

Chapter 6

Work Area Preparation, Decontamination, and Disinfection

Chapter 6: Work Area Preparation, Decontamination, and Disinfection

Objectives

After completing this chapter, participants should be able to:

1. Explain the importance of preparing an infected work area before decontamination and disinfection work begins.
2. Describe isolation and containment procedures for working around infectious diseases.
3. List the steps in preparing the work area for infectious disease decontamination and disinfection.
4. Define the purpose of the decontamination chamber on an infectious disease cleanup project.
5. List the elements of the decontamination chamber and explain the function of each.
6. Explain the purpose and function of a negative air machine.
7. Given scenarios of spaces, calculate the number of negative air machines needed to meet air change requirements.
8. Describe setting up a negative-pressure enclosure.
9. Describe decontamination and disinfection procedures for infected areas.
10. Describe the process for passing through a six-stage decontamination unit to leave the work area.
11. Demonstrate proper techniques for eliminating contaminants on surfaces.
12. Demonstrate setting up a six-stage decontamination unit to enclose a work area.
13. Demonstrate the proper inspection and donning of PPE.
14. Demonstrate the proper disinfection and doffing of PPE through the stages of the decontamination process.

Introduction

Removal of infectious pathogens is a relatively new field. This and similar problems have been successfully dealt with in the past in medical research and hospital facilities, and at certain military installations. The lessons from these past experiences are being used by contractors and government agencies in designing the approaches being used today. However, it should be remembered that the successful approaches in the past might not be fully applicable in new settings.

In addition, innovative methods are being developed that will likely be used in the future. The key point to remember regarding work area preparation, decontamination, and disinfection techniques is that prevention of exposure is the first and primary line of defense for workers. This applies both to the infectious pathogens that are the source of the problem, and to the chemicals that are used to destroy the pathogens.

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Work Area Preparation, Decontamination, and Disinfection

On an infectious disease worksite, isolation and containment may be necessary before any decontamination or disinfection of the site can be done. Isolation is the physical separation of an infected or colonized host from the remainder of the at risk population, in an attempt to prevent transmission of the specific agent to other individuals and patients. Containment prevents the spread of contaminants outside the work area.

The goal of decontamination is to remove and/or clean contaminated materials in a way that prevents infectious pathogens from leaving the work area to protect other building occupants, while protecting the health of workers performing the decontamination.

Disinfection is not the same as decontamination, even though many people use the terms interchangeably. Disinfection is a form of decontamination. Decontamination reduces the level of danger from microorganisms in an area or on an object so that it no longer poses harm. Disinfection goes one step further – it kills the pathogens by using bleach. Sterilization is the next step beyond disinfection. While disinfection eliminates the pathogens, sterilization actually removes the spores on surfaces.

The following items are some of the things to take into consideration when planning the containment area on high infectious disease remedial projects:

- work area preparation;
- worker protection (including proper controls, ppe, and decontamination);
- containment and isolation;
- movable and unmovable objects;
- enclosing an area;
- creating negative pressure;
- elimination of contaminants on hard surfaces;
- elimination of contaminants on porous surfaces;
- inspection and final clearance;
- waste disposal, including the waste load-out area; and
- transportation to the disposal site.

WORK AREA PREPARATION

Work area preparation includes all work that should be performed before work begins. This includes conveying the scope of the work to the workers, training for worker protection, and constructing the decontamination unit.

The contaminated area should not be disturbed until proper controls have been implemented, in order to avoid spreading infectious pathogens to other areas. Work area preparation procedures may include:

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*HVAC: Heating, Ventilating,
and Air Conditioning systems*

- Containment to control exposure to adjacent areas.
- Shutting down the HVAC system and covering vents and air ducts inside the work area.

Work area preparation may also include:

- Limiting access to only authorized personnel trained in the hazards of the contamination present and hazards regarding decontamination and disinfection. To avoid unauthorized entry, signs should be posted at entrances to the work area.
- Controlling electrical hazards by shutting down and/or locking out power sources.
- Cleaning, packaging, and removing non-stationary objects, such as furniture and equipment.

Worker Protection

Before entering the work area, it is required that workers be instructed in the use of respirators, protective clothing, decontamination procedures, and entry and exit procedures.

Appropriate personal protective equipment (PPE) must be used to protect workers from exposure to both infectious pathogens and to chemicals used during the decontamination and disinfection process.



Open sores and cuts should not be left exposed when working around infectious agents.

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The use of respirators, rubber boots, rubber gloves, eye protection, and protective clothing is required. Extensive contamination should be assessed by an experienced health and safety professional and/or an infectious disease specialist and remediated by personnel with training and experience handling environmentally contaminated materials.

Open sores and cuts should not be left exposed. Also, injuries resulting in breaks of the skin should be treated and reported immediately.

Respirators with high efficiency particulate air (HEPA) filters are most likely necessary during the decontamination and disinfection of highly infectious biological agents. The use of chemical agents to destroy infectious pathogens requires appropriate chemical cartridges. When eliminating any biological agents with chemicals, the use of combination HEPA/chemical cartridges is required.

ISOLATION AND CONTAINMENT PROCEDURES

Containment prevents the spread of contaminants outside the work area. Work areas can vary in size and may have several points of entrance and exit and several different defined work areas, where different cleanup operations could be simultaneously taking place. For example, HEPA vacuuming operations could be going on in one area, while the spraying of chemical disinfectants could be occurring in other areas.

Even in large operations, the basic principles for containment and isolation of a smaller area or zone should generally be followed. For example, if an entire building were the work area, one would expect the details to be different. There might still only be a single entrance/exit, or perhaps a small number of additional ones. Special attention might be paid to sealing off certain areas, such as parking garages or stairwells, which might be remediated using a different approach than offices. The whole building may have a special HEPA filtered exhaust point created that does not use the normal HVAC exhaust point. Other site-specific options are also possible.

Note: The way the infectious agent is transmitted should be taken into consideration when determining best courses of action. For example, some diseases and pathogens are considered aerosol transmissible pathogens or diseases, while others like Ebola are not. For a list of diseases and pathogens that are considered aerosol transmissible, refer to Appendix A of the Cal-OSHA Aerosol Transmissible Diseases Standards.

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The following detailed approach, appropriate for a relatively small part of a large building, presents the general principles that should be followed in larger structures as well:

- Isolate the entire work area from any other occupied spaces and seal HVAC components with polyethylene sheeting (poly), and tape (just as with anthrax, asbestos, or lead).
- Establish negative pressure in the work area. Guidelines for creating negative-pressure enclosures use of negative air units, and recommended air exchanges are discussed later in this chapter.
- Establish decontamination chambers for entering and exiting the work area.
- Isolate the problem so that the pathogens do not spread.

Typically, decontamination and disinfection work will not begin until the work area is evaluated by a safety and health professional or an infectious disease specialist.

GUIDELINES FOR WORK AREA PREPARATION

Preparing the work area will be different for each project, but there are general guidelines that should be followed for all projects. These guidelines can be modified to address specific problems encountered during infectious disease decontamination and disinfection, or changed to meet state or local requirements.

The following steps should be followed when preparing the work area.

1. Perform a risk assessment.
2. Post danger signs to limit access to the work area.
3. Shut down heating, ventilating, and air conditioning systems (HVAC).
4. Secure the work area.
5. Set up the decontamination unit.

1. Perform a Risk Assessment

The risk assessment was covered in Chapter 1 and will be conducted by health and safety experts. Administrators, supervisors, maintenance personnel, and those working closest to the hazard will have the direct experience with the tasks and operations that have the

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potential for exposure. They can help develop effective interventions that workers can and will use to improve infection prevention and control.

2. Post Danger Signs

Danger signs (Figure 1) should be placed at each entrance to the work area. Post signs at stairways and elevators warning of the dangers. Stairways and elevators must also be sealed off if leading to the work area.



Figure 1. Danger sign.

Reusable metal, plastic, or disposable cardboard signs are available.

The employer must ensure that employees working in and around the regulated areas understand the signs. This may mean that the signs need to use multiple languages, pictographs, and graphics. These signs are available from most safety supply houses.

3. Shut Down Heating, Ventilating, and Air Conditioning Systems

The heating, ventilating, and air-conditioning (HVAC) systems supplying the work area should be shut down. To avoid activating the HVAC system by mistake while removal operations are in progress, the control panel must be locked and tagged out (Figure 2).

All vents and air ducts inside the work area should be disinfected and covered with poly and duct tape. This will most likely be done just prior to the cleanup work activities. HVAC filters, which may be contaminated with airborne pathogens, should be removed and disposed of in the same manner as the other contaminated material.



Figure 2. Lock Out and Tag Out

4. Secure the Work Area

All entrances and exits should be secured when removal operations are not in progress.

Make sure decontamination unit entrance will be secured when no one is on the jobsite. Security guards may be a reasonable precaution, depending on the nature of the project.

When the work area is occupied, padlocks must be removed to permit emergency escape routes. Arrows may need to be taped on the walls to indicate the location of exits. The arrows should be approximately 1 ft. off the ground so workers can see them in case smoke fills the work area.

Nonessential personnel should not be permitted to enter the work area. An on-site job log should be maintained for recording the time each person enters and exits the work area.

5. Set Up the Decontamination Unit



*decontamination unit
decon
decon unit*

A decontamination unit is designed to allow workers to pass in and out of the work area. In asbestos, for example, the typical decontamination unit has a clean room, a shower room, and an equipment room separated by air locks. The decontamination unit that will be discussed in this chapter relates to high-risk infectious diseases and is somewhat different than the typical asbestos decontamination unit. In cases of lower-risk infectious diseases, the decontamination unit may be nothing more than the use of an anteroom.



***anteroom:** A small separate barrier room at the entrance to the work area, with doors at each end.*

How the decontamination unit is constructed and how many stages it has may vary from site to site. A healthcare specialist and/or an infectious disease specialist will determine its construction including how many stages it will contain. It will depend on what the pathogen is and what type of risk it poses. The physical layout of the facility will be a major factor on what size the decontamination unit can be. The decontamination unit used in this chapter will be a six-stage unit and will be covered later in this chapter.



Modular wall-panel anteroom.

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Decontamination units can be constructed in different ways. One way is the use of 2"× 4" lumber for the frame, one layer of 6-mil poly for the walls, floors, and ceilings, duct tape, staples and screws to build the unit. In some cases, ¼" to ½" plywood may be used to reinforce the poly walls. This type of decontamination unit can be built in sections to allow for easy disassembly and reuse at another area of the building.



Decon built with 2"× 4" lumber and poly

Another way to construct decontamination units is by using an extension pole system such as ZipWall. This system is a quick and easy way to put up temporary sheeting walls. This system comes with several types of "poly hanger" clips to attach the poly to suspended ceiling grids. Poly can then be sealed to the ceiling, walls, and floor by using tape. In many cases, blue painters' tape is used either alone or with a stronger tape. The blue tape will help to avoid damaging the paint or wall coverings.



A plastic sheeting wall with an extension pole system

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ZipWall: a company's brand name, but it is commonly used as a generic term

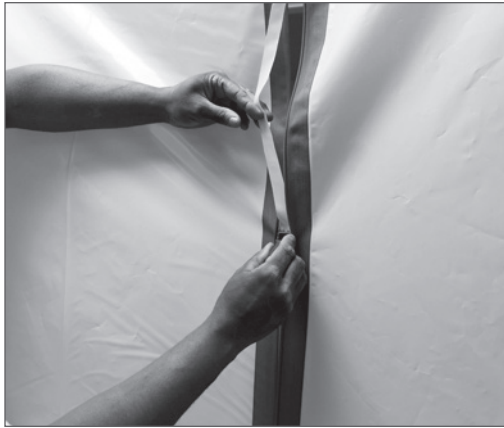
Another option to construct a decontamination unit is a modular wall panel system. These feature reusable panels that slide into metal track sections. As with the other systems mentioned, you can use tape to seal any openings. When using a modular wall panel system, you have to tape the joints in order to get a good seal. Their advantages are that the panels can be assembled and disassembled rather quickly and they form a rigid barrier that can be cleaned easier than by using poly. One disadvantage is that they can be somewhat costly to purchase.

Flap Doors And Zipper Doors

Depending on the site-specific requirements of the job you are working on, flap doors and/or zipper doors may be used to get from one area (room) to another. In some instances, a

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simple flap system may be approved to use. This would involve cutting a slit in the poly in the middle of the doorway and then hanging a separate sheet of rectangular poly at the top of the doorway on both sides of the doorway.



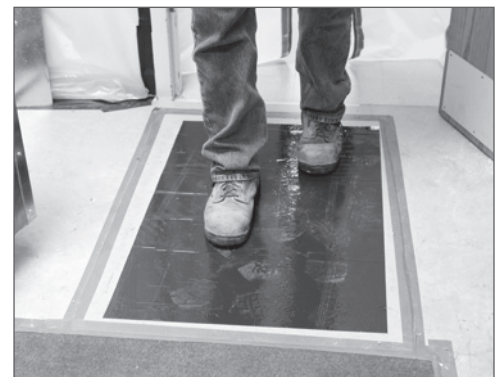
Slitting plastic sheeting for a zipper door.

The more preferred, secure way is to use a zipper door. You get a tighter air seal with a zipper door than with a flap door. For a zipper door, you press a self-adhesive zipper onto the poly where you want your opening. Then you open the zipper and use a utility knife to slit the plastic. You should make two cuts close to the zipper teeth on each side, and remove the strip of poly that is created. If you make only one slit, the remaining flap of poly can get caught in the zipper and jam it. Once the zipper

door is installed, you can open and close the zipper as needed for workers to pass through each stage of the decontamination unit and to and from the work area. Another bonus when using a zipper door is that you can use two zippers on the same door and space them approximately two feet apart. This will allow workers to remove larger items to and from the work area without damaging the zipper door.

Sticky Mats

When working in facilities cleaning an infectious disease area, the use of sticky mats may be required at the entrance and exit of the work area. These are floor mats covered with a sticky adhesive, which pulls dust and dirt off the bottom of boots and the wheels of equipment. They come stacked in pads of 30 or 60 layers (sheets), each layer is numbered so not more than one mat is pulled at a time. Sticky mats come in various sizes, from 18×36 inches up to 36×45 inches.



Sticky mats pull dust and dirt off the bottom of boots and wheels.

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For use on hard-surfaced floors, the bottom of the mat has an adhesive that sticks it to the floor. When positioning a sticky mat, be sure to position it the long way. This ensures that people step on it with both feet, and that equipment is rolled across it and the wheels do a full revolution across the sticky surface.

Once a sticky mat sheet is dirty and needs to be pulled, there is a right way and a wrong way to peel a dirty sheet off the sticky mat. Don't just grab a corner and yank it off. This can make dust and particles airborne. The proper procedure is to carefully peel up all four corners and fold them inward toward the center.

PREPARING TO ENTER THE WORK AREA

Once your decontamination unit is constructed and complete, you are now ready to do the decontamination and disinfection work. Workers must don the proper PPE before entering the work area. They typically will don their PPE in the clean room of the decontamination unit and will be monitored by a trained observer. The trained observer's duties include posting and reading aloud each step of the donning process and confirm visually that all PPE is donned properly. In this course, the clean room is Stage 6 and is the last stage when exiting the work area but it is the first stage when entering the work area.

The following are steps a worker should perform in the clean room and before entering the work area:

1. Inspect all PPE that will be used.
2. Remove clothing and personal items.
3. Put on disposable boxers or cotton underwear (optional).
4. Don inner suit (Tyvek® for example).
5. Using duct tape, prepare and put on disposable belt and attach the PAPR battery to the disposable belt (if a PAPR is being used).
6. Put on inner gloves.
7. Put on outer suit (chemical suit), do not zip the suit up at this time.
8. Put on rubber boots. The outer suit should be placed over the rubber boot and should be taped. If being used, put on boot covers at this time.

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***trained observer:**A dedicated individual with the sole responsibility of ensuring adherence to the entire donning and doffing process.*

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9. Connect PAPR battery and put on respirator face-piece and perform the user seal checks.
10. Put on double hoods over respirator head harness (straps) and zip up (seal) outer coverall. Be sure to tape outer hood to the respirator face-piece brim to gain proper seal.
11. Put on the face shield.
12. Put on outer gloves (heavy duty nitrile) and apply tape. Be sure to put the sleeve of the outer suit over the outer glove.
13. Put on plastic apron (if used).
14. Proceed through the decontamination unit to the work area.

NEGATIVE-PRESSURE ENCLOSURES

Many infectious disease cleanup sites are required to have negative pressure (air) in the work area and/or in the decontamination unit in order to keep hazardous particles and droplets from entering the areas outside the work area and decontamination areas.

Negative pressure is created by a ventilation system, within the area that it is in, that acts as a vacuum, drawing air to the area. The ventilation system should be equipped with HEPA filters and possibly a sorbent filter to make sure that contaminated air is filtered before being released to the outside air or to any other area within the building.

The negative-pressure system typically operates 24 hours a day, seven days a week for the entire project.

Portable, HEPA-Filtered Negative Air Machines

A negative air machine (NAM) is a piece of equipment containing a series of air filters and a fan with an opening at each end. One opening is for air intake and one for exhaust (*Figure 3*). A fan and a series of filters are arranged inside the machine between the openings. The fan draws contaminated air through the intake and filters and discharges clean air through the exhaust. The final filter must be a HEPA filter. A HEPA filter is made of paper-like or aluminum material that is folded into tight pleats.

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NAM: *Negative air machine; also known as hogs, HEPA units, red barons, micro-traps, and negative air units.*

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There are different size NAMs available. For instance, when working in larger area, a 2,000 CFM machine may be needed while a 600 CFM is all that may be needed for a smaller area or for the decontamination unit. Calculations can be made to determine what size and/or how many of these machines will be needed. This is discussed further later in this chapter.

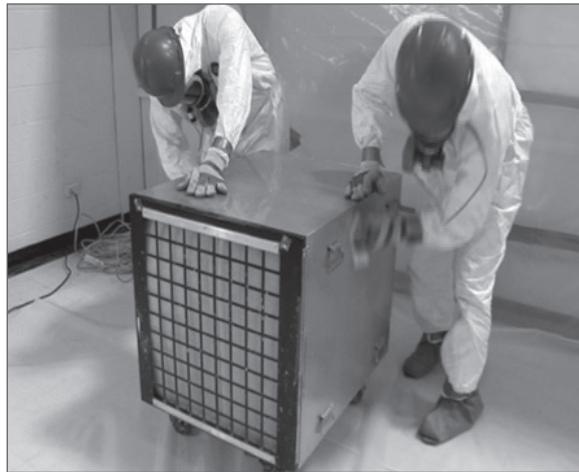


Figure 3. Negative Air Machine

Note: It is common for manufacturers to overrate their NAMs. Most machines are tested under controlled laboratory conditions. Therefore, when used under field conditions, it is recommended that a NAM should be rated at 80% of the manufacturer's rated capacity. For this course, we will use the manufacturer's rated capacity.

The internal mechanisms of most HEPA-filtered exhaust fans are pictured in *Figure 4*. A continuous rubber gasket is located on the filter between the filter and the filter housing to form a tight seal. The gasket material should be $\frac{1}{4}$ " thick and $\frac{3}{4}$ " wide. It should be checked for cracks and gaps when installing the filter. Contaminated air can leak through any breaks.

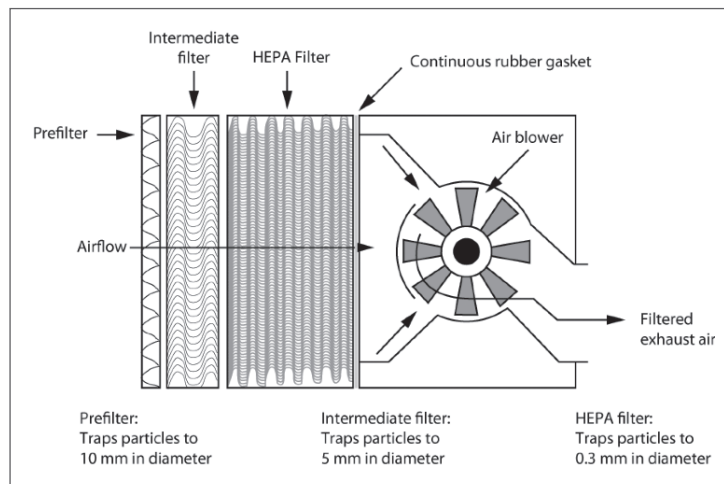


Figure 4. Cross-section HEPA Exhaust

The NAM lowers the air pressure in the work area, making it negative, compared to the air pressure outside the work area. The negative pressure is created by continuously exhausting the air in the work area to the environment outside. This means that air moves into the work area from the clean area outside the chamber. The negative pressure also prevents

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CFM: Cubic feet per minute;
a measure of airflow.

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contaminated air from leaving the work area until it is filtered.

Because the negative pressure is always pulling air into the work area, it protects against the release of hazards to the outside areas where it is not wanted. A negative-pressure system also reduces the concentration of airborne hazards in the work area by bringing in clean air to dilute the contaminated air in the chamber and by exhausting contaminated air through HEPA filters.

HEPA Filters

Each HEPA filter should be individually tested and certified by the manufacturer to have an efficiency of no less than 99.97% for 0.3 μm (micron) particles at the rated airflow. Each HEPA filtration unit can be tested on-site to ensure that it is working properly. This is called an in-place test and should be done by an independent consultant. In-place filter testing is especially recommended if HEPA units must be vented indoors.

Each filter should be marked with the following:

- Name of the manufacturer
- Serial number
- Airflow rating
- Efficiency and resistance
- Direction of airflow

Parts of the Negative Air Machine

Each NAM should have pre-filters, which extend the life of the expensive HEPA filter by filtering out the larger particles in the air first. Pre-filters keep the HEPA filter from getting overloaded too quickly. One (minimum) or two (preferred) stages of pre-filters can be used. The first-stage pre-filter should be a low-efficiency type (i.e., for particles 10 μm and larger). The second-stage (or intermediate) filter should have a medium efficiency (i.e., effective for particles 5 μm and larger). Intermediate filters should be installed in the intake grid of the unit and held in place with special housings or clamps.

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SETTING UP A NEGATIVE-PRESSURE SYSTEM

In order to set up a negative-pressure air filter system, you must determine the amount of air-to-exhaust for a work area.

Determining the Amount of Air to Exhaust for an Area

In order to determine the amount of air that needs to be exhausted to meet requirements, you will first have to do some simple math to calculate what size (or how many) negative air machines you will need to accomplish the necessary air changes per hour (ACH). Specific site requirements will determine how many ACH are required.

ACH is a common measurement for ventilation requirements. They can range anywhere from 4 to 30 ACH, depending on how the space is occupied, how much fresh air is needed, or what amount of particles, droplets, or odor needs to be filtered out of the air in the space. For example, regular patient rooms may require 6 ACH while a room contaminated with an infectious disease may require 12 or more ACH.

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ACH: Air changes per hour; a measure of how many times per hour a fan, NAM, or HVAC system replaces the air in a space with fresh air.

Calculation Formulas

The following three formulas will help to determine how much air to exhaust in the area you are in:

1. Volume of air in your space in cubic feet:

$\text{Length} \times \text{width} \times \text{height} = \text{volume in cubic feet}$

2. CFM required for given ACH:

$\text{ACH} \times \text{volume} \div 60 \text{ minutes per hour} = \text{CFM}$

3. ACH produced by given CFM:

$\text{CFM} \times 60 \text{ minutes per hour} \div \text{volume} = \text{ACH}$

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Let's say your work area is 15' x 20' x 8' and your NAM is rated at 600 CFM and you are required to have 12 ACH.

Step 1: $\text{Volume} = L \times W \times H$
 $\text{Volume} = 15' \times 20' \times 8'$
 $\text{Volume} = 2,400 \text{ cubic feet}$

Step 2: $\text{CFM} = \text{ACH} \times \text{volume} \div 60 \text{ minutes per hour}$
 $\text{CFM} = 12 \times 2,400 \div 60$
 $\text{CFM} = 480$

In this case, you will need to move 480 CFM in order to achieve 12 ACH so your NAM is big enough to accomplish this. Even if you rated your NAM at 80%, it would just be enough ($600 \text{ CFM} \times .80 = 480 \text{ CFM}$).

If your site does require the use of NAMs, a backup unit(s) is necessary. The general rule is to have one backup unit for up to four machines. If there are more than four machines, add two backups. In the example, a total of one machine is needed to get the 12 ACH so you will need one additional one for backup.

Location of Negative-pressure Unit

The negative-pressure unit(s) should be located so that make-up air (air from outside the work area) enters the work area usually through the decontamination unit and sweeps across the work area as much as possible. This can be achieved by putting the negative-pressure unit(s) as far as possible from the work area entrance/exit or other make-up air sources.

Routing the Exhaust

In order to route the exhaust, you will first need to attach the exhaust flex duct to the exhaust outlet on the NAM with either a metal clamp, zip ties, or duct tape. To create negative air pressure, the exhaust air must go outside of your work area (barrier). Your specific site requirements will decide where the air will be exhausted. Ideally, exhausting the air outside would be best but in most cases, not feasible. Although the exhaust air has been cleaned by the NAM filters, it comes out at a higher speed than normal HVAC supply vent air, so it can stir up contaminants on surfaces outside the work area or decontamination unit.

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Changing the Air Filters

When you remove any of the filters of the NAM, immediately seal them in an approved waste bag or container so no pathogens go back into the air. Be sure to install new filters in the correct order or correct slots on the NAM. If the filters have to be installed facing a certain way (airflow arrow), be sure they are facing the correct way. Also, the proper PPE must be worn whenever changing any of the NAM filters.

Removing the NAM

When dismantling the NAM at the end of the job, you want to minimize dust and the spread of pathogens. Remove the filters and immediately seal them in the appropriate receptacles. Disinfect the entire machine, inside and out (including the wheels if there are any) with an approved disinfectant. Wrap the entire machine in an approved bag or wrap and tape with poly. You may have to disinfect the wrapping as well in Stage 2 of the decontamination unit as well before bringing the NAM out of the decontamination unit.

DECONTAMINATION AND DISINFECTION PROCESS

Once in the work area, there are several steps involved in the decontamination and disinfection of an area where infectious agents are known or suspected to be present. Note that these steps may vary depending on the type of facility or the pathogens present.

Step 1: Before removal of either porous or hard materials, all contaminated surfaces should be misted with a bleach solution to reduce the formation of aerosols.

Bleach solutions should be applied with an airless sprayer and left on contaminated surfaces for 5 to 15 minutes before wiping. Improper disinfecting can occur if the bleach solution is left on for less than 5 to 15 minutes, depending on the solution. (The EPA-approved solution list will provide this information.)

Step 2: After bleaching, items with porous surfaces containing high levels of contamination should be disposed of when feasible, according to applicable regulations.

Step 3: Contaminated surfaces that remain after the bleaching process should be disinfected according to the guidelines for the type of infectious agent.

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Step 4: A final sanitation wash using an EPA-approved solution is then used. The surface should then be rinsed with water, dried, and HEPA-vacuumed for final cleaning.

Step 5: Any remaining contaminated medical waste should be bagged and disposed of as recommended.

Note: Workers tasked with cleaning surfaces that may be contaminated with infectious pathogens must be protected from exposure. Employers are responsible for ensuring that workers are protected from exposure to infectious pathogens and harmful levels of chemicals used for cleaning and disinfection.

Elimination of Contaminants on Hard Surfaces

Workers must immediately clean and disinfect any surfaces contaminated with blood, urine, feces, vomit, or other body fluids that are suspected or known to contain infectious pathogens.

OSHA guidelines for cleaning and disinfection of infectious agents include the following:

Use an EPA-registered disinfectant suitable for non-enveloped viruses (for example: norovirus, rotavirus, poliovirus) to treat contamination/spills, and to disinfect surfaces after bulk spill material has been removed. Always follow the manufacturer's instructions (for example, concentration, application method, and contact time) for the specific disinfectant being used.

Non-enveloped viruses are typically more difficult to destroy than enveloped viruses, such as Ebola. Stronger disinfectants used to destroy non-enveloped viruses are considered effective against more susceptible enveloped viruses. The EPA List L of selected registered antimicrobial products for use against Ebola virus is available on the EPA website (www.epa.gov).

Note: Currently, no EPA-registered hospital disinfectant products will have a statement on the label that specifically says it can kill Ebola virus. However, any EPA-registered hospital disinfectant that is effective against a non-enveloped virus will also be effective against Ebola virus.

When EPA-registered disinfectants are unavailable, a 10 percent solution of common household bleach in water – for example, 1 cup of bleach in 9 cups of water – may be an effective alternative.

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A bleach solution that is applied to contaminated surfaces should be allowed to remain on the surfaces for 5 to 15 minutes to be effective. After the 5- to 15-minute period, the surface can be wiped and HEPA-vacuumed.

Note: Bleach has been associated with aggravating asthma and new onset asthma among healthcare workers. Precautions, information and training about the use of any chemical disinfectant is required under the OSHA Hazard Communication Standard.

Never mix chemicals together. Certain combinations of chemicals can be deadly or can reduce the effectiveness of the disinfectant. Be sure to always read the labels and/or read the SDS for whatever disinfectant you are using.

Elimination of Contaminants on Porous Surfaces

If biological agents have been found on porous surfaces (such as wallboard, carpets, padded furniture, wallpaper, wood products, and textured ceiling tiles), disposal of these materials may be the only option. Full protective measures should be used during demolition or removal work because biological agents may well be released into the air during the process.

Post-decontamination and Disinfection Inspection

A visual inspection should be made after completion of the project to ensure the elimination of any organisms. Worksites should be part of the inspection process, including basements, lower rooms, crawl spaces, and rooms with water or flooding damage. Window frames, ceiling tiles, as well as any cellulose-based materials, should also be closely examined.

Carefully examine all accessible heating, ventilation, and air conditioning components. Air monitoring or other assessments could be conducted after extensive or large-scale decontamination and disinfection to determine its effectiveness and to determine whether an area is fit for occupation.

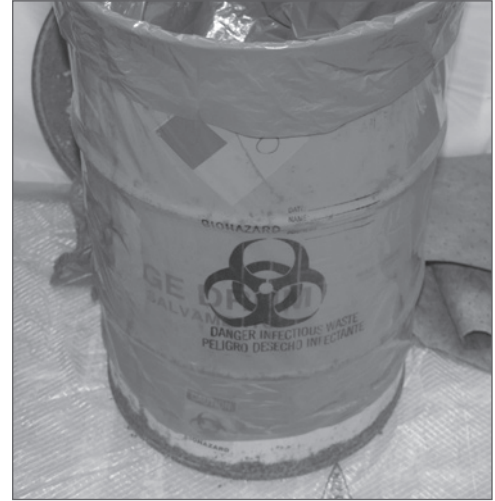
Final Disposal Procedures

The final step of the decontamination and disinfection process is to remove contaminated debris from the work area. Care must be taken to avoid spreading any contaminated debris back into the areas determined to be clean.

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OSHA provides guidelines for safe handling and disposal of infected waste:

- Place materials in a biohazard-labeled bag or container and to further reduce the risk of worker exposure. Use a puncture-proof container for sharps.
- It may be necessary to dispose of contaminated objects with porous surfaces that cannot be disinfected.
- Larger infected objects, such as mattresses or medical equipment, may need to be wrapped in biohazard bags, duct-taped shut, and disinfected before disposal.
- Dispose of waste from surface cleanup in accord with OSHA's Bloodborne Pathogens standard (29 CFR 1910.1030); CDC guidelines; the U.S. Department of Transportation's (DOT) Hazardous Materials Regulations (HMR), and the multi-agency Interim Planning Guidance for the Handling of Solid Waste Contaminated with a Category A Infectious Substance.



Infected waste must be disposed of in biohazard-labeled bags or containers.

See *Chapter 7* for more detailed information about waste management.

Waste Load-out Area

Before infected waste is transported away from the worksite, it may be stored in the waste load-out area. This area is used for:

- Short-term storage for bagged waste.
- Port for transferring waste to a truck or dumpster.

The outside of the waste containers should be free of all contaminated material before removal from the work area. Gross contamination should be wiped or scraped off containers before they are placed in the load-out area. Any remaining contamination should be removed by wet-wiping. Alternatively, the bagged material can be placed in a second clean bag. To

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save cleanup time, fiber drums can be covered with an outside bag of polyethylene before they are taken into the work area. The polyethylene bag can then be removed before taking the drum into the load-out area.

Transportation to the Disposal Site

As work progresses – and to prevent exceeding available on-site storage capacity – sealed and labeled containers of infected waste should be removed and transported to the prearranged disposal location. Safe transportation procedures should be followed in any operation involving microbial waste disposal.

See Chapter 7 for more detailed information about transportation of infected waste.

PREPARING TO LEAVE THE WORK AREA

Before leaving the work area, workers should be sure that the area is left in a safe, acceptable condition. Workers will now be ready to enter the decontamination unit to be properly decontaminated.

As discussed earlier in this chapter, the decontamination unit described in this course is a six-stage unit and is an in-depth one with very strict requirements. Certain job sites with a lower risk may not require such an in-depth unit with this many steps. Remember: each job site is different, and it is the employer's responsibility to ensure that workers are trained in the PPE that is appropriate for the job and are trained in the proper decontamination process for that job.

Similar to the process of preparing to enter the work area, the process of leaving the work area is conducted under the supervision of a trained observer, or in many cases, the trained observer's assistant. The trained observer's assistant's duties include posting and reading aloud each step of the decontamination procedures and confirm visually that all PPE is removed properly. (Prior to doffing PPE, the trained observer's assistant must remind the worker to avoid reflexive actions that may put them at risk, such as touching their face.) During the doffing process, the trained observer's assistant may assist with removal of specific components of PPE.

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An example for a six-stage decontamination unit has been provided below. (See *Figure 5* for a sample decon unit illustrating the location of all six stages.)

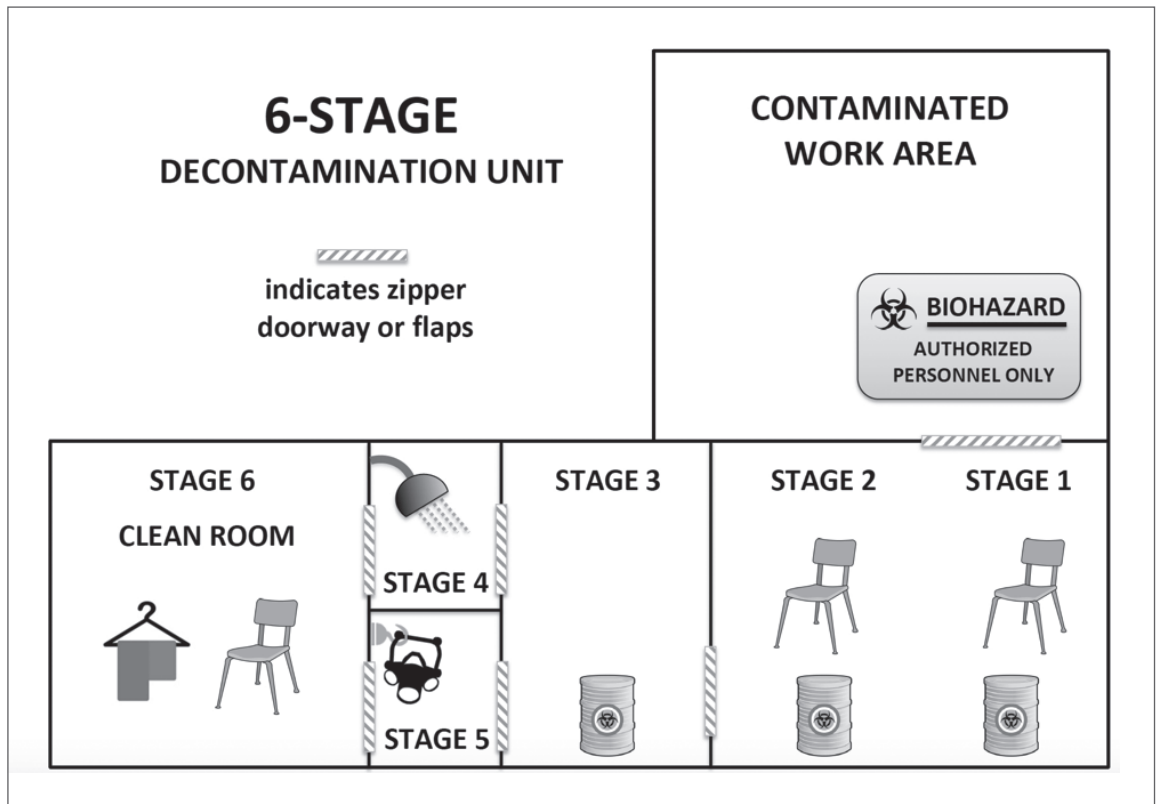


Figure 5. Sample six-stage decon layout.

Stage 1:

Stage 1 is the first stage when leaving the contaminated work area and is typically separated from the work area by a zipper door. Stage 1 involves disinfecting the plastic apron, face shield, outer gloves, outer suit, boot covers (if used, and rubber boots if covers are not used) with an EPA-registered disinfectant spray. The trained observer's assistant may perform the disinfecting. Then the plastic apron, face shield, and boot covers (if used) are removed and disposed of in the appropriate receptacle.

Next, the exposed surfaces of the respirator, the outer part of the suit that the apron was covering (if apron was used), the rubber boots (if boot covers were used), and all exposed

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tape are disinfected. Then all exposed tape and outer gloves are removed and placed in the appropriate receptacle. Be sure to take off outer gloves carefully so you do not contaminate the inner gloves.

Note: Be sure NOT to remove the respirator at this time.

The last step in Stage 1 is to inspect the inner gloves' outer surfaces for visible contamination, cuts, or tears. If inner glove is visibly soiled, cut, or torn, remove the inner gloves, perform hand hygiene on bare hands and don a clean pair of inner gloves. If no visible contamination, cuts, or tears are identified on the inner gloves, then disinfect the inner gloves.

Stage 2:

Stage 2 may or may not be separated from Stage 1. If they are separated, it is usually done by a layer of plastic sheeting forming a barrier between the two stages and a zipper door or flaps are used to gain access.

In Stage 2, the first step is to remove the rubber boots and outer suit and carefully place them in the appropriate receptacle. When removing the outer suit, slowly and carefully reach for the zipper or fasteners and unzip or unfasten the outer suit completely before rolling down and turning inside out if possible. Avoid contact of the outer surface of the outer suit with the outer surface of the inner suit during removal. Next, the inner suit is disinfected.

The last step in Stage 2 is to disinfect the inner gloves again. Remove and discard inner gloves making sure not to contaminate bare hands during removal process. Perform hand hygiene with disinfectant and don a new pair of inner gloves.

At this time, the trained observer's assistant will perform a final inspection of the worker for any indication of contamination of the inner suit, respirator, and respirator battery (if a PAPR is used). If contamination is identified, the trained observer's assistant will immediately inform the trained observer who will then inform the project supervisor, infectious disease specialist, or occupational safety and health coordinator before permitting the worker to exit the decontamination area.



Remember that the trained observer's assistant supervises this entire process and will read aloud each step of it. The decontamination steps should also be posted in the decontamination area. Workers must listen and obey each and every step the trained observer's assistant is conveying to them.

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Stage 3:

In Stage 3, remove the PAPR battery (if a PAPR is used), including the duct tape belt, and place the battery in a container or area designated for the collection of PAPR components. Place the tape in the appropriate receptacle.

Next, the inner suit can be removed. Slowly and carefully reach for the zipper or fasteners and unzip or unfasten the inner suit completely before rolling down and turning inside out. Avoid contact of the outer surface of the disposable inner suit with skin, undergarments, or any other surface during removal. Pull inner suit away from the body, rolling inside out and touching only the inside of the suit. Carefully dispose of the suit in the appropriate receptacle.

Next, inspect the inner gloves' outer surfaces for visible contamination, cuts, or tears. If inner glove is visibly soiled, cut, or torn, remove the inner gloves, perform hand hygiene on bare hands and don a clean pair of inner gloves. If no visible contamination, cuts, or tears are identified on the inner gloves, then disinfect the inner gloves.

Workers can now remove their PAPR, being careful not to touch the inside of the respirator. Once the PAPR is removed, the workers can remove their inner gloves and their non-contaminated undergarments (if any are used) and place in the appropriate receptacle.

They can then proceed to the shower. Also in this stage, workers can place their disinfected PAPR and battery in the Stage 5 area. The worker can bring this PPE into the clean room after they leave the shower. They can access Stage 5 from the clean room. There is typically a zipper door or flap door separating Stages 2 & 3 and a zipper door separating Stages 3 & 5. A zipper door or a flap door will typically separate Stages 3 & 4 as well. Whether a zipper door or flap is used will depend on what is required on the specific site plan.

Stage 4:

Stage 4 is the shower room. Every worker is required to take a full, thorough shower using anti-bacterial soap after going through Stages 1–3. This includes the trained observers, occupational safety and healthcare professionals, infectious disease specialists, and supervisors. Disposable towels must be provided for drying off and placed in the appropriate receptacles after use. A zipper door or a flap door will typically separate Stages 4 & 5 as well as Stages 4 & 6. Whether a zipper door or flap is used will depend on what is required on the specific site plan.

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Stage 5:

Stage 5 is where the disinfected PPE is stored while workers are in the shower. This stage is also accessible from the clean room. Once the worker enters the clean room from the shower, they can retrieve their PPE in Stage 5 from the clean room. Stage 5 may also be used to bring out waste barrels, bags, and containers that have been properly disinfected. Lastly, workers may go through Stage 5 when entering the work area, rather than cutting through the shower room, Stage 4.

Stage 6:

Stage 6 is the clean room, sometimes called the support area. This is where anyone coming out of the work area and has been properly decontaminated can redress in their street clothes. Typically, there are benches for workers to sit on to redress and hooks for them to hang their street clothes on while they are in the work area. Some sites may use an adjacent room as the clean room if available.

REMOVING THE DECONTAMINATION UNIT

Once the cleanup in the work area is complete and it passes final clearance, the decontamination unit can now be disassembled and removed. Before removing the unit, it will have to be cleaned and disinfected as well.

The poly used to cover ceilings, walls, and floors should be sprayed and wet-wiped with a bleach and water solution. This process should begin by working from the stage closest to the work area and continue the cleaning process toward the clean room.

Cleaning should be done from the top down. Workers should start with the ceilings and work their way to the walls, then the floors. Once all poly surfaces are cleaned to satisfaction and approved, then the poly can be removed.

Once again, the removal process should be from top down. As the poly is being removed, it should be folded or rolled inwardly to prevent accidental release of pathogens that may have been left behind. The poly can then be placed in approved bags and/or containers and sent to the load-out area.

Summary

Removal of infectious pathogens is a relatively new field, and innovative methods are being developed that will likely be used in the future. The key point to remember, regarding both work area preparation and decontamination and disinfection techniques, is that prevention of exposure is the first and primary line of defense for decontamination and disinfection workers. This applies to both the infectious pathogens and the chemicals that are used to destroy them.

On an infectious disease worksite, isolation and containment may be necessary before any decontamination and disinfection can be done. Isolation is the physical separation of an infected or colonized host from the remainder of the at-risk population. Containment prevents the spread of contaminants outside the work area. The goal of decontamination is to remove and/or clean contaminated materials in a way that prevents infectious pathogens from leaving the work area. Disinfection goes one step further – it kills the pathogens by using bleach. Sterilization is the next step beyond disinfection. While disinfection eliminates the pathogens, sterilization actually removes the spores on surfaces.

Work area preparation includes conveying the scope of the work to the workers, training for worker protection, and constructing the decontamination unit. The contaminated area should not be disturbed until proper controls have been implemented. Work area preparation may include containment to control exposure to adjacent areas, shutting down the HVAC (heating, ventilating, and air conditioning) systems and covering vents and air ducts, and posting signs to limit access to authorized personnel only.

Before entering the work area, workers must be instructed in the use of respirators, PPE, decontamination procedures, and entry and exit procedures. The use of respirators, rubber boots, rubber gloves, eye protection, and protective clothing is required. Respirators with high-efficiency particulate air (HEPA) filters are most likely necessary during the decontamination and disinfection of highly infectious biological agents. When eliminating any biological agents with chemicals, the use of combination HEPA/chemical cartridges is required.

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Even in large operations, the basic principles for containment and isolation of a smaller area or zone should generally be followed. This includes isolating the entire work area, establishing negative pressure and decontamination areas, and isolating the problem. Preparing the work area includes performing a risk assessment, posting danger signs, securing the work area, setting up the decontamination unit, and shutting down the HVAC systems.

Depending on the site-specific requirements of the job you are working on, flap doors and/or zipper doors may be used to get from one area to another. Zipper doors are preferred because they are more secure and provide a tighter air seal. Sticky floor mats are required in most facilities when cleaning an infectious disease area.

Infectious disease cleanup sites may require negative pressure (air) in the work area and/or in the decontamination unit, in order to keep hazardous particles and droplets from entering the areas outside the work area and decontamination areas. A negative-pressure air filter machine, also called a negative air machine or NAM, lowers the air pressure in the work area and prevents contaminated air from leaving the work area until it is filtered.

Before entering the work area, workers must don the proper PPE, which is typically done in the clean room of the decontamination unit. Workers should also remove clothing and personal items and inspect all PPE before donning, among other steps, before proceeding to the work area.

Once in the work area, there are several steps involved in remediating an area where infectious agents are known or suspected to be present. These steps may vary depending on the type of facility or the pathogens present. Workers must immediately clean and disinfect any surfaces contaminated with blood, urine, feces, vomit, or other body fluids. Chemicals should never be mixed together. If biological agents are found on porous substances like carpets and wallpaper, etc., disposal may be the only option.

The final step of the decontamination and disinfection process is to remove contaminated debris from the work area. OSHA provides guidelines for safe handling and disposal of infected waste, which include:

- Double-bagging materials and placing them in leak-proof containers.
- Disposing contaminated objects with porous surfaces.
- Disposing waste from surface cleanup.

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Before infected waste is transported away from the worksite, it may be stored in the waste load-out area, which is used for short-term storage of bagged waste and as a port for transferring waste to a truck or dumpster. Sealed and labeled containers of infectious waste should be removed as often as necessary, and transported to the prearranged disposal location.

After making sure that the work area is left in a safe and acceptable condition, workers are then ready to enter the decontamination unit and be properly decontaminated. The decontamination unit described in this course is a six-stage unit, and is an in-depth one with very strict requirements. Certain jobsites with a lower risk may not require such an in-depth unit with this many steps.

Once the cleanup in the work area is complete and it passes final clearance, the decontamination unit can be disassembled and removed. It also needs to be cleaned and disinfected.

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