Remove Boots/Gloves and Outer Garments (For Disposal and Off Site Decontamination) with a circle below indicating the location of a 32 gallon can. Another series of arrows pointing downward go to another rectangle, the Remove Mask final decon area.

EQUIPMENT NEEDED TO PERFORM MAXIMUM DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 1:	<ul style="list-style-type: none"> a. Various Size Containers b. Plastic Liners c. Plastic Drop Cloths 	Station 10:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools d. Boot Jack
Station 2:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Decon Solution or Detergent Water c. 2-3 Long-Handled. Soft-Bristled Scrub Brushes 	Station 11:	<ul style="list-style-type: none"> a. Rack b. Drop Cloths c. Bench or Stools
Station 3:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) Station OR High-Pressure Spray Unit b. Water c. 2-3 Long-Handled. Soft-Bristled Scrub Brushes 	Station 12:	<ul style="list-style-type: none"> a. Table
		Station 13:	<ul style="list-style-type: none"> a. Basin or Bucket b. Decon Solution c. Small Table
Station 4:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners 	Station 14:	<ul style="list-style-type: none"> a. Water b. Decon Solution c. Small Table
Station 5:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools 	Station 15:	<ul style="list-style-type: none"> a. Containers (20-30 Gallons) b. Plastic Liners

EQUIPMENT NEEDED TO PERFORM MAXIMUM DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 6:	a. Containers (20-30 Gallons) b. Plastic Liners	Station 16:	a. Containers (20-30 Gallons) b. Plastic Liners
Station 7:	a. Containers (20-30 Gallons) Station b. Decon Solution c. 2-3 Long-Handled. Soft-Bristled Scrub Brushes	Station 17:	a. Containers (20-30 Gallons) b. Plastic Liners
Station 8:	a. Containers (20-30 Gallons) Station OR High-Pressure Spray Unit Station b. Water c. 2-3 Long-Handled. Soft-Bristled Scrub Brushes	Station 18:	a. Water b. Soap c. Small Table d. Basin or Bucket e. Field Showers f. Towels
Station 9:	a. Air Tanks or Face Masks and Cartridge Depending on Level b. Tape c. Boot Covers d. Gloves	Station 19:	a. Dressing Trailer is Needed in Inclement Weather b. Tables c. Chairs d. Lockers e. Cloths

EQUIPMENT NEEDED TO PERFORM MINIMUM DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 1:	a. Various Size Containers b. Plastic Liners c. Plastic Drop Cloths	Station 4:	a. Air Tanks or Masks and Cartridges Depending Upon Level b. Tape c. Boot Covers d. Gloves
Station 2:	a. Containers (20-30 Gallons) b. Decon Solution c. Rinse Water d. 2-3 Long-Handled, Soft-Bristled Scrub Brushes	Station 5:	a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools
Station 3:	a. Containers (20-30 Gallons) b. Plastic Liners c. Bench or Stools	Station 6:	a. Plastic Sheets b. Basin or Bucket c. Soap and Towels d. Bench or Stools
		Station 7:	a. Water b. Soap c. Tables d. Wash Basin or Bucket

FSOP 7: MAXIMUM MEASURES FOR LEVEL A DECONTAMINATION

Station 1:	Segregated Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. During hot weather operations, a cool down station may be set up within this area.
Station	Boot Cover and	2. Scrub outer boot covers and gloves with decon solution or detergent/water.

2:	Glove Wash	
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7. Wash encapsulating suit and boots using scrub brush and decon solution or detergent/water. Repeat as many times as necessary.
Station 8:	Suit and Boot	8. Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Tank Change	9. If an air tank change is desired, this is the last step in the decontamination procedure. Air tank is exchanged, new outer gloves and boot covers donned, and joints taped. Worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	Fully Encapsulating Suit and Hard Hat Removal	11. Fully encapsulated suit is removed with assistance of a helper and laid out on a dropcloth or hung up. Hard hat is removed. Hot weather rest station maybe set up within this area for personnel returning to site.
Station 12:	SCBA Backpack Removal	12. While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve and proceed to next station.
Station 13:	Inner Glove Wash	13. Wash with decon solution that will not harm the skin. Repeat as often as necessary.
Station 14:	Inner Glove Rinse	14. Rinse with water. Repeat as many times as necessary..
Station 15:	Face Piece Removal	15. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	16. Remove inner gloves and deposit in container with liner.
Station 17:	Inner Clothing Removal	17. Remove clothing and place in lined container. Do not wear inner clothing off-site since there 'is a possibility that small amounts of contaminant might have been transferred in removing the fully-encapsulating suit.
Station 18:	Field Wash	18. Shower if highly toxic skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19:	Redress	19. Put on clean clothes.

FSOP 7: MINIMUM MEASURES FOR LEVEL A DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations. cool down stations maybe set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and fully-encapsulating suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4. If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boots, Gloves and Outer Garment Removal	5. Boots, fully-encapsulating suit, inner gloves removed and deposited in separate containers lined with plastic.

Station 6:	SCBA Removal	6. SCBA backpack and facepiece is removed (avoid touching face with fingers). SCBA deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

FSOP 7: MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Segregated Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Safety Boot Wash	7. Wash chemical-resistant splash suit, SCBA, gloves and safety boots. Scrub with long-handle scrub brush and decon solution. Wrap SCBA regulator (if belt mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloths.
Station 8:	Suit, SCBA, Boot and Glove Rinse	8. Rinse off decon solution using copious amounts of water.
Station 9:	Tank Change	9. If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged. new outer gloves and boot covers donned, and joints taped. Worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	SCBA Backpack Removal	11. While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve.
Station 12:	Splash Suit Removal	12. With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 13:	Inner Glove Wash	13. Wash inner gloves with decon solution.
Station 14:	Inner Glove Rinse	14. Rinse inner gloves with water.
Station 15:	Face Piece Removal	15. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	16. Remove inner gloves and deposit in container with liner.
Station 17:	Inner Clothing Removal	17. Remove inner clothing. Place in container with liner. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 18:	Field Wash	18. Shower if highly toxic. skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19:	Redress	19. Put on clean clothes.

FSOP 7: MINIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations. cool down stations maybe set up within this area.
Station	Outer Garment,	2. Scrub outer boots, outer gloves and chemical-resistant splash suit with decon solution or detergent and water. Rinse off using

2:	Boots, and Gloves Wash and Rinse	copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4. If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boots, Gloves and Outer Garment Removal	5. Boots, chemical-resistant suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	6. SCBA backpack and facepiece is removed Avoid touching face with finger. SCBA deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

FSOP 7: MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Segregated Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7. Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Station 8:	Suit, SCBA, Boot and Glove Rinse	8. Rinse off decon solution water. Repeat as many times as necessary.
Station 9:	Canister or Mask Change	9. If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged. new outer gloves and boot covers donned, and joints taped. Worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	Splash Suit Removal	11. With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 12:	Inner Glove Wash	12. Wash inner gloves with decon solution.
Station 13:	Inner Glove Rinse	13. Rinse inner gloves with water.
Station 14:	Face Piece Removal	14. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	15. Remove inner gloves and deposit in container with liner.

^aSource: Excerpted from *Field Standard Operating Procedures for the Decontamination of Response Personnel {FSOP 7}*. EPA Office of Emergency and Remedial Response. Hazardous Response Support Division, Washington. DC. January 1985.

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