UNITED STATES ATOMIC ENERGY COMMISSION

ALI-16

INVESTIGATION OF STACK GAS FILTERING REQUIREMENTS AND DEVELOPMENT OF SUITABLE FILTERS (Report No. 6)

July 29, 1949

Arthur D. Little, Inc.

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Date: July 29, 1949

This report covers work
from: May 1, 1949
to: June 30, 1949

ALI-16
Waste Disposal

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SUMMARY

New quarters were obtained to provide working space for making and testing model filters. Equipment located there includes a slitting machine, small pleater, circular and band saws, and other tools necessary for filter manufacture and test equipment construction.

Sketches are presented to show various designs of cone seals, large filter installations, and general applications for the hollow cube and roll type filters.

Test data on 24" x 24" filters indicate that an increase in capacity of from 30 to 50% can be obtained over comparable size Chem. Corps filters.

Accelerated aging tests show that the plastisol used for end sealing the pleats is appreciably affected by storage for one month at 100° C. Further tests are planned to determine aging at probable working temperatures.

Photographs of modifications to the hollow cube and the roll type filters are presented.

Test data from the portable media tester at Brookhaven show a very slow build up in pressure drop, indicating relatively clean air.

Small scale models of high temperature filters show promise. Ignited high mineral content paper and compressed fine fiber glass mats both show potentialities as high efficiency,

high temperature media. Sealing methods and frame design need more consideration and work.

A paper mill run on June 8, 1949 was successful, but a weak paper resulted, and another run will be made in an attempt to produce stronger paper with the same efficiencies.

Equipment and techniques for the evaluation of filters and media in terms of actual particles are being worked out. Actual tests should begin within a short time.

Conferences were held at Oak Ridge on May 10, 1949, to discuss general problems and at Brookhaven on May 26, 1949 to discuss filtration of pile cooling air. A summary of our work and the exhibition of models was presented to the Stack Gas Working Group June 21 and 22, 1949.

The chemical resistance tests on Chemical Corps paper is presented in Appendix A. These data show that the paper is resistant to low concentration of some chemical reagents.

Filter Construction Facilities

To provide room to accommodate the equipment and facilities required to construct large size filters, space at a nearby location was obtained. At this location the filters are also tested to determine performance characteristics.

A paper slitter manufactured by the Cameron Machine Co. which will accommodate a paper width of up to 40"is used to cut the long strips of paper necessary to make large capacity filters. The slitting is done by passing the paper between a roller and a sharp hardened steel wheel under spring tension. A tempered steel blade is located directly behind the wheel. This blade assures complete separation of the paper cut by the wheel. This slitter operates very well on the relatively soft and fragile filter paper.

The small Chandler Co. pleating machine which is used to make sharp pointed corrugated kraft paper is also in this new location. This small pleating machine turns out 1/8 to 3/8" pleats, which are now used principally as spacers for circular filters, and was mentioned in the last report.

In order to cure the plastisol which is used to seal the ends of the pleats, a hot plate was constructed. This plate is 1/2" thick, 40" long, and 8" wide, and is chrome plated to give a smooth surface. The heating is accomplished by four chromolox strip heaters together with a thermostatic temperature control, which holds the temperature within 5° of 130° C.

An 8" circular saw is available for cutting the wood filter frames to shape and for other miscellaneous work. To trim the ends of the pleats for sealing, a band saw has been modified so that the pleats are cut at a 10° angle from the vertical. When the blade is at this angle, it cuts the paper and corrugated spacers evenly, but if the filter is trimmed without this angle between the blade and the work, the result is a torn and ragged edge. A ragged edge of course gives a poor seal.

The large scale testing apparatus consists of a duct which contains a flow measuring orifice and taps for measuring the pressure drop across the filter being tested. The air flow can be controlled up to a flow of 1500 CFM.

Two large size tables are provided for working space for the construction of filters and for building special equipment involved in the manufacture or testing of filters. Sufficient hand and power tools are on hand or being purchased to do the necessary work.

Methods of Mounting Air Filters and Air Filter Assemblies

During the work on filter design we have been aware of the need to provide methods of mounting air filters to give a maximum of convenience and protection to personnel servicing an installation. In the following sketches numbered I to XII inclusive various suggestions are illustrated.

Sketch No. I shows a cube type filter assembly composed of four rectangular filters supported in a wood frame. In this filter air enters the bottom opening and passes outwardly through the pleated paper sides. Contamination is then contained within the structure which acts as a shield to protect those who must handle the filter when it is removed.

A cone base (machined casting) is shown in Sk. No. I which seats into a conical receptacle in the mounting surface. Sketch II shows methods of making the base seal in more detail. Scheme "A" shows a sheet gasket (dense felt) between the conical surfaces. Scheme "B" shows a rubber ring gasket located in a machined channel and making the seal between the cone flanges. The conical surfaces in this second case serve only to position the filter. Scheme "C" shows a mounting without cone base in which the filter is clamped directly to a mounting plate with a bolted latch and sealed by compression of a rubber gasket.

Sketch No. III illustrates the installation of a hollow cube filter over a space, or duct from which air is drawn for filtration. It is evident that the pressure drop through the filter multiplied by the cross section of the cone opening must be less than the total **weight** of the filter, or the filter will lift up. This will allow air to escape past the seal. Under some conditions it may be necessary to use hold-own latches to maintain the seal. This sketch also indicates the ease with which a filter assembly of this kind can be removed by remote means of control.

Sketch IV shows a cube filter located in a low pressure duct into which air is drawn from a contaminated area.

Where filters are to be installed in a vertical wall, adapter plates may be used so that filters are seated in an upright position. Fewer filters of this type are required to replace the flat face type since is is estimated that cube filters would be made in capacities of 1000 CFM. Sketch V illustrates this use.

Sketch VI pictures the use of a light weight sealing bell in a simple pent-house exhausting system. Since all contamination is retained within the filter the bell may be removed safely for replacing the filter when necessary.

In Sketch VII another method of using a sealing bell is shown. Here the filter unit and bell are mounted on a truck. This provides a movable exhaust chamber which can be coupled to a working cell or other area requiring the removal of contaminated air. When a filter change is needed the whole device can be taken to a servicing room for removing the bell and replacing the filter. Again the danger of exposing personnel to radiation and contact with contamination is reduced to a minimum.

Where air is to be filtered in a large duct banks of hollow cube filters may be mounted upright in horizontal levels of a barrier wall built into the duct. Sketch VIII illustrates the method. Here one step is shown in the barrier. For a large volume of air flow a large level area or several stepped levels would be required.

A cylindrical or roll type filter is shown in Sketch IX. The cutaway view allows the seal locations to be seen. The filter is wound on a central core of paper board or wood shown also in the sketch. An ordinary fiber shipping drum is the outer casing. This kind of filter is simple, compact, light weight, disposable by combustion and retains all contamination within. It can be made in small sizes only with the capacities of 300 or 400 CFM as the maximum. As a replaceable cartridge filter it should find use in ventilating small areas like hoods, cells, and dry boxes.

Sketch X suggests a very simple arrangement for use of a cartridge filter in a cell exhaust system.

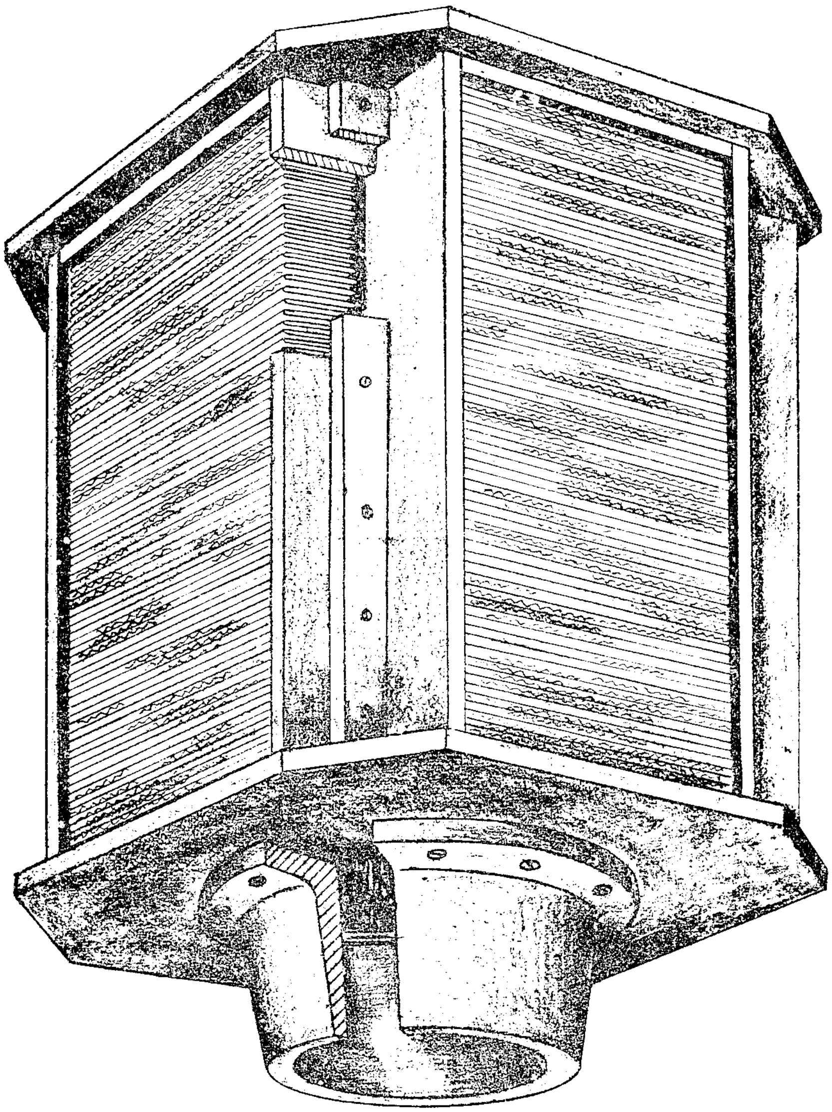
Sketch XI has a cartridge filter located at the top of a hood. In this sketch the filter could acquire contamination on the exterior surface. A better arrangement would have the filter outside of the hood between the exterior wall and exhaust duct.

Sketch XII is a dry box installation and the remarks in the previous paragraph apply here also.

24" x 24" Square Pleated Paper Filters

Several 24" x 24" O.D. square filters have been made and tested to obtain a comparison with the standard Chemical Corps filters now used. Two 6" deep filters were made using B and C flute corrugated spacers. A 6" filter using A flute is under construction now, and has not been tested. A 12" deep filter using "A" flute corrugated spacers has been made and tested. These filters show a considerable increase in capacity for the same pressure drop when compared with similar Chem. Corps filters. The pertinent data for the filters is shown in the table.

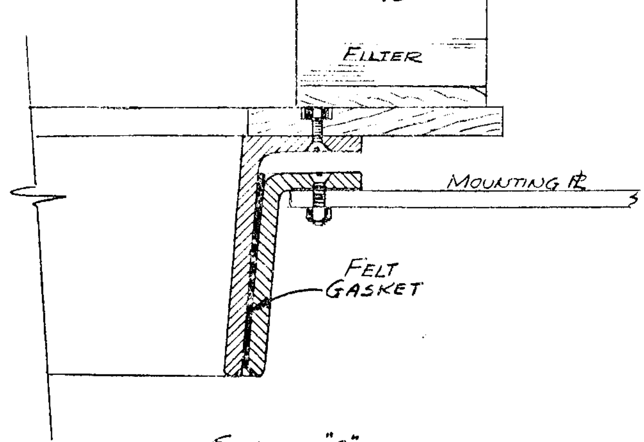
The performance curves of pressure drop vs flow rate are shown in figure I, together with a 24" x 24" x 6' Chem. Corps filter which we have for test purposes. The pressure drop for the Chem. Corps filter at the rated flow of 300 CFM is slightly lower than that indicated by Chem. Corps data.



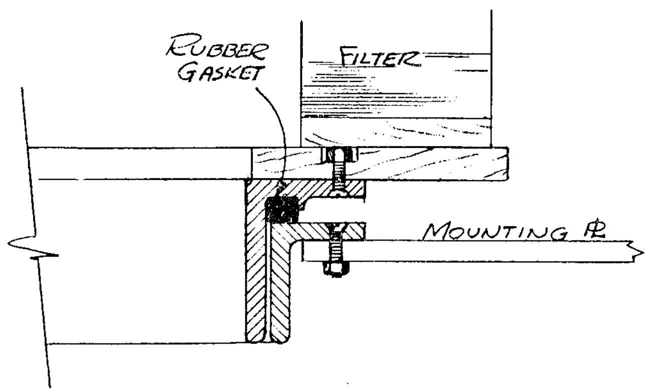
SK. No I
HOLLOW CUBE FILTER

A.E.C.-57896

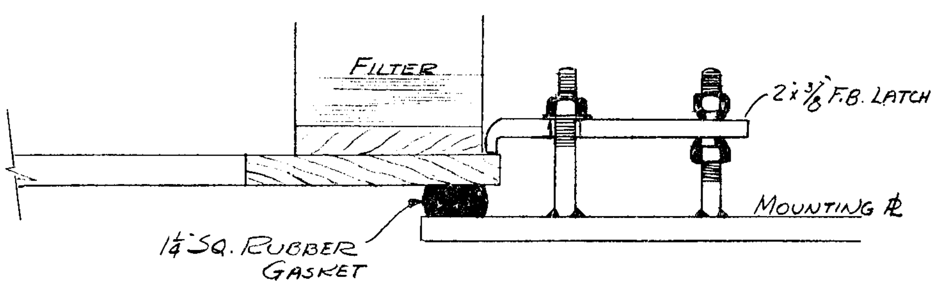
ARTHUR D. LITTLE INC.
CAMBRIDGE, MASS.
E.A.E. - MAY 5, 1949



SCHEME "A"
3" = 1 FT.



SCHEME "B"
3" = 1 FT.

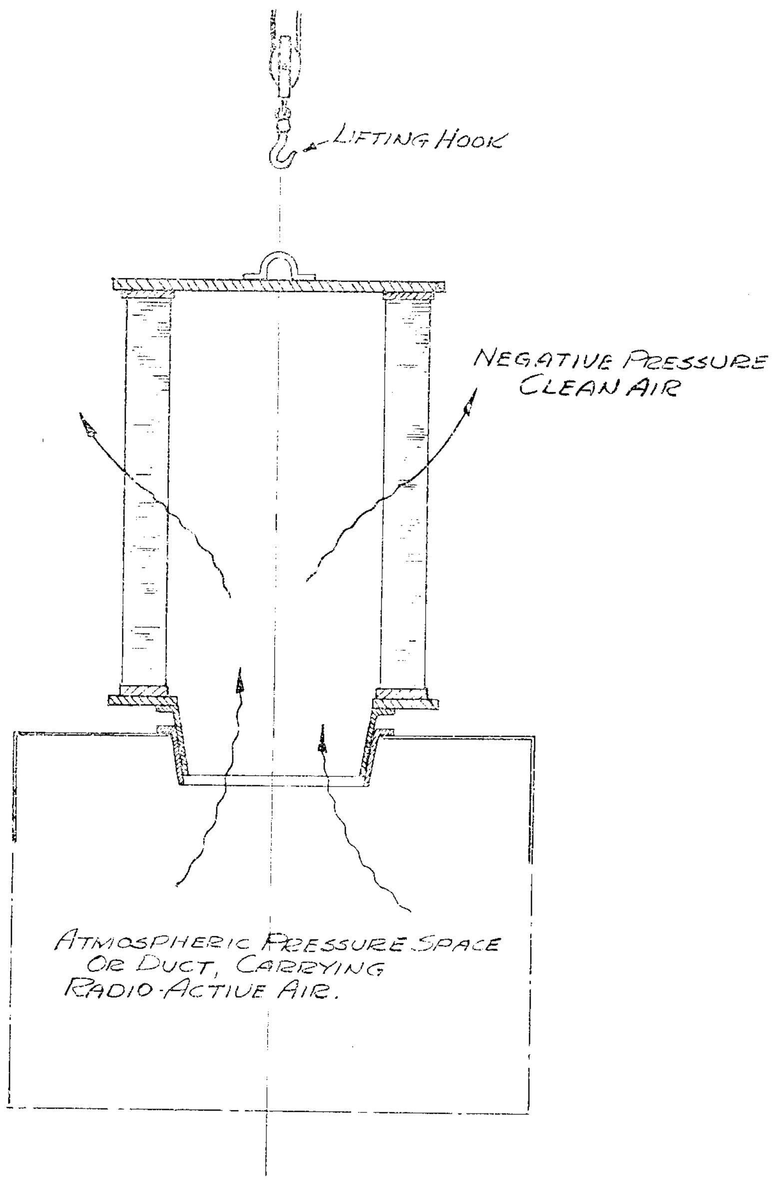


SCHEME "C"
3" = 1 FT.

SK. NO. II

METHODS OF MOUNTING
HOLLOW CUBE FILTER

ARTHUR D. LITTLE INC.
CAMBRIDGE, MASS
E.A.E. — MAY 5, 1949

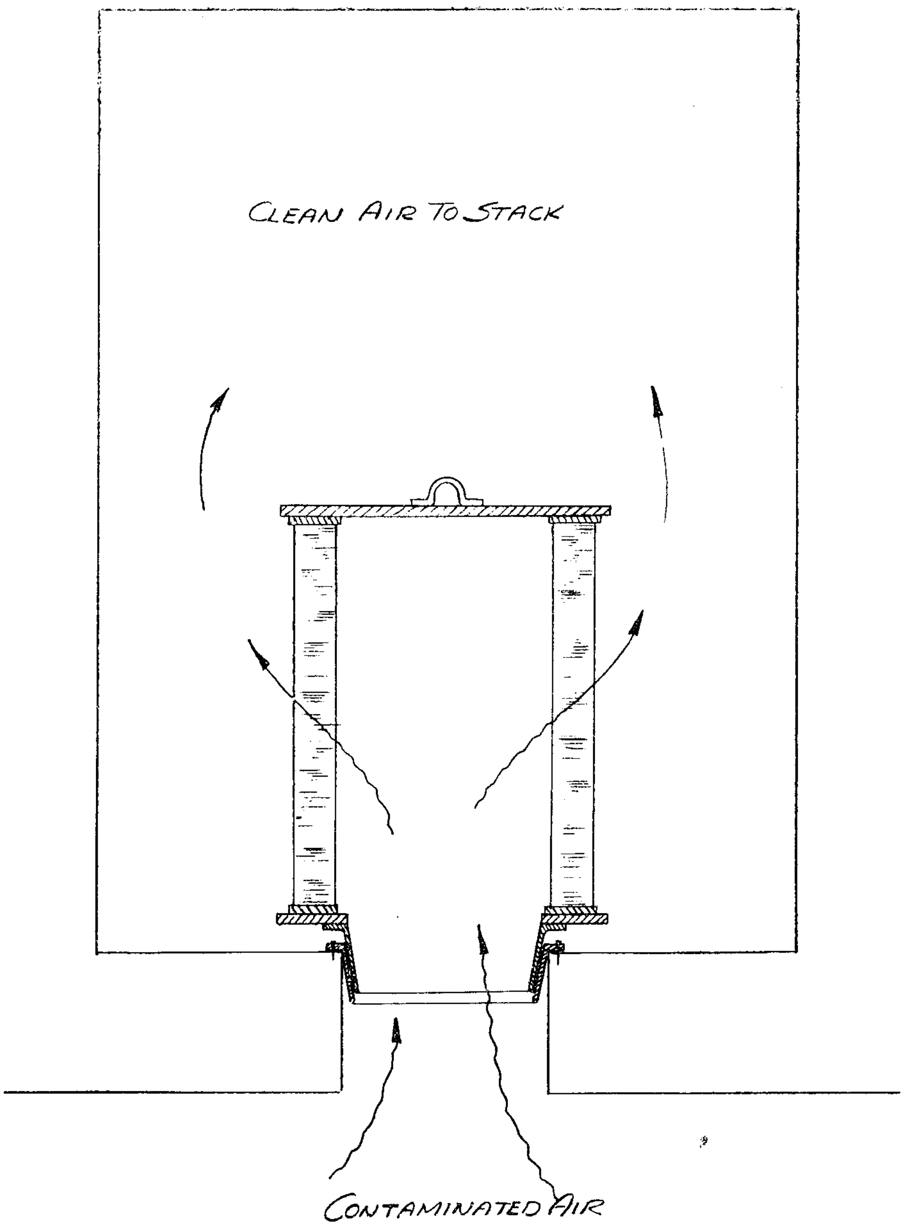


HOLLOW-CUBE FILTER INSTALLED IN
NEGATIVE PRESSURE CHAMBER
ABOVE A CONTAMINATED ROOM
OR DUCT.

SK. NO. III
CUBICAL FILTER INSTALLATION
SCHEME I.

AEC-57896

ARTHUR D. LITTLE INC.
CAMBRIDGE, MASS.
E.A.E. MAY 5, 1949

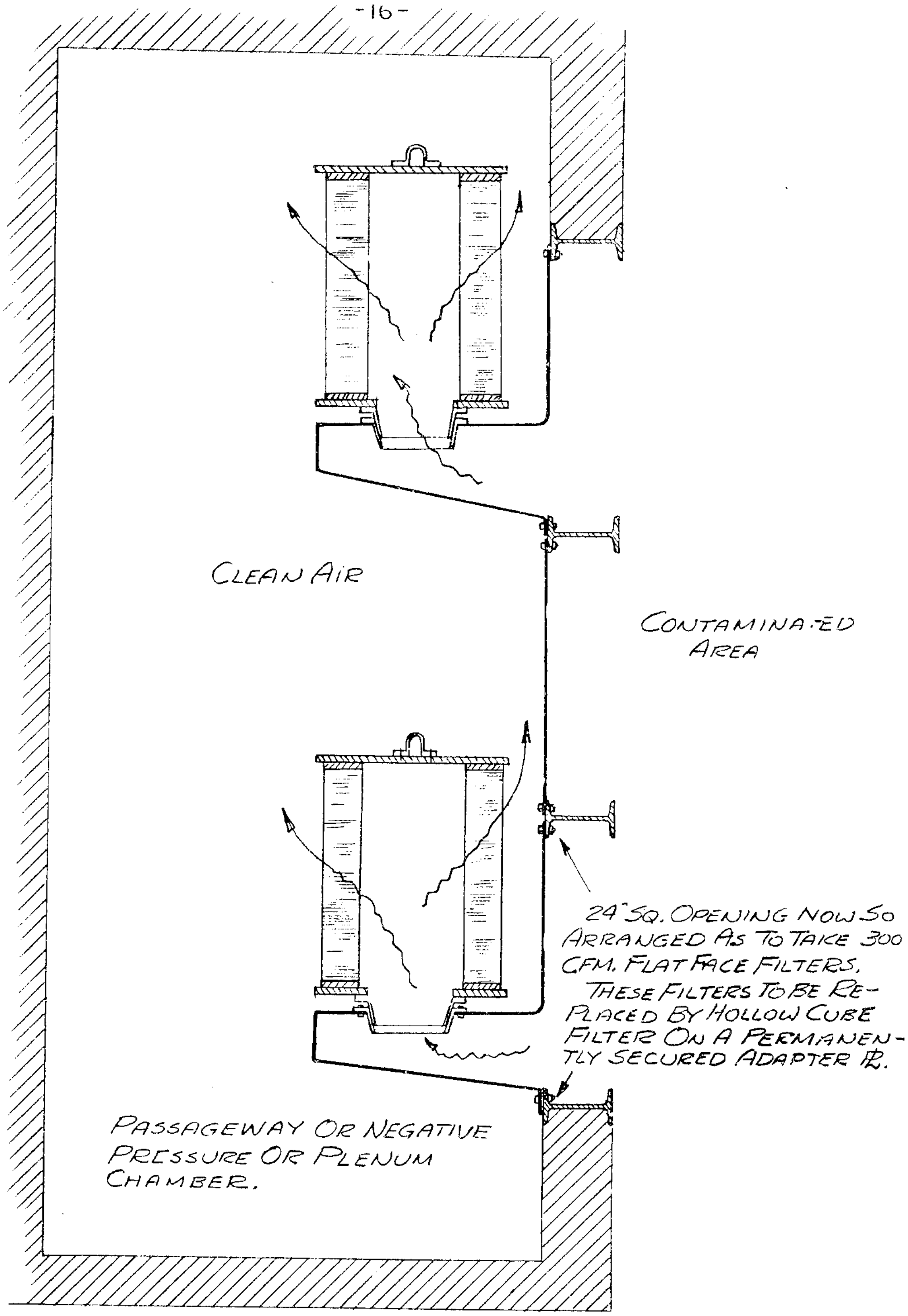


HOLLOW-CUBE FILTER INSTALLED IN NEGATIVE PRESSURE DUCT WHICH DRAWS FROM CONTAMINATED AREA.

SK. No. IV
CUBICAL FILTER INSTALLATION
SCHEME II

AEC 57896

ARTHUR D. LITTLE INC.
CAMBRIDGE, MASS.
E.A.E. - MAY 5, 1949

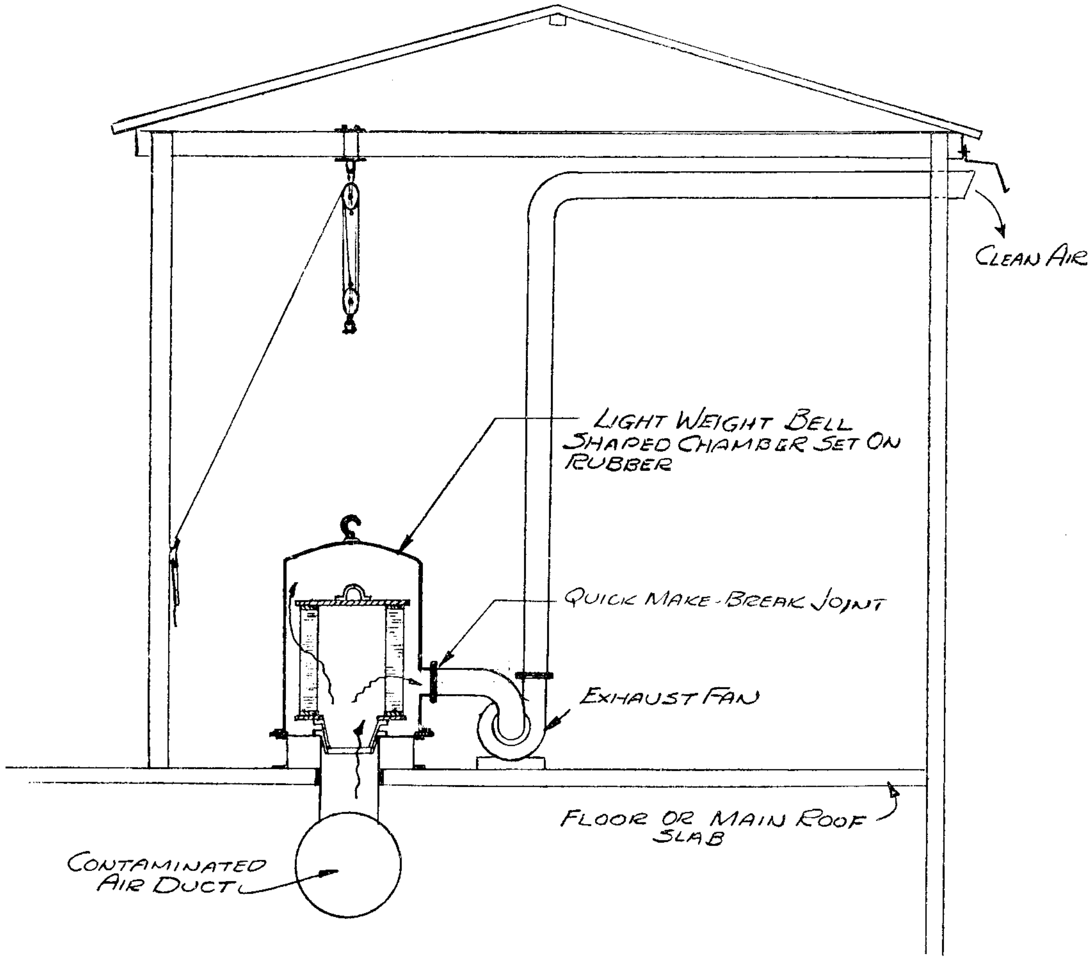


CUBICAL FILTER REPLACING 24" x 24" FLAT FACE FILTER. ONE FILTER REPLACING EITHER ONE OR TWO 300 CFM FLAT FACE FILTERS.

AEC 57896

SK. NO. V
CUBICAL FILTER INSTALLATION
SCHEME III

ARTHUR D. LITTLE INC.
CAMBRIDGE, MASS.
E.A.E. MAY 5, 1949

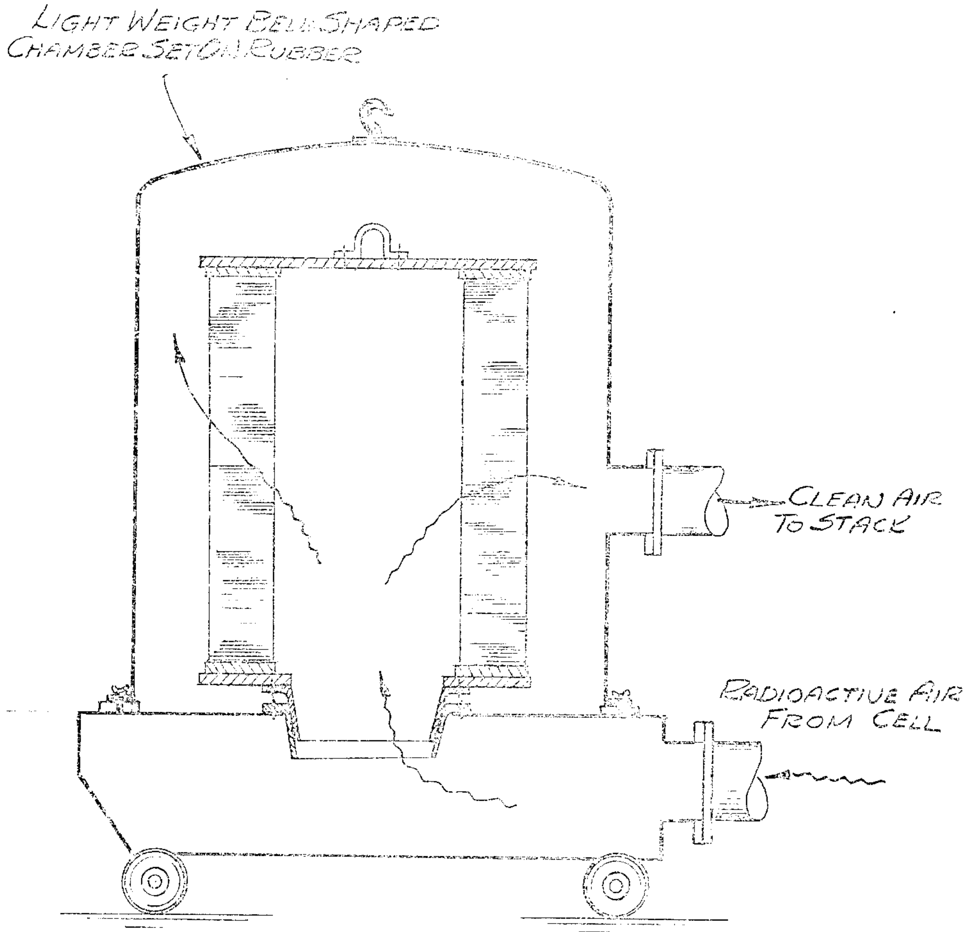


INSTALLATION OF HOLLOW-CUBE FILTER IN PENT HOUSE ABOVE LABORATORY OR ON PROCESSING PLANT ROOF.

SK NO. VI
CUBICAL FILTER INSTALLATION
SCHEME IV

ARTHUR D. LITTLE, INC.
CAMBRIDGE, MASS.
E.A.E. · MAY 5, 1949

AEC 57896

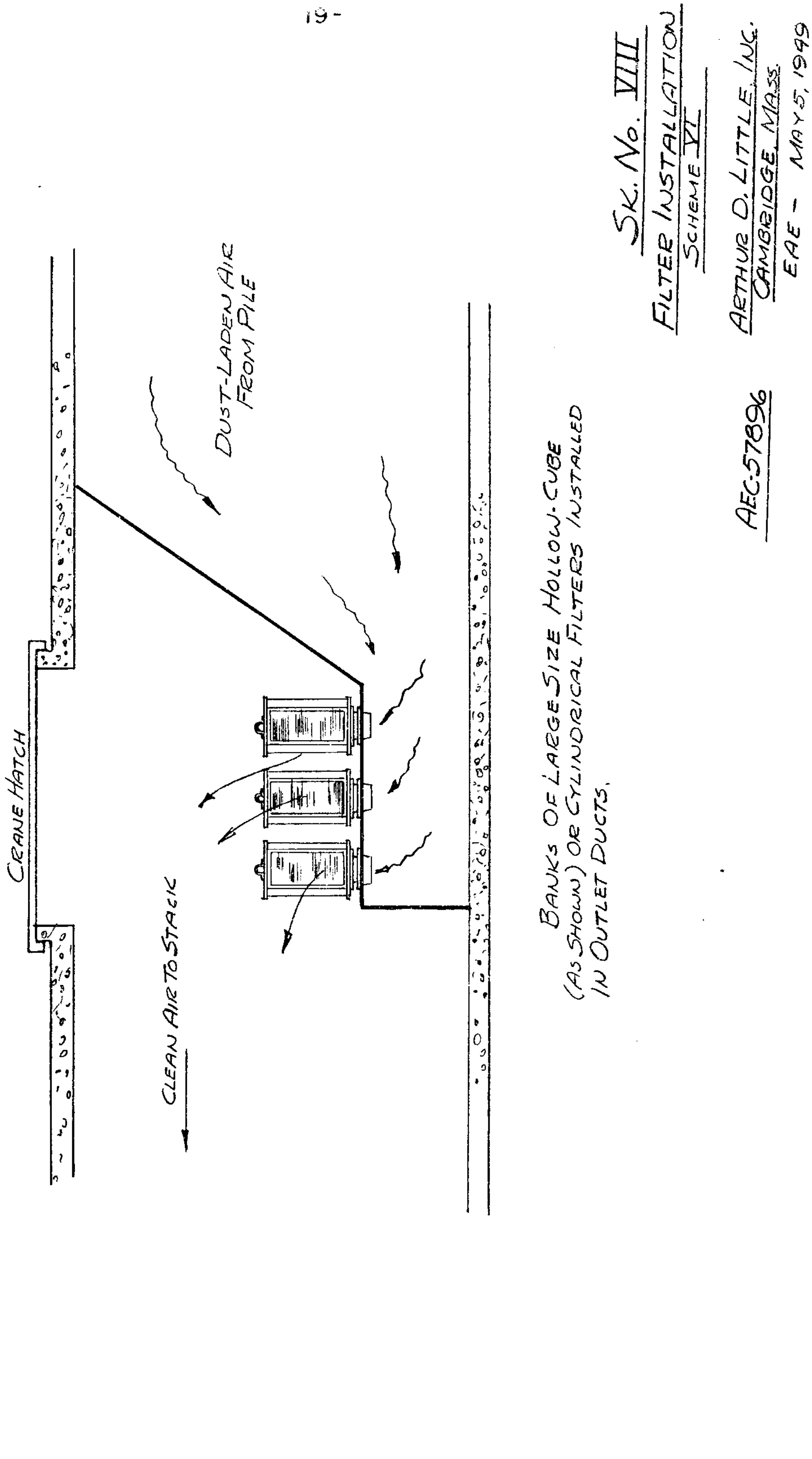


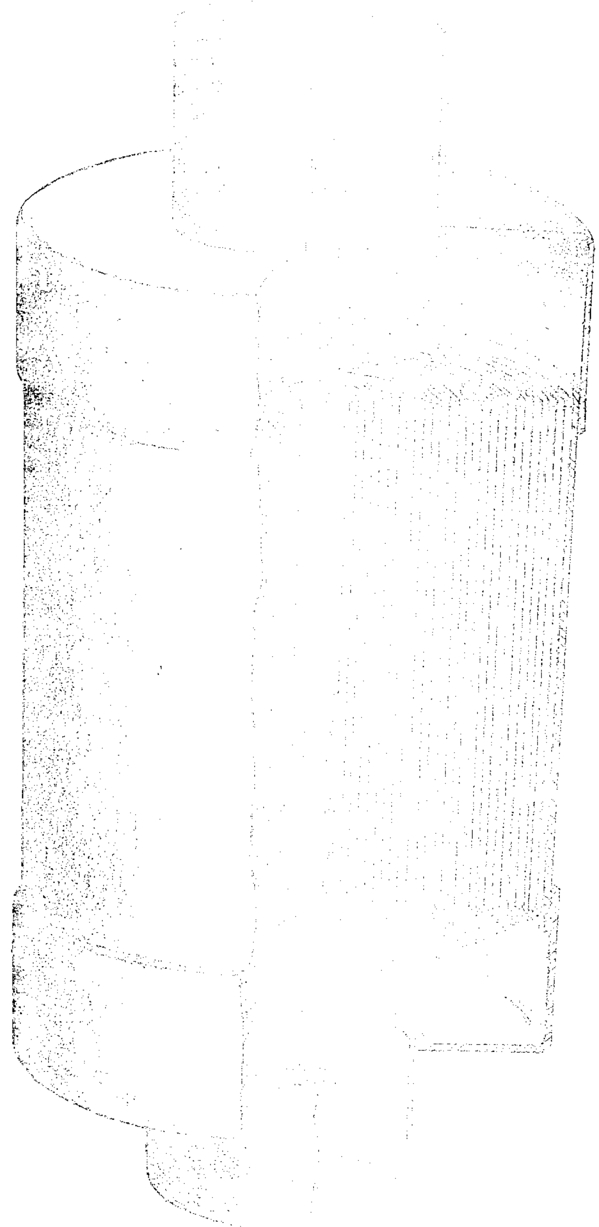
HOLLOW-CUBE FILTER (AS SHOWN) OR CIRCULAR FILTER SET IN MOVEABLE EXHAUST CHAMBER SO AS TO BE ROLLED UNDER AN OVERHEAD HOIST LOCATED ELSEWHERE TO REMOVE BELL & REPLACE FILTER

SK. NO. VII

FILTER INSTALLATION
SCHEME V

AEC 57896 ARTHUR D. LITTLE, INC.
CAMBRIDGE, MASS
E.A.E. - MAY 5, 1949

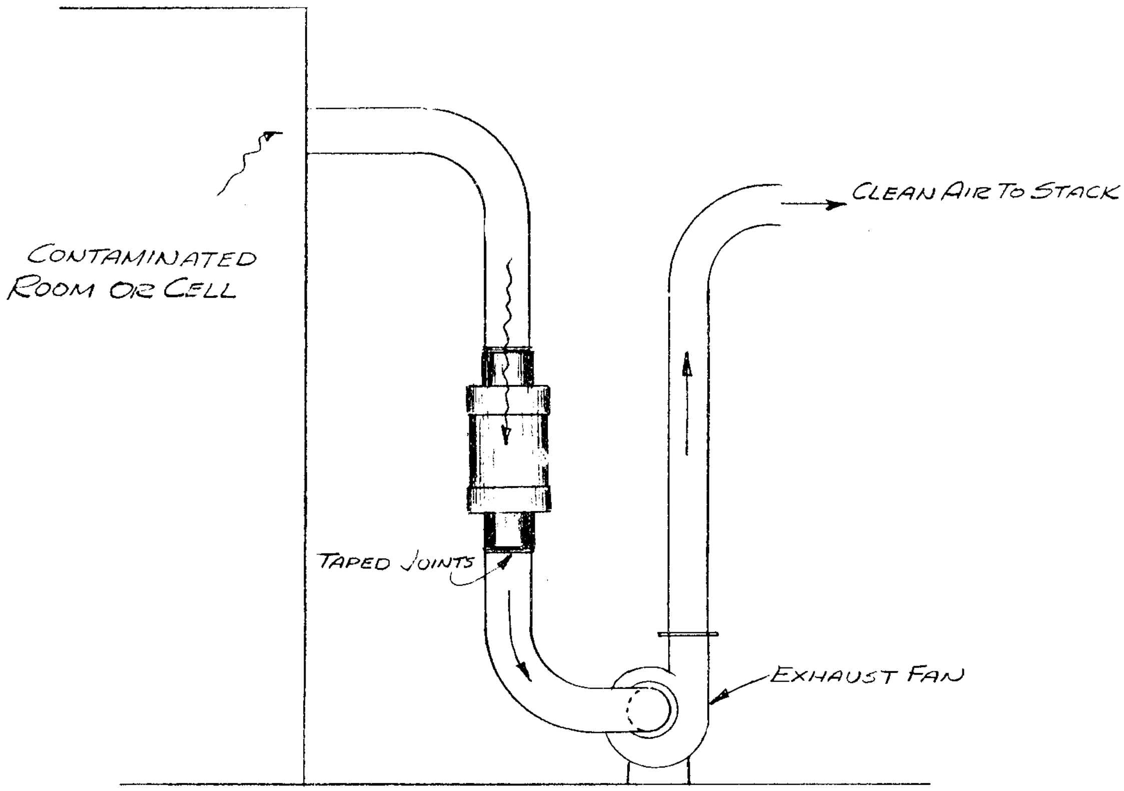

SK. No. VIII
FILTER INSTALLATION
SCHEME VI
ARTHUR D. LITTLE, INC.
CAMBRIDGE, MASS.
EAE - MAY 5, 1949
AEC-57896
DUST-LADEN AIR FROM PILE
CRANE HATCH
CLEAN AIR TO STACK
BANKS OF LARGE SIZE HOLLOW-CUBE (AS SHOWN) OR CYLINDRICAL FILTERS INSTALLED IN OUTLET DUCTS.



SK. No. IX

CYLINDRICAL FILTER

ARTHUR. D. LITTLE, INC.
CAMBRIDGE, MASS.
E.A.E. - MAY 5, 1949

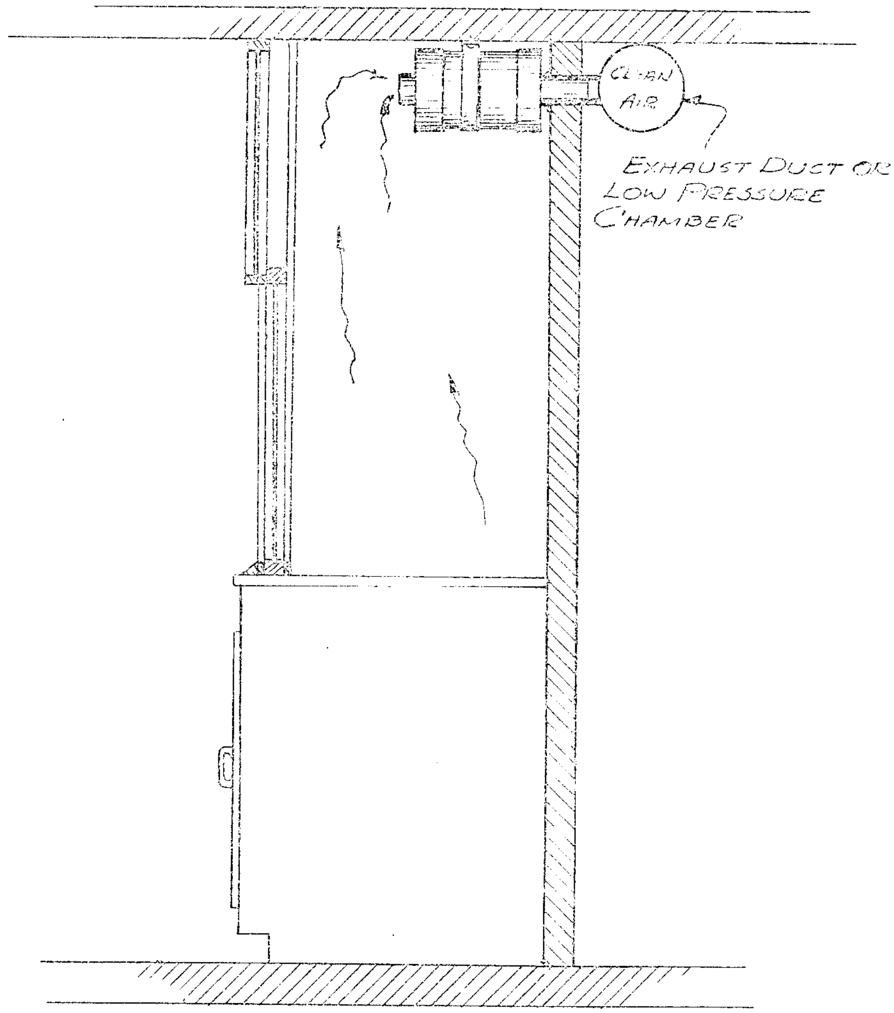


SK. NO. X

CYLINDRICAL FILTER
INSTALLED IN EXHAUST SYSTEM

AEC-57896

ARTHUR D. LITTLE INC.
CAMBRIDGE, MASS.
EAE- MAY 5, 1949

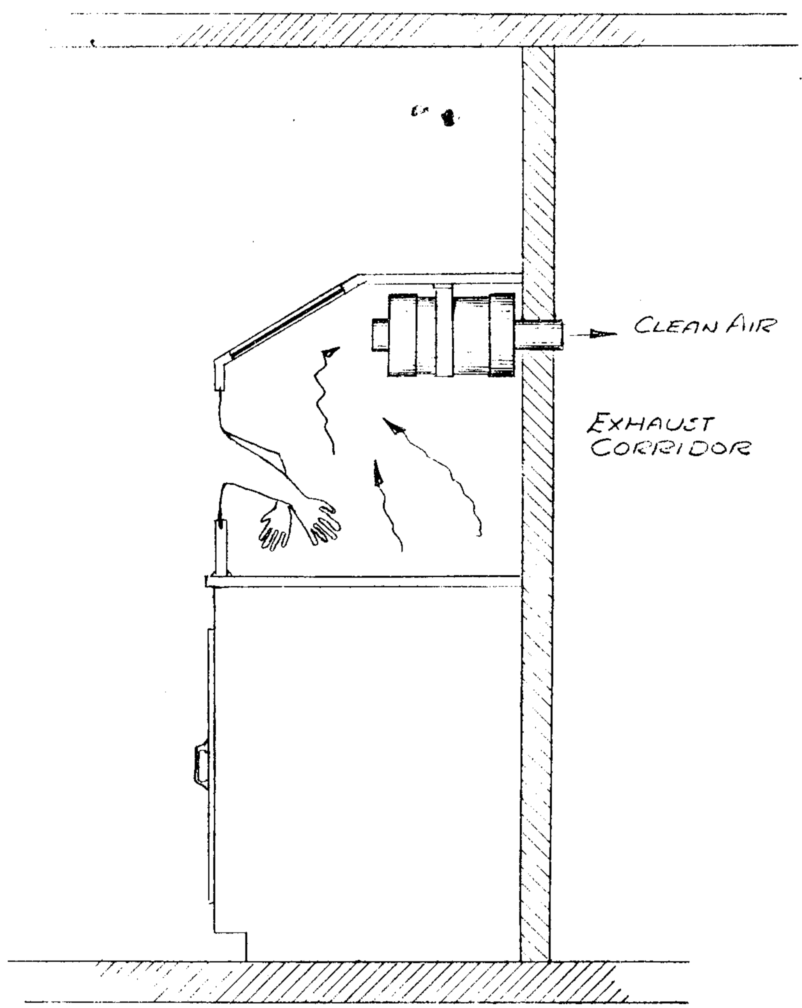


SK. No. XI

CYLINDRICAL FILTER INSTALLATION IN HOODS —

AEC-57896

ARTHUR D. LITTLE, INC.
CAMBRIDGE MASS.
E.A.E. - MAY 5, 1949



SK. NO. XII

CYLINDRICAL FILTER
INSTALLATION IN DRY BOXES.

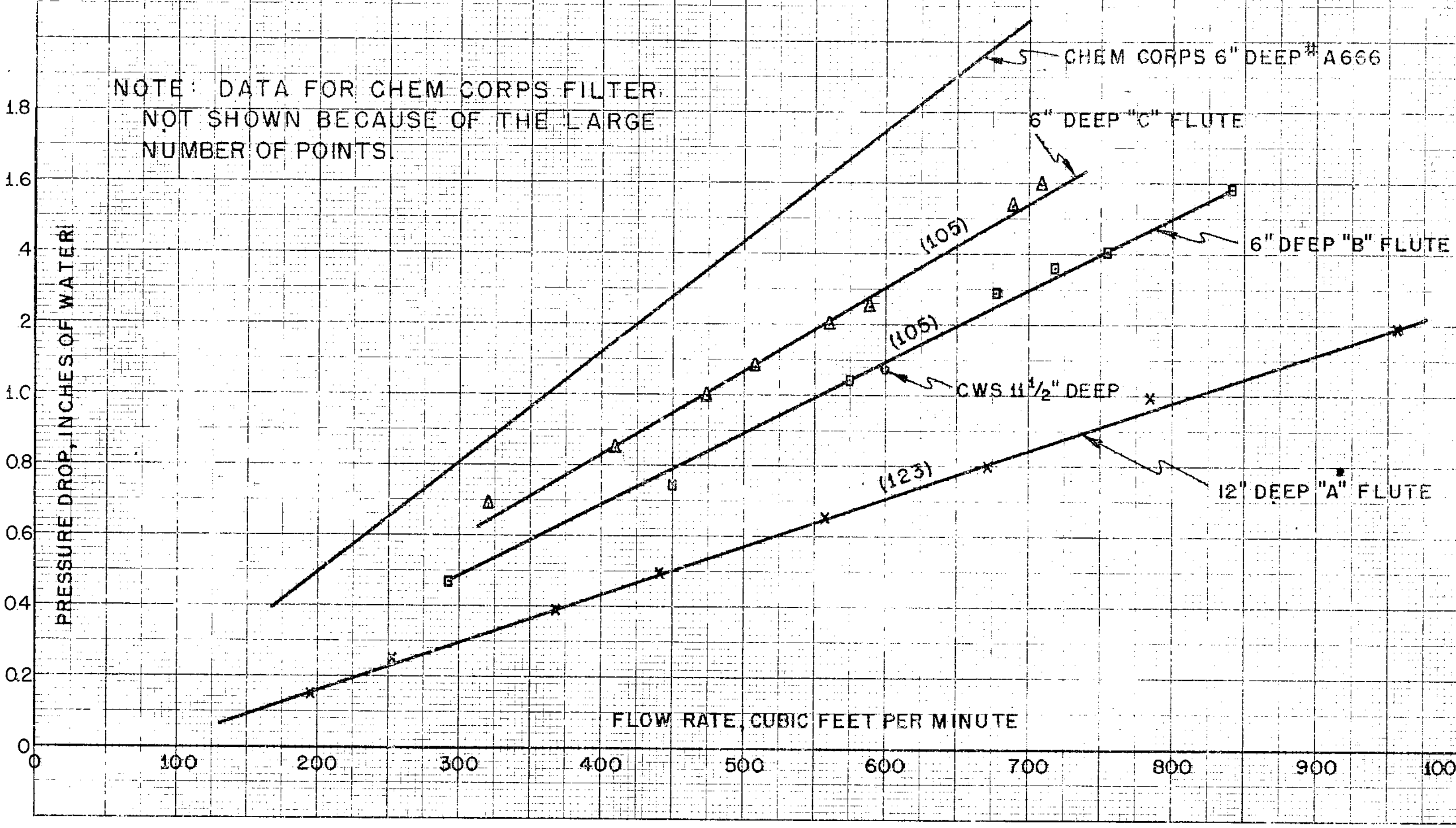
AEC-57896

ARTHUR D. LITTLE, INC.
CAMBRIDGE, MASS.
E.A.E - MAY 5, 1949

FIGURE I

PRESSURE DROP vs FLOW RATE FOR
24" x 24" O.D. SQUARE PLEATED FILTERS

THE DEPTHS INDICATED ARE THE OUTSIDE
DIMENSIONS OF THE FRAME



Filter No. and Type	Pleat Depth	No. of Pleats	Pressure drop of paper at 28 ft/min mm·H_2O	Ft^2 of paper	Flow Rate at 1" Pressure Drop
CWS #A666	5 1/4"	50	110*	82	360 CFM
ADL #2 "C" flute	5 1/8"	70	105	112	470 "
ADL #3 "B" flute	5 1/8"	90	105	144	550 "
CWS 11 1/2" deep O.D.*	10 1/2-11"	50	110*	164	560 "
ADL #4 "A" flute	11 1/8"	67	123	232	810 "

*Figures are approximate

The inside dimensions of the frame, or the dimensions of the face of the filter are 22 3/8" x 22 1/8" for the ADL filters, except in the case of filter #3 with "B" flute corrugated spacers, which has dimensions of 18 3/8" x 22 3/8". The information in the above table and in figure I are the actual data for this filter corrected to the larger size. Some error may arise from the difference in the pressure drop of the paper itself in these various filters; this correction was not made and may introduce an error of 10% in the calculations. However, the differences in the flow rates at the same pressure drop for these filters is much greater than the probable error due to omitting this correction. The general accuracy of the data is estimated to be better than 10%.

The increase in capacity of the 6" deep filters over the present 6" Chem. Corps filter amounts to approximately 30% in the case where "C" flute corrugated paper is used as a spacer and approximately 55% when "B" flute is used. At 600 CFM the performance of the 6" deep "B" flute filter is nearly identical with that of the C.W.S. 11 1/2" deep filter (Chem. Corps data). The ADL 12" deep filter shows an increase in capacity of approximately 45% over the 11 1/2" Chem. Corps filters at the same pressure drop.

The increase in capacity of the present ADL filters over comparable CWS filters is probably due to a combination of the following factors:

1. More paper area can be placed in the ADL filters because of the smaller distance between pleats. This is the major factor effecting an increase in capacity.

2. A much greater portion of the total filter paper area in the ADL filters is effective area when compared with CWS filters; the comb-like spacers and seal in Chem. Corps filters close off approximately 10% of the paper area.

3. The closely spaced flutes in the corrugated paper spacers provide a uniform pleat spacing. The 2" spacing of the Chem. Corps cardboard spacers allow the paper to be pressed together in the center by the pressure drop through the paper, thus blocking out filtering area. The corrugated paper spacers, however, have more resistance to flow down the pleats.

The factors which control the performance of pleated type filters are being studied and sufficient data are being assembled to allow correlations to be made. It is believed that by this method, a filter can be designed and constructed which will give the maximum flow per unit face area at a given pressure drop. This filter would be the optimum as far as space required for an installation is concerned, but may not be the best filter in regard to other considerations. These considerations would include the cost of filter per unit of air filtered, effective filter life, air moving costs, particulate concentration, and would be different for different installations.

Plastisol Seal

The plastisol described in previous reports still is the best pleat end sealing material. The method of applying the plastisol to the pleats has remained essentially as previously described, with some modifications, and refinements of procedure. A discussion of plastisols in general and a description of the plastisol now used is located in Appendix A.

The problem of sealing the plastisol to the wood frame is now receiving attention. The solvent type cement composed of Hycar rubber and Durez resins which is described below, has some serious shortcomings which arose from its nature. The rubber and resins are dispersed in a solvent, which must diffuse through the wood or through the plastisol in order to provide a seal of maximum strength; this process requires such a long time as to be impracticable. Moreover, the plasticizer in the plastisol leaches out into the bonding adhesive and may prevent the adhesive from ever setting up.

The best combination adhesive and sealer found to date is as follows: The surface of the plastisol is painted with a layer of Elastomer 105 W-66 primer. This coating provides a relatively hard surface which acts as a barrier to the migration of the plasticizer into the adhesive. Weldwood glue is spread over the wood surface with a notched trowel, and the resultant seal appears to be satisfactory. The strength and sealing properties will be tested.

If necessary Hycar rubber and Durez resin sealing material may be used as a final bead seal between the edge of the frame and the filter proper. The formula now used is as follows: Hycar OR 15-50% and Durez resin 12687-50% on a solids basis are milled together then dissolved to approximately 35% total solids in a solvent mixture consisting of equal parts of ethylene dichloride and methyl ethyl ketone.

The aging characteristics of the various adhesives and the plastisol are of considerable importance, particularly since these filters may be used at temperatures of 70° C. Two tests have been performed on the plastisol itself to determine the aging characteristics.

Several sections of filter which had been sealed with the plastisol were exposed to ultra-violet light generated by a Hanovia high pressure mercury lamp for one month. Under the conditions of this test the plastisol showed considerable darkening, although some degree of flexibility remained. The paper also became darkened and apparently lost strength. This test is frequently used to test the aging qualities of plastics.

Other sections of plastisol sealed filter were placed in an oven at 100° C. for a period of one month. These samples changed from a light tan color to almost black and lost all flexibility after it had cooled down after the test. The paper took on a light brown color. It is difficult to interpret these results in terms of strength and sealing properties. The tests also show that the paper deteriorates to some extent.

The mechanism by which plastic materials fail of course is different for different materials. For some vinyl type plastics it has been found that the failure time is a logarithmic function of the temperature. This means that a material which is relatively stable at room temperatures may deteriorate in a short time at high temperatures. Apparently the hydrochloric acid released from the decomposition of vinyl chloride plastics catalyzes further decomposition. There also may be some loss of plasticizer at high temperatures. More comprehensive tests are planned to determine the probable effective life of the plastisol at various temperatures.

Miscellaneous Filter Tests

The small Aeroturn unit discussed in previous reports has been received and is now under test. The results of these tests will be presented in a future report.

Tests on Fiberglas mats to be used as prefilters is continuing; the results of which will be discussed in future reports. Because of the pressure and importance of other work to be done, less effort and time will be devoted to these tests after those now running are completed.

Preliminary tests have been made on Dollinger Glastex filters similar to those which are being installed at Brookhaven. These filters were selected because of their ability to operate at high temperatures. They are somewhat less efficient than the intake filters. Asbestos and Santocel have been blown in dry in an attempt to increase the efficiency of test units, but the results are not as good as should be obtained. Equipment is being assembled to eliminate the difficulties which were present in the first tests.

Report on Media Tests at Brookhaven

In March a portable media tester was constructed and sent to the Brookhaven National Laboratory at Upton, L. I., N.Y. A description of the unit was given in our report no. 4 of this series (ALI-13). The purpose was to determine what might be expected of certain filter media operating in that area. Test samples of media were installed in the four positions of the test instrument as follows:

(a) 2 layers of FG-50

(b) 1 layer FG-25, 1 layer FG-50

(c) 1 layer 1/2" 1 lb/cu.ft. density "B" fiber, 1 layer FG-50

(d) 1 layer #6 Chem. Corps paper

Although performance data had been obtained for these filter materials on outdoor air at Cambridge, Mass., it was recognized that the sea salt particle concentration in the atmosphere at Brookhaven might be enough greater to result in early clogging of filters used at the pile air intake.

At Brookhaven the tester is mounted at the base level of the meteorological tower (King Tower). It was placed here rather than at the pile building to avoid the abnormal dustiness caused by construction activity. The meteorological group at Brookhaven has been most cooperative and has maintained a daily log of pressure drop readings across the filter samples since March 28. During this time the tester has operated continuously.

For each of the glass fiber filters air flow rate was held at 30 linear feet per minute while the rate through Chem. Corps paper was held at 15 linear feed per minute. Flow rate through the glass fibers corresponds to that expected in the actual filter installation whereas the normal flow through Chem. Corps paper is 5 linear feet per minute.

At the end of the tests it is intended to weigh the filters to find amount of dust accumulated and to analyze for its character.

Figure II shows the data obtained by the meteorological group at Brookhaven to May. 27. Pressure drops are shown in inches of kerosene (sp. gr. .82 at 70° F.) because cold weather at the beginning of the run would not allow the use of water. Shown also are concurrent readings of temperature, percent relative humidity, and wind direction and velocity.

For the first four days there was a decrease in pressure drop at each of the four tester stations, then a distinct rise over the next seven days. Thereafter for two months the increase was very slight for stations 1 and 3 and almost no increase was perceptible for stations 2 and 4.

Conclusions which may be drawn tentatively at this time are:

(1) The filter media combination (b) in the table, selected for use at the pile air intake should fill up but very slowly at the Brookhaven site.

(2) Changing weather conditions do not cause any appreciable corresponding changes in flow resistance of the air filters.

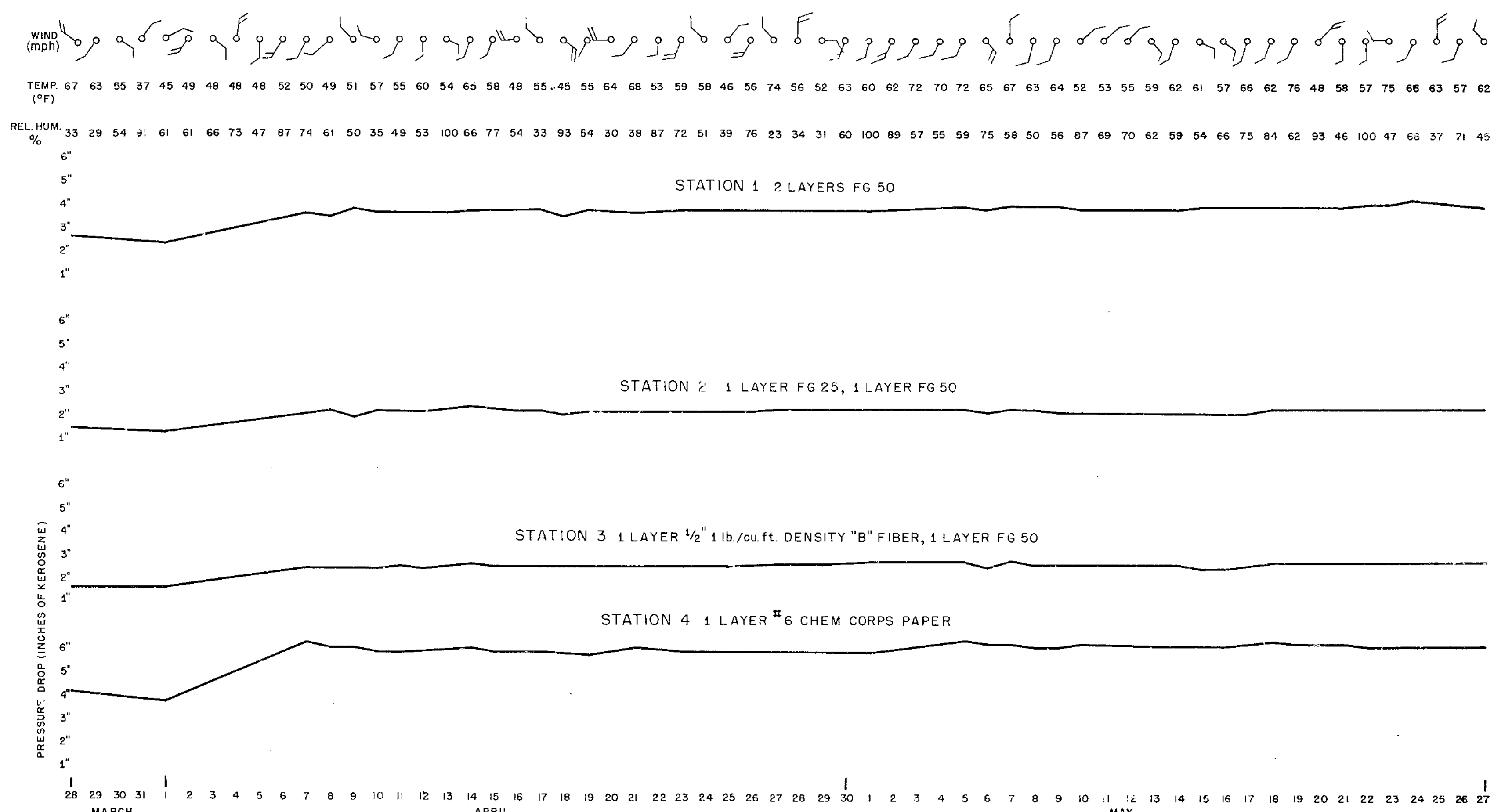
High Temperature Filters

There is a need in the scope of A.E.C. for a filter which will not deteriorate under service where air temperatures may be as high as 500° F. There are two lines of approach which

FIGURE II

DAILY READINGS OF A.D. LITTLE PORTABLE MEDIA TESTER, MARCH 28 THROUGH MAY 27

LOCATION: BASE OF KING TOWER, BROOKHAVEN NATIONAL LAB.



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are being pursued to this end at the present time.

One line of attack is based on the property of certain types of filter papers with a large asbestos and glass fiber content. It has been found that paper made in the first A.E.C. run, which contains 40% asbestos and glass, increases in efficiency when the organic fibers are burned out. Typical results of such burning are shown below, which data were obtained on the smoke tester. The conditions of this test are a linear face velocity of 28 ft/min., and 0.3 micron diameter dioctyl phthalate particles.

	Pressure Drop mm H_2O	% 0.3 micron smoke passing	E
Before ignition	130	.42	1.8
After ignition	95	.036	3.6
After further ignition	88	.027	4.1

The figures shown above represent an appreciable increase in filtering performance after the organic matter has been burned out. However, the strength of the paper is greatly reduced and a method of reinforcing using a medium such as glass gauze or web must be found.

For the high temperature filters, asbestos paper which has been pleated probably can be used as spacers. The whole filtering element can be sealed in a steel container with a ceramic cement. Some small models have been constructed in this manner, but design details must be worked out before a satisfactory filter is made.

The second line of attack is based on the compression of the 1/2" 0.6 lbs/ft^3 AA fiberglas mat to dimensions which can be pleated. It seems evident that the only way a high efficiency filter of reasonable pressure drop can be constructed is by pleating. This line of attack is based on the following data. This basic material has been called FG-50 in previous reports.

	Pressure Drop mm H_2O	% 0.3 micron smoke passing	E
Blank FG-50 1/2" thick	15	18	-
FG-50 - Binder ignited	15	19	-
Three layers - 1 1/2" thick	70	.13	4.1
Three layers - 1/4" thick (ignited)	85	.055	3.8

The results above seem to indicate

(1) That the ignition of the binder does not seriously affect the performance, and

(2) The compression of the fibers increases the pressure drop and decreases the amount of smoke passing through.

These tests are indications only, and more carefully controlled tests are necessary.

A filter constructed in the above manner may be more resistant to chemical fumes than the present Chem. Corps paper, although the paper filters are reasonably resistant to most low fume concentrations. The tests are described in another part of this report.

Instruments for Particle Study*

Our interest in the study of particles has an immediate practical objective. We wish to determine as closely as we can what size particles and how many are passed by any filter material.

At the present time commercial filters of high efficiency are rated by use of the discoloration test. We have used a modification of this test in our work. The test has serious limitations when used to evaluate really effective filters. Hours may be required to build up a detectable soil spot and the test paper itself may pass many of the smallest particles. In this test soil spots before and after the test filter are compared directly by reduction in light transmission but we know that they should not be so compared because particle sizes in the air before and after the filter can be quite different.

The DOP smoke test using 0.3 micron diameter liquid droplets is regularly used to evaluate papers for air filters. It is a valuable tool. However, we question if it represents faithfully the performance of a filter collecting solid particles of random sizes.

A high speed cascade impactor which was described in the previous report has been mounted as a mobile unit complete with suction pump, gages, and piping for back-flushing, figure III.

Experiments with the impactor have shown that operation on room air for a minute only (17.5 l. air per min.) produces a

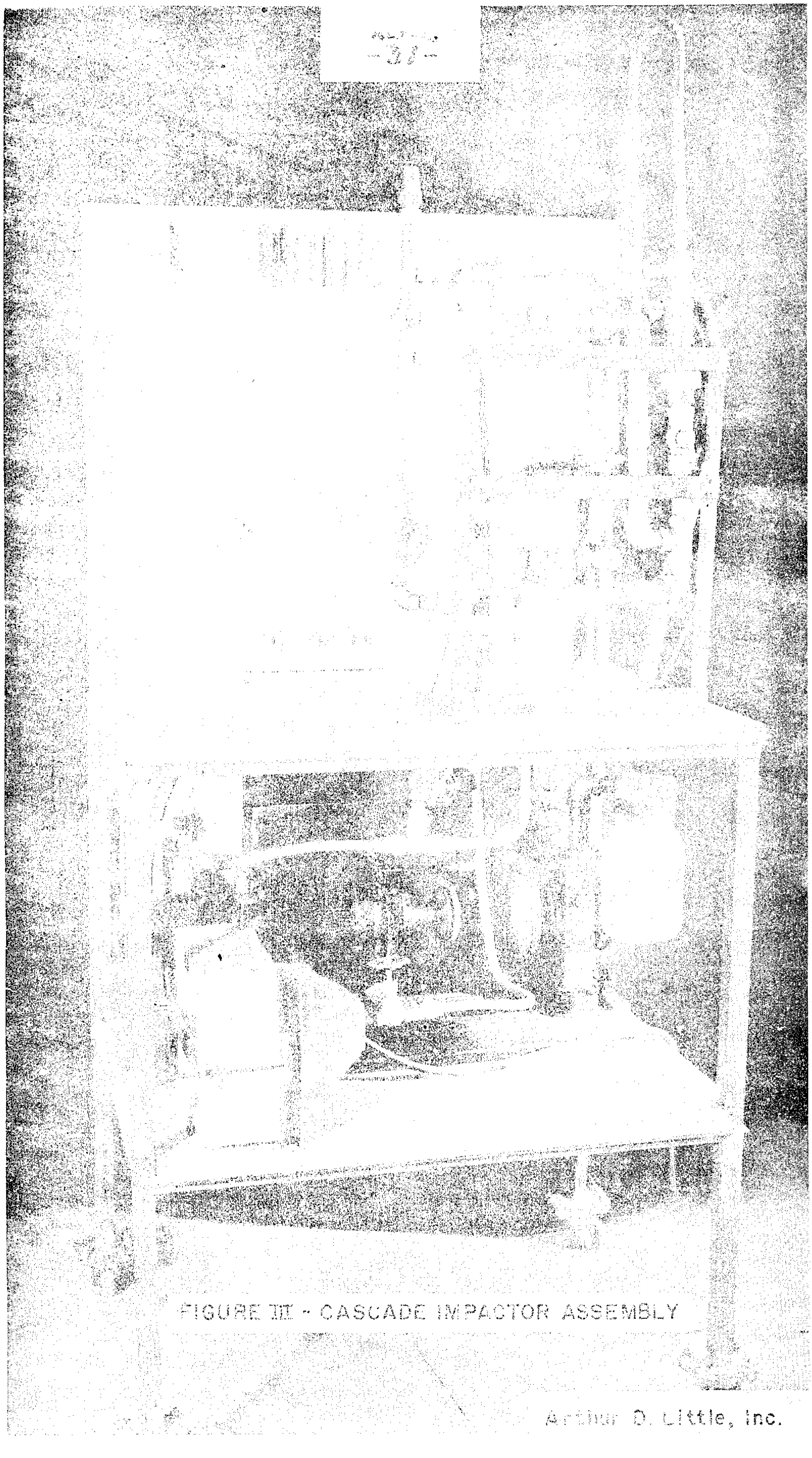

FIGURE III - CASCADE IMPACTOR ASSEMBLY

dense field of deposited particles in the final stage. This indicated the need for diluting a test sample with filtered air. The paper filter shown in the photograph was installed for this reason.

Where we are concerned with individual particles, the matter of cleanliness becomes very important. Unfiltered air left in the instrument and pipe lines may contain or deposit thousands of particles. We have arranged the connections so that the impactor may be flushed out with a stream of filtered air in either direction.

It is important also that all connections be perfectly tight. Particles entering through a minute leak will concentrate on the impactor targets to give an erroneous result. This we have learned by experience.

A device for estimating the concentration of particles on a slide by the reduction in illumination was set up roughly to determine if the method might be useful. Readings were sufficiently reproducible to justify a more permanent set-up. This has been done and the equipment is awaiting a more sensitive meter the need of which was indicated by the first trials.

To collect or detect particles below the sizes removed by impaction we intend both to use a thermal precipitator and to make particle observations with strong dark field illumination.

A test chamber has been constructed for the study of filters and media with respect to particle transmission. It has been equipped with a duct for bringing in outdoor air when normally-occurring atmospheric dust particles are wanted. An air micronizer will be mounted so that prepared dusts of known size may be introduced without danger of agglomeration. Pressure drop across the sample will be induced by a multi-stage Spencer Turbine blower of 85 CFM capacity and a suction of 18" of water.

With the equipment that has been constructed and that which is nearly ready for use we are in good position to evaluate filters and media in terms of actual particles.

<u>Chemical Resistance Tests
on No. 6 Chemical Corps Paper</u>

In connection with studies for the design of radioactivity laboratories, the Argonne National Laboratory sponsored work to determine the utility of Chemical Corps No. 6 paper for chemical hood ventilation. This work was done by Arthur D. Little, Inc. under its sub-constract No. W-31-109-Eng-38-232 with the University of Chicago. The Argonne National Laboratory has given Arthur D. Little, Inc. permission to provide a description of the work to the Atomic Energy Commission.

A photograph of the experimental equipment is shown as figure IV. There are five paper test positions - all alike. A sheet metal chamber which is visible behind the glass manometers houses each paper specimen.

Air is drawn into the apparatus through a Chemical Corps filter located at the left end of the manifold shown on the shelf under the table. From a tap in the manifold filtered air passes through a glass valve into the test chamber. Part of the air before the valve is shunted through a glass tube tip submerged in the reagent solution for that position. After bubbling through the liquid, air carrying entrainment and volatilized matter from the flask also enters the test chamber to mix with the current of clean air.

All of the air leaving the test chamber passes through

Arthur D. Little, Inc.

a test specimen of paper located in the chamber then through a flow meter and finally discharges through a manifold (behind the panel) and is exhausted outdoors through a blower.

Flow rates of air through the filters are shown by the manometer readings of calibrated flow meters and pressure drops across the filters are indicated on other manometers.

Samples of Chemical Corps No. 6 filter were folded to represent single pleats 2 3/8" deep. Each section was 1 3/4" wide, giving an exposed area of 8 1/4 square inches. One such sample was located in each test chamber and was removable so that a smoke holding test (D.O.P.) could be made at any time without removal from its frame to determine efficiency and tightness. Air was passed through the filter at the rate of 0.3 cu.ft. per min.

Table I is a condensed presentation of the experimental results. We may summarize by stating that this work indicates a surprisingly strong resistance in Chemical Corps No. 6 paper to most moderate concentrations of acid (except SO_3) and of alkaline fumes. It should be usable therefore for filtration of air from most areas where there is occasional evolution of reagent materials. It must be noted, however, that the tests described here are all for separate reagents. Mixed reagents might introduce unpredictable difficulties.

Chemical Corps No. 6 paper is particularly sensitive to SO_3 fumes. This is shown by the very short life of the test sample. Another experiment (not in the table) employed a very much lower concentration of this acid gas. Here again the life was short and the paper failed by becoming gelatinized.

TABLE I

Resistance of Chemical Corps No. 6 Paper to Various Chemical Reagent Fumes

Data Listed / Reagent used	Average conc. reagent in flask - percent	Average conc. reagent through *1 filter wt. percent	Initial pressure drop through filter - inches of water	Final pressure drop through filter - inches of water	Total time of run - hours	Total weight of reagent passed in run - grams
Fuming sulfuric acid	-	0.83	1/2	6 1/2	0.2	0.85
Hydrochloric acid	24	.032	1/2	1 1/8	1,086	213
Hydrofluoric acid Run A	2.77	.0012	5/8	1 1/4	1,205	0.021
Hydrofluoric acid Run B	10.0	.012	1	1	110	8.0
Nitric acid	67	0.12	3/4	2 1/4	456	350
Ammonia	28 6 hrs 2	1.4	3/4	5/4	310	2800
Sodium Hydroxide	10-12	-	5/8	7/8	607	[illegible]

Notes: Conditions of runs: 0.3 CFM air passed through 8 1/4 sq. inches paper in 1 pleat.

*1 Calc. on dry basis, air at 70° F.

Continued on page 45

TABLE I continued

Resistance of Chemical Corps No. 6 Paper to Various Chemical Reagent Fumes

Data Listed / Reagent used	Total weight of water passed with reagent - grams	Nature of filter failure	Change in filter efficiency %.3μ D.O.P. smoke passing	Calculated equiv. performance of 77 sq. ft. 400 CFM filter: *2 Filter life	lbs/hr Reagent evap'd	Reagent conc. wt.%
Fuming sulfuric acid	-	gelatinized	-	none	-	
Hydrochloric acid	768	mech. break	no change	6 1/2 mos.	1.5	37
Hydrofluoric acid Run A	3,400	did not fail	no change	over 7 mos.	.108	2
Hydrofluoric acid Run B	268	loss of eff.	14% loss	2 3/4 weeks	11	2
Nitric acid	-	mech. break	2% loss	3 mos.	2.16	67
Ammonia	192	did not fail	no change	over 2 mos.	90	28
Sodium Hydroxide	1,190	did not fail	no change	over 3.5 mos.	8	87

Notes: Conditions of runs: 0.3 CFM air passed through 8 1/4 sq. inches paper in 1 pleat.

*2 Calc. on basis: 8 hr. day 40 hrs/week

CONFERENCES

Conference at Oak Ridge

Date: May 10, 1949

Place: Oak Ridge National Laboratory,
Oak Ridge, Tenn.

Personnel: Mr. J. A. Lieberman of A.E.C. (Washington)
Messrs. F. McCullough, J. Gost, W. Stockdale, F. Culler, T. Tench, H. McAlduff, J. Cheka, Coughlin, Savage, and Reid of O.R.N.L.
Mr. J. H. May of American Air Filters Co.
and Messrs. T. Stearns and W. J. Smith of Arthur D. Little, Inc.

Subject: General review and discussion of filters and air filtration in the light of experience with the filter house at Oak Ridge. It was believed that filtration of pile exit air was quite satisfactory and that the indicated useful life of filters would be sufficient to keep costs at an acceptable level.

Emphasis was placed on the need for suitable means of removing chemical fume arising from dissolving and processing operations.

Conference at Brookhaven

Date: May 26, 2949

Place: Brookhaven National Laboratory, Upton, L.I., N.Y.

Personnel: Dr. W. Page, Messrs. Maynard Smith, D. Mazzarella, B. Manowitz, and Ritzert of B.N.L. and W. J. Smith of Arthur D. Little, Inc.

Subject: Filtration of pile cooling air was discussed. Performance curves for the media samples in the portable tester were studied. The indication was that the FG-25 - FG-50 combination medium planned for intake filters would probably give good service life under the dust load existing at the site.

The Glastex filters to be used in the exit air stream were selected for temperature resistance. They are less efficient than the intake filters. It was thought that efficiency might be improved by priming the filters with some such material as hammermilled asbestos fiber.

Meeting at Oak Ridge

(Stack Gas Working Group)

Date: June 21 and 22, 1949

Place: Oak Ridge National Laboratory, Oak Ridge, Tenn.

Personnel: A total of 59 representatives from the various A.E.C. offices, working areas and laboratories; contractors for A.E.C.; and manufacturers of equipment for A.E.C. were present.

Subject: In addition to the executive meetings of the Stack Gas Working Group, various papers were presented and the contractors gave reports of their activities. For Arthur D. Little, Inc., Model Filters were demonstrated and discussed at a special session on filter design.

APPENDIX A

General Discussion of Plastisols

Plastisol is a term generally applied to dispersions of vinyl chloride polymers in non-volatile liquids which are poor solvents for the polymers. Polyvinyl chloride, polyvinyl chloride-acetate and the copolymer of vinyl chloride-vinylidene chloride have been used successfully. The liquid dispersing medium consists of a mixture of materials which mixture must be a good plasticizer for the polymer. The solubility of the resin in the liquid, the particle size of the resin and the solvent activity of the liquid on the resin all play important parts in making a successful plastisol. Plastisols are made by grinding or otherwise dispersing the powdered resin in the liquid by means of a ball mill, a 3-roll mill or other suitable means. During this step the resin particles must become sufficiently swollen by the solvent action of the liquid, but the liquid must not be so good a solvent that the resin particles actually go into solution.

The resin dispersion at this stage, therefore, consists of particles of resin, swollen by the liquid, dispersed in the remainder of the liquid. Such a mixture may be used as an adhesive, coating material, etc. After application it is heated, which completes the solution of the resin in the liquid. The liquid plasticizer, therefore is a material or mixture of materials which at room temperatures is a poor solvent or a swelling agent for the resin particles and at some elevated temperature is a complete solvent for the resin particles. Depending upon the nature of the product desired, the ratio of resin to plasticizing liquid may vary to a great extent. Very soft, rubber-like adhesives may be made as well as rather hard, abrasion resistant coatings.

The manufacturer's description of the plastisol which we are using is shown on the following page.

ELASTOMER CHEMICAL CORPORATION
113 East Centre Street
Nutley 10, New Jersey

ELASTOMER NO. 105

Elastomer No. 105 is an essentially novel, rubber-like vinyl compound. It is sold in the form of a free-flowing, viscous material with a 100% solid content which will cure and polymerize by the simple application of heat without pressure. It will not substantially shrink or expand during the curing process, and will take even the finest details of the mold. After curing it becomes a solid elastomeric mass similar to pure gum ribber. It differs from rubber and other plastic compounds in its unusual resistance to most solvents, including aromatic hydrocarbons, oils, acids, alkalies and water, and will not oxidize and harden on ageing; will retain its flexibility even at low temperatures; and will not sustain a flame.

The recommended curing temperature is 130° C, however, special compounds may be custom formulated to be cured at as low a temperature as 85° C. The curing time depends on the thickness of the finished product - approximately 5 minutes per 1/8" is required at 130° C.

	Depending on Formulation
Specific Gravity	1.4 - 1.7
Tensile Strength - #'s per sq. in.	200 - 1100
Elongation %	200 - 350
Dielectric Strength - .015 thickness - volts per mil	500 - 750

PRICE:

From 1 to 250 pounds . . . . $0.75 per lb.
From 250 to 500 pounds . . . . .73 per lb.
Prices on larger quantities on request
All prices are F.O.B. Nutley, N.J.

Shipment in 1, 5, 30 and 50 gallon containers (approx. 9 lbs. per gal.)

END OF DOCUMENT