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DESIGN OF VENTILATION AND AIR CLEANING SYSTEMS FOR THE NEW LOS ALAMOS PLUTONIUM FACILITY*

Robert Mitchell
James DeField
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Wilbur McNeese
William Eberhardt
Nikolai Laushkin**

Industrial Hygiene Group
Health Division
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

*Work supported by the U. S. Atomic Energy Commission.

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R. Mitchell, J. DeField, R. Stafford
W. McNeese, W. Eberhardt, N. Laushkin**
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico
**Fluor Engineers and Constructors, Inc.
Los Angeles, California

Abstract

The Los Alamos Scientific Laboratory's new plutonium facility will conform to AECM Appendix 6301-Part II, Section H-Minimum Design Criteria for New Plutonium Facilities. The glove box process exhaust air is filtered through three or four stages of HEPA filters. The design of this multi-stage filter installation is shown with a method of in-place testing of each stage individually. A glove box filter holder and the in-place test procedure is described. General room air from plutonium work areas is recirculated at the rate of eight air changes per hour with a 10% fresh air make-up. The filter plenums for the recirculated air are designed to permit in-place testing of each of the two filter stages.

I. Introduction

The plutonium facilities at the Los Alamos Scientific Laboratory (LASL) are used for work on the two major isotopes, ^{239}Pu and ^{238}Pu, of the man-made element plutonium. The programs encompass many phases of plutonium research and development in support of several AEC projects.

The core of the present facilities was constructed in 1944-45 by moving in used warehouse buildings and installing the equipment needed. Over the years there have been revisions to improve the safety and operability. However, following the fire at the Rocky Flats Plant, a review of the facilities indicated that a considerable program of further upgrading was needed to provide for the level of fire protection desired. Subsequently, an ad hoc committee of AEC and contractor personnel developed AECM Appendix 6301 Part II, Section H-Minimum Design Criteria for New Plutonium Facilities which not only establish requirements for fire protection, but also requirements for radiation, health, and safety protection for the worker and protection to the environment. The Fluor Corporation, a California process-engineering firm, was engaged to make a conceptual design of a new facility or a re-do of the existing facility to meet these criteria. Their study concluded that a new facility could be constructed at about the same cost as redoing the existing facility; further, there would be substantially less impact on the operations if a new facility were built. The design of the new LASL plutonium facility has been essentially completed and construction has been started.

*Work supported by the U. S. Atomic Energy Commission.

This paper will be limited to a discussion of the design and procedures that will conform to the Minimum Design Criteria requiring "the filtration system shall be designed to allow reliable in-place testing of high efficiency filters and ease of replacement." The filter systems that will be described are the process exhaust systems for glove boxes and the room air recirculation systems.

II. Process Exhaust

The design of the process exhaust system is most important because of the necessity to confine the high level of contamination. The first step in the process exhaust air cleaning is the filter at the glove box. The criteria requires that "a high efficiency filter be installed as close as practical to the source to minimize the contamination of duct work." It is important that this filter be easily replaced and reliably in-place tested even though the criteria does not permit taking credit for this filter in the calculation of the number of filter stages required for air cleaning.

Figure 1 shows the schematic of the design developed for the glove box filter holder. The 203 mm (8") round HEPA filter will be introduced at the top of the cylindrical holder and pushed into the position as shown using the spacer or pusher. The filter and the pusher each have gaskets at the top and bottom for sealing against the wall of the holder. The design of the gasket permits movement of the pieces while maintaining a satisfactory seal. To replace the filter, a new filter and pusher are introduced at the top of the holder and the old filter and pusher are forced into the glove box for disposal. The top of the holder is tightly sealed.

In-place testing HEPA filters installed inside glove boxes has been limited because of the high level of contamination in the boxes. The connecting of the smoke generator to the glove box and the insertion and removal of test probes can result in the spread of contamination to the room, also, the light scattering chamber of the test equipment may become seriously contaminated. The testing of the filter in the holder shown eliminates many of these problems.

Figure 2 shows a schematic of the in-place test method. The glove box filter will be tested as follows: (1) A temporary cover will be placed over the filter holder opening into the glove box. (2) A temporary duct will be installed on the filter holder outside of the glove box. (3) Air will be drawn through the temporary duct and filter by the process exhaust system. (4) The test aerosol will be introduced into the duct and after a suitable mixing device the initial concentration will be determined. (5) The penetration will be measured downstream of the filter.

The compartmentalization of the new plutonium facility resulted in four separate process exhaust systems of less than .95 m^3/s (2000 CFM) each. Figure 3 shows a schematic of the filter installation process exhaust system. The design consists of two glove box type enclosures connected back-to-back permitting up to four stages of HEPA

filters. Each stage will have two 24 x 24 x 12" HEPA filters with space available if required for an additional filter in each stage. The filters will be changed by normal glove box procedures and the contaminated filter will be removed from the glove box by accepted bagging out techniques. This method of changing filters will eliminate complicated procedures required when personnel enter highly contaminated filter plenums.

The figure also shows the arrangement of the permanently installed ductwork that will be used to in-place test each filter stage. Blank flanges are used in the test duct instead of valves to remove the uncertainty that could result from leaky valves during in-place testing. More important is that the positive shut-off of a blank flange will completely eliminate the possibility of bypassing a filter bank through the test ductwork during normal operations.

The 203 mm (8") round test duct will permit in-place testing at approximately the normal rate of flow. Each process exhaust system will have a parallel 100% capacity redundant installation with separate exhaust blowers. One filter installation can be isolated and tested without interruption of the flow in the process exhaust system. The filter installation to be tested is valved off from the process exhaust and by removal of specific blank flanges in the test duct each filter stage can be in-place tested.

Figure 4 shows the flow for testing the first filter stage. The DOP aerosol will be introduced into the test duct and after mixing the aerosol concentration in the challenge atmosphere will be measured. A temporary cover, such as a sheet of plastic, will be used to blank off the 2nd stage to direct the flow into the test duct where the penetration of the 1st stage can be measured.

There is a good chance that the glove box containing the first bank of HEPA filters will become contaminated because the possibly highly contaminated process exhaust will have passed through only the first stage of filters. The test air is, therefore, passed through the fourth stage of filters before being discharged to the atmosphere.

Figure 5 shows the positioning of the valves and blank flanges for testing the 2nd stage of filters. The concentration of the DOP aerosol is measured as before. The flow is directed through the 2nd stage of filters, around the 3rd and 4th stages and the penetration is measured after the blower.

Figures 6 and 7 show the air flow for in-place testing the 3rd and 4th stages of filters. The initial aerosol concentration and the penetration are measured at the same locations as when testing the 2nd stage.

The process exhaust system should satisfy the criteria for reliable in-place testing and ease of replacement.

III. Room Air

The only reference in the AEC Design Criteria to room air that is pertinent to this discussion states, "A partial recirculating ventilation system shall be considered for economic and safety reasons; however, such systems shall be designed to preclude the entry of enclosure exhaust into room air recirculating system."

The room air in the operating area of the LASL new plutonium facility will be recirculated at a rate of eight air changes per hour with an approximate 10% fresh air make-up. The recirculated air will be filtered through two stages of HEPA filters. The air exhausted from chemical fume hoods and the 10% of room air that is not recirculated will also be filtered through two stages of HEPA filters before being discharged to the atmosphere. The compartmentalization of the facility has made it possible to size the room recirculation filter plenums and the room air bleed-off filter plenums for approximately 9.4 m^3/s (20000 CFM) or less. Thus, each compartment recirculation system will have two filter plenum handling 50% of the total compartment air flow. The bleed-off systems will have two filter plenums with each sized for 100% of the required normal air flow.

Figure 8 is a schematic of the typical room air recirculation plenum or a bleed-off plenum. In the actual design, there will be differences in each system, such as cooling coils in the recirculation plenums and not in the bleed-off plenums. But for the purposes of in-place filter testing, the same methods and procedures will be followed. The figure shows the flanged openings with blind covers in place for normal operations. Temporary ducts will be installed on the openings for the in-place testing. The ducts will be 609 mm (24") in diameter allowing testing at approximately 50% of the normal rate of flow.

Two methods of introducing the DOP aerosol to the plenum are contemplated. The first method is to introduce the aerosol by way of a room exhaust duct in the operating area. Figure 9 shows the flow for testing the 1st stage of filters. A temporary cover is placed over the exhaust from the plenum and the flow of air will bypass the 2nd stage through a temporary duct. The penetration is measured after the blower. Figure 10 shows the testing of the 2nd stage with the DOP aerosol introduced in the operating area. The initial concentration and penetration will be measured as before.

Figures 11 and 12 show the testing of the two banks of filters by introducing the DOP aerosol through a temporary duct and recirculating the air in the immediate area of the plenum. The 1st stage of filters is tested by closing valves in the intake plenum and the fan discharge. The DOP will be introduced into the plenum before the 1st stage and the 2nd stage will be bypassed with a temporary duct. The penetration will be measured at the blower discharge. Figure 12 shows the in-place testing of the 2nd stage. The DOP aerosol will be introduced between the filter stages through a temporary duct and the penetration measured at the blower discharge.

Summary

The compartmentalization of the new plutonium facility has made it possible to design HEPA filter installation of an optimum size for ease of in-place testing and replacement. The process exhaust which usually have a high degree of contamination is small enough to make it practical to use glove box type enclosures for the installation. The filter changes can be made without exposure of personnel to high concentration of plutonium and the in-place test procedure is not complicated. The room air and bleed-off filter systems are of such a size that the method of using temporary ducts to accomplish in-place testing of both stages seems very practical.

Glove Box Filter Installation

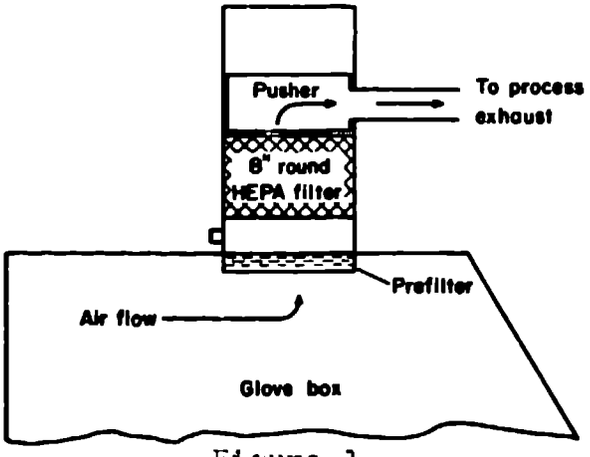


Figure 1.

Glove Box Filter Installation
Filter Test

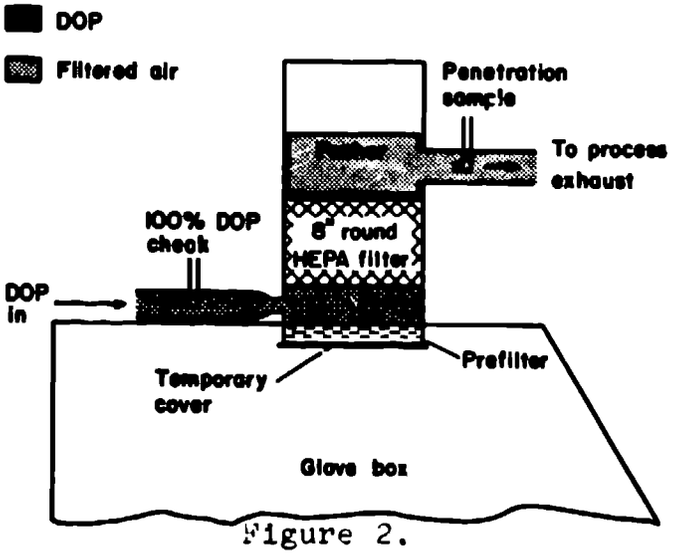
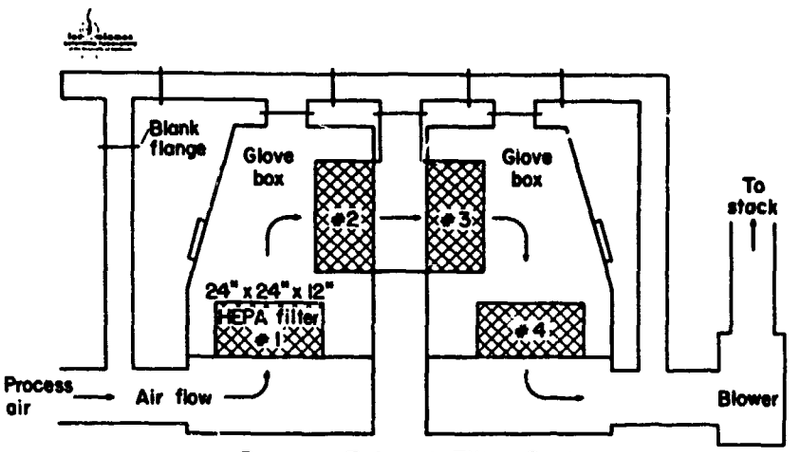
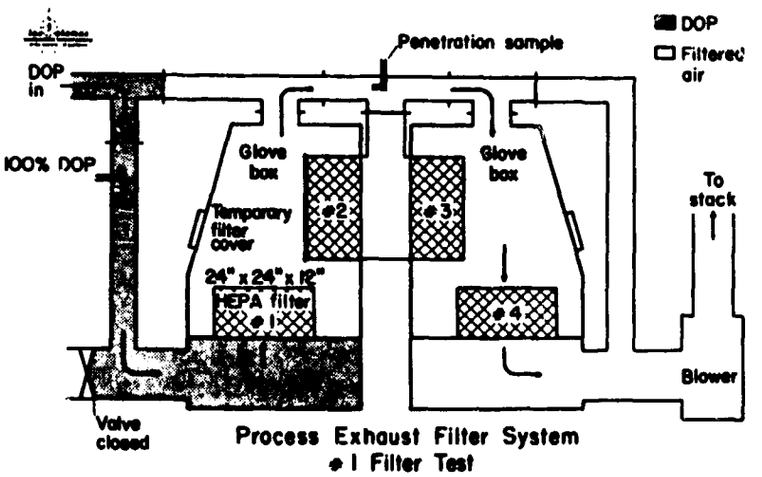


Figure 2.



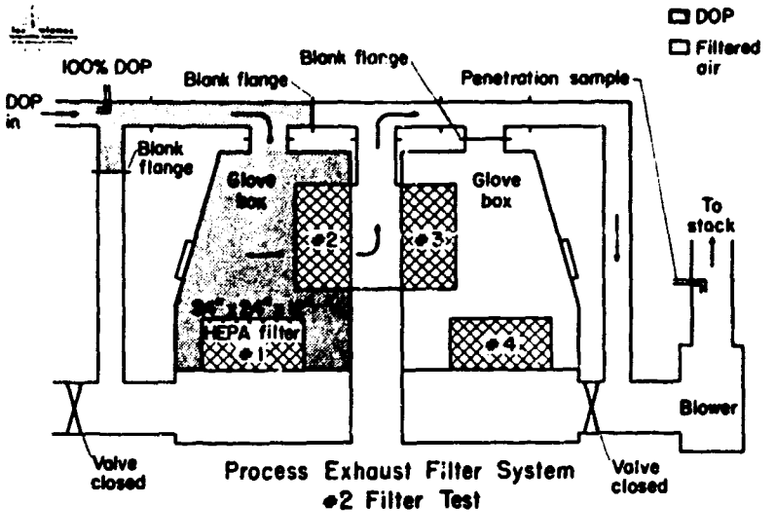
Process Exhaust Filter System

Figure 3.



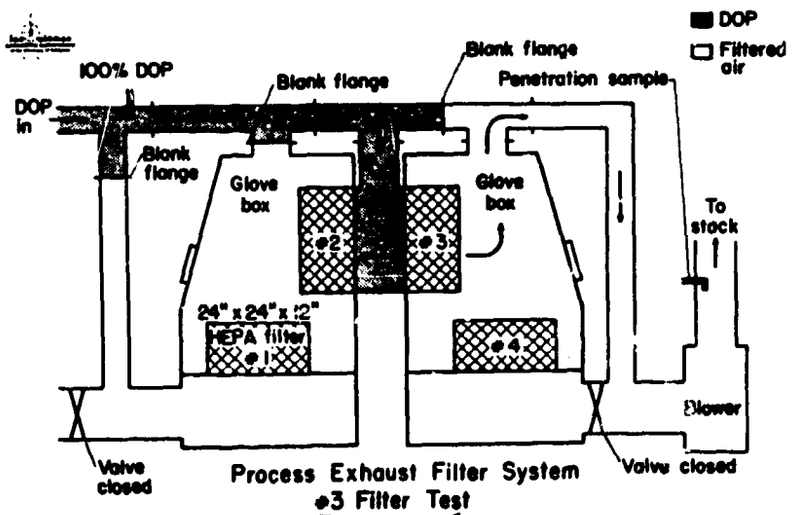
Process Exhaust Filter System
#1 Filter Test

Figure 4.



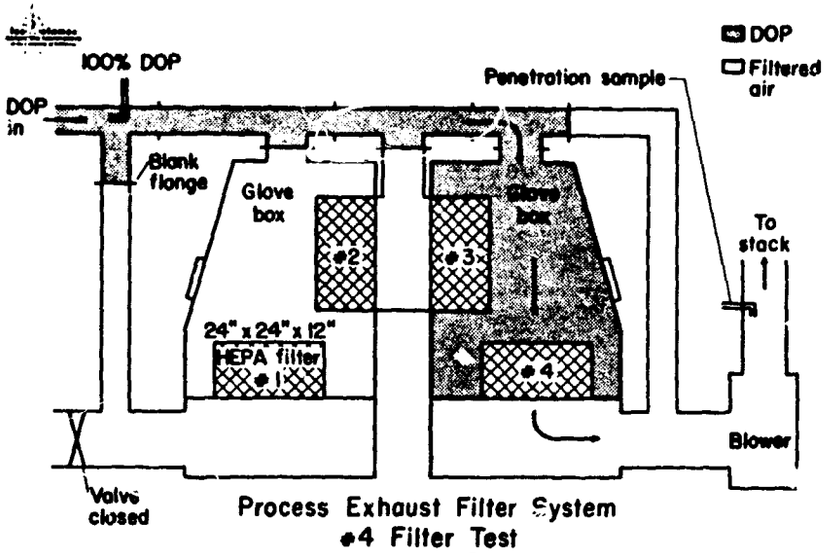
Process Exhaust Filter System
#2 Filter Test

Figure 5.



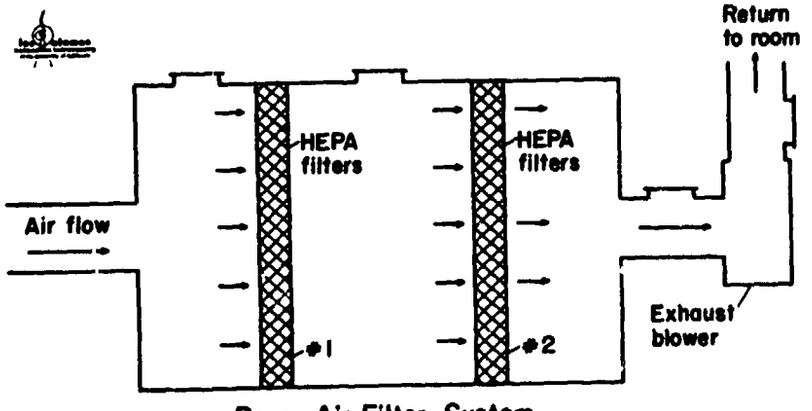
Process Exhaust Filter System
#3 Filter Test

Figure 6.



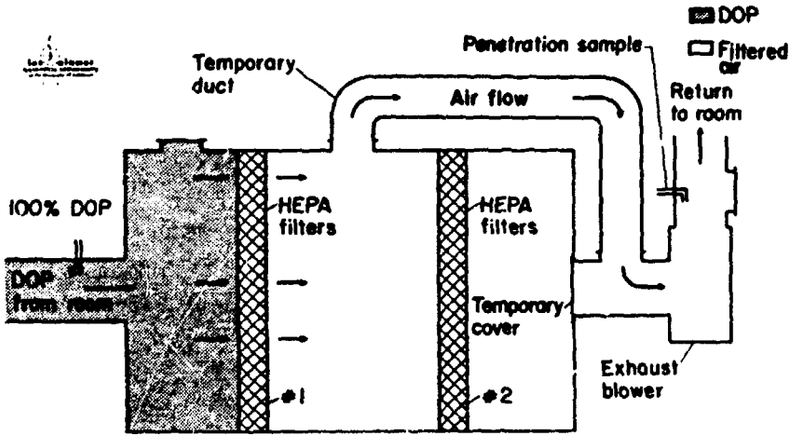
Process Exhaust Filter System
#4 Filter Test

Figure 7.

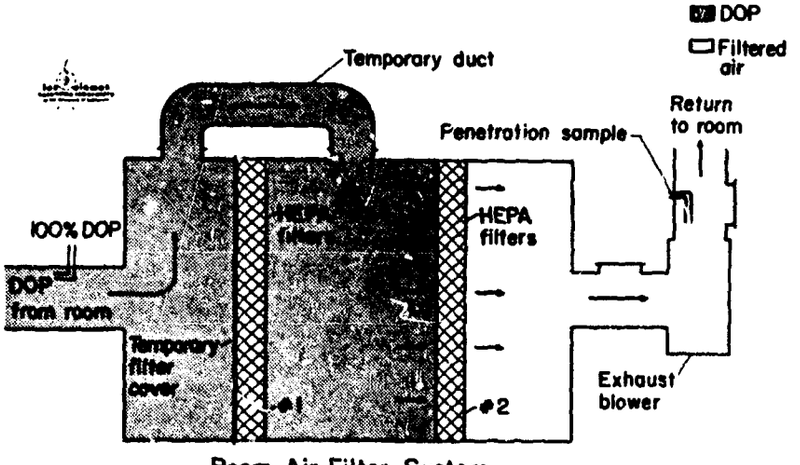


Room Air Filter System

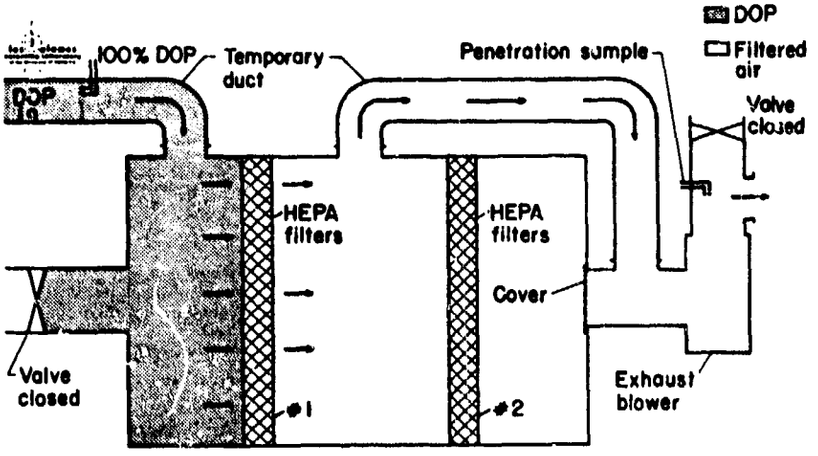
Figure 8.



Room Air Filter System
Filter Bank #1 Test
Figure 9.

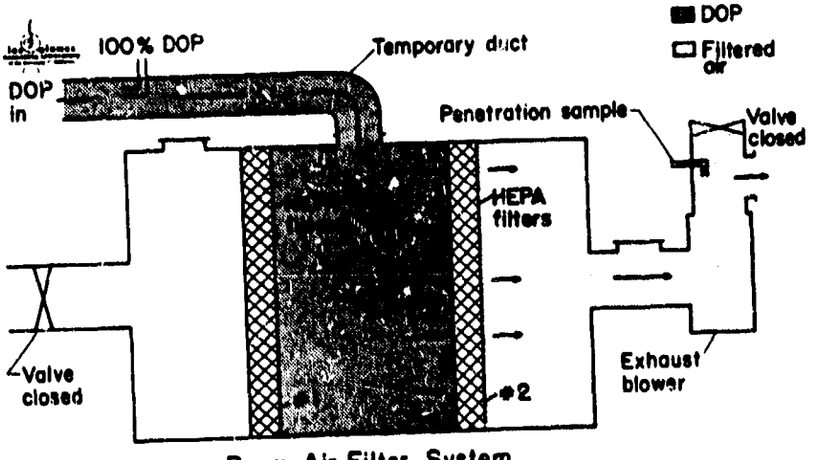


Room Air Filter System
Filter Bank #2 Test
Figure 10.



Room Air Filter System
Filter Bank #1 Test

Figure 11.



Room Air Filter System
Filter Bank #2 Test

Figure 12.