

APPENDIX A

Recommended Specifications and Operating Procedures for the Use of Negative Pressure Systems for Asbestos Abatement

***Appendix J. Recommended Specifications and Operating
Procedures for the Use of Negative Pressure
Systems for Asbestos Abatement**

J.1 Introduction

This appendix provides guidelines for the use of negative pressure systems in removing asbestos-containing materials from buildings. A negative pressure system is one in which static pressure in an enclosed work area is lower than that of the environment outside the containment barriers.

The pressure gradient is maintained by moving air from the work area to the environment outside the area via powered exhaust equipment at a rate that will support the desired air flow and pressure differential. Thus, the air moves into the work area through designated access spaces and any other barrier openings. Exhaust air is filtered by a high-efficiency particulate air (HEPA) filter to remove asbestos fibers.

The use of negative pressure during asbestos removal protects against large-scale release of fibers to the surrounding area in case of a breach in the containment barrier. A negative pressure system also can reduce the concentration of airborne asbestos in the work area by increasing the dilution ventilation rate (i.e., diluting contaminated air in the work area with uncontaminated air from outside) and exhausting contaminated air through HEPA filters. The circulation of fresh air through the work area reportedly also improves worker comfort, which may aid the removal process by increasing job productivity.

J.2 Materials and Equipment

J.2.1 The Portable, HEPA-Filtered, Powered Exhaust Unit

The exhaust unit establishes lower pressure inside than outside the enclosed work area during asbestos abatement. Basically, a unit (see Figure J-1) consists of a cabinet with an opening at each end, one for air intake and one for exhaust. A fan and a series of filters are arranged inside the cabinet between the openings. The fan draws contaminated air through the intake and filters and discharges clean air through the exhaust.

Portable exhaust units used for negative pressure systems in asbestos abatement projects should meet the following specifications.

J.2.1.1 Structural Specifications

The cabinet should be ruggedly constructed and made of durable materials to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. The cabinet must be appropriately sealed to prevent asbestos-containing dust from being emitted during use, transport, or maintenance. There should be easy access to all air filters from the intake end, and the filters must be easy

*EXCERPTED FROM GUIDANCE FOR CONTROLLING ASBESTOS-CONTAINING MATERIALS IN BUILDINGS ("PURPLE BOOK"), EPA PUBLICATION NUMBER: 560/5-85-024.

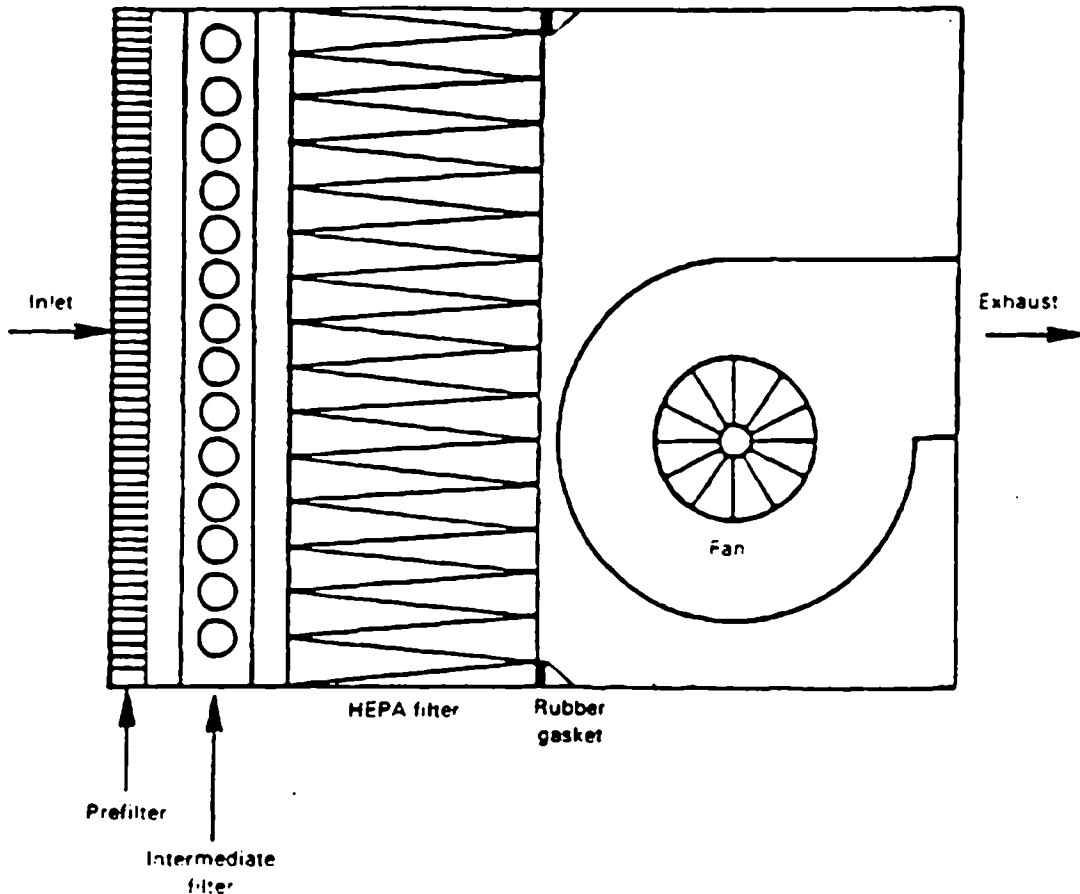


Figure J-1 An example of a HEPA-filtered exhaust unit. This scheme is one of several possible designs.

to replace. The unit should be mounted on casters or wheels so it can be easily moved. It also should be accessible for easy cleaning.

J.2.1.2 Mechanical Specifications

J.2.1.2.1 Fans

The fan for each unit should be sized to draw a desired air flow through the filters in the unit at a specified static pressure drop. The unit should have an air-handling capacity of 1,000 to 2,000 ft³/min (under "clean" filter conditions). The fan should be of the centrifugal type.

For large-scale abatement projects, where the use of a larger capacity, specially designed exhaust system may be more practical than several smaller units, the fan should be appropriately sized according to the proper load capacity established for the application, i.e.,

$$\text{Total ft}^3/\text{min (load)} = \frac{\text{Volume of air in ft}^3 \times \text{air changes/hour}}{60 \text{ min/hour}}$$

Smaller-capacity units (e.g., 1,000 ft³/min) equipped with appropriately sized fans and filters may be used to ventilate smaller work areas. The desired air flow could be achieved with several units.

J.2.1.2.2 Filters

The final filter must be the HEPA type. Each filter should have a standard nominal rating of at least 1,100 ft³/min with a maximum pressure drop of 1 inch H₂O clean resistance. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame and cross-braced as required. The exact dimensions of the filter should correspond with the dimensions of the filter housing inside the cabinet or the dimensions of the filter-holding frame. The recommended standard size HEPA filter is 24 inches high x 24 inches wide x 11-1/2 inches deep. The overall dimensions and squareness should be within 1/8 inch.

A continuous rubber gasket must be located between the filter and the filter housing to form a tight seal. The gasket material should be 1/4 inch thick and 3/4 inch wide.

Each filter should be individually tested and certified by the manufacturer to have an efficiency of not less than 99.97 percent when challenged with 0.3- μ m dioctylphthalate (DOP) particles. Testing should be in accordance with Military Standard Number 282 and Army Instruction Manual 136-300-175A. Each filter should bear a UL586 label to indicate ability to perform under specified conditions.

Each filter should be marked with the name of the manufacturer, serial number, air flow rating, efficiency and resistance, and the direction of test air flow.

Prefilters, which protect the final filter by removing the larger particles, are recommended to prolong the operating life of the HEPA filter. Prefilters prevent the premature loading of the HEPA filter. They can also save energy and cost. One (minimum) or two (preferred) stages of prefiltration may be used. The first-stage prefilter should be a low-efficiency type (e.g., for particles 10 μ m and larger). The second-stage (or intermediate) filter should have a medium efficiency (e.g., effective for particles down to 5 μ m). Various types of filters and filter media for prefiltration applications are available from many manufacturers. Prefilters and intermediate filters should be installed either on or in the intake grid of the unit and held in place with special housings or clamps.

J.2.1.2.3 Instrumentation

Each unit should be equipped with a Magnehelic gauge or manometer to measure the pressure drop across the filters and indicate when filters have become loaded and need to be changed. The static pressure across the filters (resistance) increases as they become loaded with dust, affecting the ability of the unit to move air at its rated capacity.

J.2.1.3 Electrical

J.2.1.3.1 General

The electrical system should have a remote fuse disconnect. The fan motor should be totally enclosed, fan-cooled, and the nonoverloading type. The unit must use a standard 115-V,

single-phase, 60-cycle service. All electrical components must be approved by the National Electrical Manufacturers Association (NEMA) and Underwriter's Laboratories (UL)

J.2.1.3.2 Fans

The motor, fan, fan housing, and cabinet should be grounded. The unit should have an electrical (or mechanical) lockout to prevent the fan from operating without a HEPA filter.

J.2.1.3.3 Instrumentation

An automatic shutdown system that would stop the fan in the event of a major rupture in the HEPA filter or blocked air discharge is recommended. Optional warning lights are recommended to indicate normal operation, too high of a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge). Other optional instruments include a timer and automatic shut-off and an elapsed time meter to show the total accumulated hours of operation.

J.3 Setup and Use of a Negative Pressure System

J.3.1 Preparation of the Work Area

J.3.1.1 Determining the Ventilation Requirements for a Work Area

Experience with negative pressure systems on asbestos abatement projects indicates a recommended rate of one air change every 15 minutes. The volume (in ft³) of the work area is determined by multiplying the floor area by the ceiling height. The total air flow requirement (in ft³/min) for the work area is determined by dividing this volume by the recommended air change rate (i.e., one air change every 15 minutes).*

$$\text{Total ft}^3/\text{min} = \text{Volume of work area (in ft}^3\text{)}/15 \text{ min}$$

The number of units needed for the application is determined by dividing the total ft³/min by the rated capacity of the exhaust unit.

$$\text{Number of units needed} = [\text{Total ft}^3/\text{min}]/[\text{Capacity of unit (in ft}^3\text{)}]$$

J.3.1.2 Location of Exhaust Units

The exhaust unit(s) should be located so that makeup air enters the work area primarily through the decontamination facility and traverses the work area as much as possible. This may be accomplished by positioning the exhaust unit(s) at a maximum distance from the worker access opening or other makeup air sources.

Wherever practical, work area exhaust units can be located on the floor in or near unused doorways or windows. The end of the unit or its exhaust duct should be placed through an opening in the plastic barrier or wall covering. The plastic around the unit or duct should then be sealed with tape.

* The recommended air exchange rate is based on engineering judgment

Each unit must have temporary electrical power (115V AC). If necessary, three-wire extension cords can supply power to a unit. The cords must be in continuous lengths (without splice), in good condition, and should not be more than 100 feet long. They must not be fastened with staples, hung from nails, or suspended by wire. Extension cords should be suspended off the floor and out of workers' way to protect the cords from damage from traffic, sharp objects, and pinching.

Wherever possible, exhaust units should be vented to the outside of the building. This may involve the use of additional lengths of flexible or rigid duct connected to the air outlet and routed to the nearest outside opening. Windowpanes may have to be removed temporarily.

If exhaust air cannot be vented to the outside of the building or if cold temperatures necessitate measures to conserve heat and minimize cold air infiltration, filtered air that has been exhausted through the barrier may be recirculated into an adjacent area. However, this is not recommended.

Additional makeup air may be necessary to avoid creating too high of a pressure differential, which could cause the plastic coverings and temporary barriers to "blow in." Additional makeup air also may be needed to move air most effectively through the work area. Supplemental makeup air inlets may be made by making openings in the plastic sheeting that allow air from outside the building into the work area. Auxiliary makeup air inlets should be as far as possible from the exhaust unit(s) (e.g., on an opposite wall), off the floor (preferably near the ceiling), and away from barriers that separate the work area from occupied clean areas. They should be resealed whenever the negative pressure system is turned off after removal has started. Because the pressure differential (and ultimately the effectiveness of the system) is affected by the adequacy of makeup air, the number of auxiliary air inlets should be kept to a minimum to maintain negative pressure. Figure J-2 presents examples of negative pressure systems denoting the location of HEPA-filtered exhaust units and the direction of air flow.

J.3.2 Use of the Negative Pressure System

J.3.2.1 Testing the System

The negative pressure system should be tested before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, the unit(s) should be started (one at a time). Observe the barriers and plastic sheeting. The plastic curtains of the decontamination facility should move slightly in toward the work area. The use of ventilation smoke tubes and a rubber bulb is another easy and inexpensive way to visually check system performance and direction of air flow through openings in the barrier. Another test is to use a Magnehelic gauge (or other instrument) to measure the static pressure differential across the barrier. The measuring device must be sensitive enough to detect a relatively low pressure drop. A Magnehelic gauge with a scale of 0 to 0.25 or 0.50 inch of H₂O and 0.005 or 0.01 inch graduations is generally adequate. The pressure drop across the barrier is measured from the outside by punching a small hole in the plastic barrier and inserting one end of a piece of rubber or Tygon tubing. The other end of the tubing is connected to the "low pressure" tap of the instrument. The "high pressure" tap must be open to the atmosphere. The pressure is read directly from the scale. After the test is completed, the hole in the barrier must be patched.

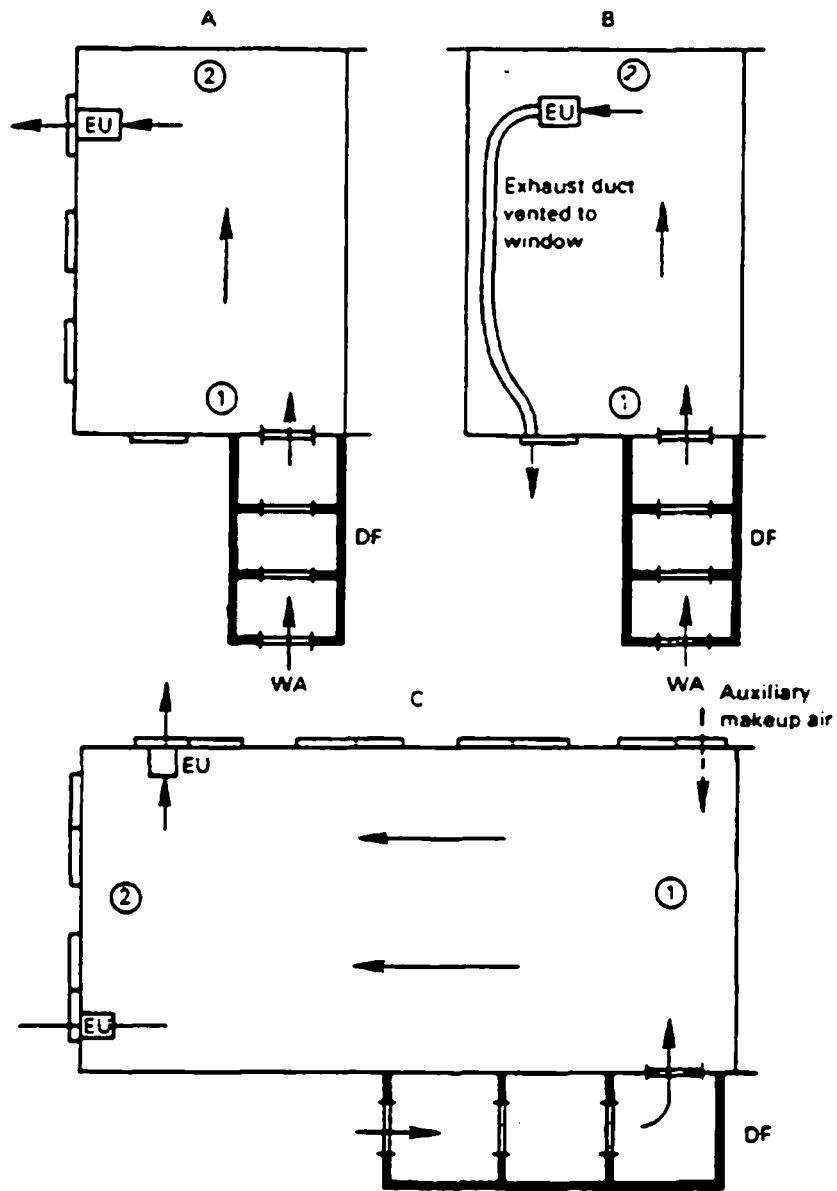


Figure J-2. Examples of negative pressure systems. DF, Decontamination Facility; EU, Exhaust Unit; WA, Worker Access. A, Single-room work area with multiple windows; B, Single-room work area with single window near entrance; C, Large single-room work area with windows and auxiliary makeup air source (dotted arrow). Arrows denote direction of air flow. Circled numbers indicate progression of removal sequence.

J.3.2.2 Use of System During Removal Operations

The exhaust units should be started just before beginning removal (i.e., before any asbestos-containing material is disturbed). After removal has begun, the units should run continuously to maintain a constant negative pressure until decontamination of the work area is complete. The units should not be turned off at the end of the work shift or when removal operations temporarily stop.

Employees should start removing the asbestos material at a location farthest from the exhaust units and work toward them. If an electric power failure occurs, removal must stop immediately and should not resume until power is restored and exhaust units are operating again.

Because airborne asbestos fibers are microscopic in size and tend to remain in suspension for a long time, the exhaust units must keep operating throughout the entire removal and decontamination processes. To ensure continuous operation, a spare unit should be available.

After asbestos removal equipment has been moved from the work area, the plastic sheeting has been cleaned, and all surfaces in the work area have been wet-cleaned, the exhaust units can be allowed to run for at least another 4 hours to remove airborne fibers that may have been generated during wet removal and cleanup and to purge the work area with clean makeup air. The units may be allowed to run for a longer time after decontamination, particularly if dry or only partially wetted asbestos material was encountered during removal.

J.3.2.2.1 Filter Replacement

All filters must be accessible from the work area or "contaminated" side of the barrier. Thus, personnel responsible for changing filters while the negative pressure system is in use should wear approved respirators and other protective equipment. The operating life of a HEPA filter depends on the level of particulate contamination in the environment in which it is used. During use, filters will become loaded with dust, which increases resistance to air flow and diminishes the air-handling capacity of the unit. The difference in pressure drop across the filters between "clean" and "loaded" conditions (ΔP) is a convenient means of estimating the extent of air-flow resistance and determining when the filters should be replaced.

When ΔP across the filters (as determined by the Magnehelic gauge or manometer on the unit) exceeds 1.0 inch of H_2O , the prefilter should be replaced first. The prefilter, which fan suction will generally hold in place on the intake grill, should be removed with the unit running by carefully rolling or folding in its sides. Any dust dislodged from the prefilter during removal will be collected on the intermediate filter. The used prefilter should be placed inside a plastic bag, sealed and labeled, and disposed of as asbestos waste. A new prefilter is then placed on the intake grill. Filters for prefiltration applications may be purchased as individual precut panels or in a roll of specified width that must be cut to size.

If the ΔP still exceeds 1.0 inch of H_2O after the prefilter has been replaced, the intermediate filter is replaced. With the unit operating, the prefilter should be removed, the intake grill or filter access opened, and the intermediate filter removed. Any dust dislodged from the intermediate filter during removal will be collected on the HEPA filter. The used intermediate filter should be placed in a sealable plastic bag (appropriately labeled) and disposed of as asbestos waste. A new replacement filter is then installed and the grill or access closed. Finally, the prefilter on the intake grill should be replaced.

The HEPA filter should be replaced if prefilter and/or intermediate filter replacement does not restore the pressure drop across the filters to its original clean resistance reading or if the HEPA filter becomes damaged. The exhaust unit is shut off to replace the HEPA filter, which requires removing the prefilter first, then opening the intake grill or filter access, and finally removing the HEPA filter from the unit. Used HEPA filters should be placed in a sealable plastic bag (appropriately labeled) and disposed of as asbestos waste. A new HEPA filter (structurally identical to the original filter) should then be installed. The intake grill and intermediate filter should be put back in place, the unit turned on, and the prefilter positioned on the intake grill. Whenever the HEPA filter is replaced, the prefilter and intermediate filter should also be replaced.

When several exhaust units are used to ventilate a work area, any air movement through an inactive unit during the HEPA filter replacement will be into the work area. Thus, the risk of asbestos fiber release to the outside environment is controlled.

Any filters used in the system may be replaced more frequently than the pressure drop across the filters indicates is necessary. Prefilters, for example, may be replaced two to four times a day or when accumulations of particulate matter become visible. Intermediate filters must be replaced once every day or so, and the HEPA filter may be replaced at the beginning of each new project. (Used HEPA filters must be disposed of as asbestos-containing waste.) Conditions in the work area dictate the frequency of filter changes. In a work area where fiber release is effectively controlled by thorough wetting and good work practices, fewer filter changes may be required than in work areas where the removal process is not well controlled. It should also be noted that the collection efficiency of a filter generally improves as particulate accumulates on it. Thus, filters can be used effectively until resistance (as a result of excessive particulate loading) diminishes the exhaust capacity of the unit.

J.3.2.3 Dismantling the System

When a final inspection and the results of final air tests indicate that the area has been decontaminated, all filters of the exhaust units should be removed and disposed of properly and the units shut off. The remaining barriers between contaminated and clean areas and all seals on openings into the work area and fixtures may be removed and disposed of as contaminated waste. A final check should be made to be sure that no dust or debris remain on surfaces as a result of dismantling operations.