"A Review of Air Cleaning Activities at Argonne National Laboratory"

Presented at
1955 Air Cleaning Conference
by
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ARGONNE NATIONAL LABORATORY

To facilitate this discussion of the air cleaning setup at Argonne, I'd like to describe the physical layout of the Laboratory by areas and discuss the type of work or operation taking place in these areas, the type of air cleaning equipment utilized and efficiencies realized. The costs of operating and maintaining one of these systems will be dealt with by Mr. R. W. Van Valzah, who follows with a discussion of the costs involved in cleaning exhaust air for this, the Chemistry Building, which is in many ways typical of the research buildings you saw while coming in here this morning.

The Laboratory as it now exists, is divided into four separate areas, only three of which require the cleaning of exhaust air. These areas have been designated as the East Area, the 200 Area, where we are now, and the 300 Area.

East Area

In the East Area are our Central Shops Department and Metallurgy Division which are housed in quonset huts.

The Central Shops Department is separated into two buildings; one for ordinary operations and the other, called the Special Materials Shops, for work with uranium, thorium, beryllium, graphite, etc. Many of the operations are ventilated by elephant trunks or 4" flex duct which is located close to the source of contamination, while other Shop tools are enclosed or hooded to one degree or another. Those for uranium grinding, graphite work and beryllium work are segregated into three separate rooms off the main Shop area. The machine tools for beryllium work are completely enclosed in sheet steel and safety glass hoods to contain the dust as much as possible.

All the air from the Special Materials Shops area is exhausted through seven systems each with a type N rotoclone followed by an AAF Electro cell electrostatic precipitator. One exception is the graphite room, the air from which is cleaned by a cloth-type bag filter. One of the seven systems exhausts all operations in both the beryllium room and the uranium grinding room. It is interesting to note that efficiencies for this system, determined about once every two or three weeks, (the frequency of our routine stack sampling in this area since 1953) have been consistently high for beryllium, averaging around 99%, while for uranium the average efficiencies have been much lower, approximately 72%. This, we attribute to the fact that all the beryllium operations on machines such as lathes, mills, drills, etc. are exhausted through this system, while for uranium, only the grinding operations are tied into this system. The tremendous difference in the particle size between the chips from a beryllium turning job and the oxidized particles from a uranium grinding job result in much lower efficiencies for uranium collection.

Efficiency studies of other systems exhausting routine uranium machining operations fall between the low of 72% for uranium grinding and the high of 99% for beryllium. This is probably because the chips, unless doused, oxidize rapidly giving off a fine fume. Since this sometimes happens, the small particles are not collected as efficiently and tend to lower the overall efficiency of the system.

The Metallurgy Division's work in this area runs the gamut from foundry and high temperature ceramic operations to corrosion, metallographic and high purity crystal studies. All these many and varied operations, except the ceramic work, are also exhausted through type N Rotoclones followed by the AAF electro cell electrostatic precipitators. Efficiencies of these systems are comparable to that for the uranium grinding system. This isn't too good, of course, but we're not too concerned since the load on these systems and the subsequent dumping to the outside is extremely light. If the operations in the area should change radically, a re-evaluation of the entire air cleaning setup would, of course, be necessary.

The ceramics building, containing numerous glove boxes, dry presses, vibrators, furnaces, hoods, etc., is exhausted entirely (except for a spray booth and a few pieces of small equipment) through high efficiency AEC filters.

As a somewhat tenuous measure of the efficiency in this, the East Area, or more accurately as a measure of the effectiveness of the air cleaning setup, background samples taken outside the buildings in the immediate area, i. e., within 50 - 1000' of the exhausts at ground level have shown only negligible quantities of either uranium or beryllium.

Maintenance shutdowns of the 21 exhaust systems in the East Area utilizing both electro cells and rotoclones have occurred, on the average, twice a year since early 1952, with the most active systems requiring as many as eight shutdowns in a single year, each requiring from 1 to 10 man-days.

200 Area

The 200-Area research laboratories were designed and constructed from a basic policy that all radioactive work or manipulations would take place in either Blickman or vacuum frame hoods. To implement this policy, a module system has been used wherein each laboratory may consist of one or more 10-foot modules, each module having a normal exhaust of 1000 CFM and a maximum of three hoods. Since each hood at maximum opening could exhaust 1000 CFM, Johnson Service controls are used to control the face velocity through the hood to 135 LFM, plus or minus 25 LFM, and to cut in extra exhaust when the normal 1000 CFM must be exceeded. All the air exhausted from these laboratories is filtered first through pre-filters and then finally through AEC high efficiency filters. A more thorough explanation of the entire supply and exhaust system for Building 200 was made at the 1953 Air Cleaning Conference by Mr. Van Valzah and can be found in the published record of that meeting so I'll not go into it any further; suffice to say it represents the Argonne philosophy and is typical of the situation in the 200 Area. There are, of course, variations or complete exceptions to the typical system and I'd like to mention briefly two of these now. You may have noticed that there is a small building just to the north of this building. That is the Reactor Engineering Division's liquid metals building wherein there are numerous experimental heat transfer loops containing NaK or liquid sodium. Of course, when either of these comes in contact with air or water, copious caustic fumes result, i. e., sodium or potassium oxide, or both, and these not only irritate the eyes and respiratory tract, but also have a peculiar affinity for late model automobiles in the parking lot and a number of older models that are in dire need of refinishing jobs. As a result of this startling information, and numerous insurance difficulties, disposal operations which had originally been carried out just to the north of the building had to be relocated. And, consideration had to be given to an exhaust system which could be used to vent and clean the air from normal disposal operations. In addition, it was desirable to be able to cut in the exhaust system during fires within the building to both clean the fumes from the fire and keep a negative pressure on the building, thereby eliminating the possibility of fumes leaking from the building. With this setup, the building could be evacuated and the scrubber kept on to clean the fumes generated by the fire.

As a result of the investigation of Mr. F. A. Smith of the Reactor Engineering Division, the installation of a Pease-Anthony venturi scrubber followed by noncombustible high efficiency filters is nearing completion. This is none too soon, since on one occasion recently it became necessary to evacuate the parking lot when a leak occurred in one of the loops and it was thought as many as 50 gallons of sodium might burn and drift over the parked cars.

We, of course, don't have any data on the operation of our unit as yet but do know that the *Ethyl Corporation, in a pilot plant project using a venturi scrubber, removed over 99% of the sodium oxide smoke from an airstream of approximately 1200 CFM. If we can do as well scrubbing approximately 3000 CFM at a maximum disposal rate of 50 lbs. per hour, I think everyone will be satisfied.

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* Letter from Donald Debacher, Technical Service Section, Ethyl Corp., to F. A. Smith, Argonne National Laboratory 7-19-54.

The second exception to the typical air cleaning system is the interhalogen scrubber in the Chemical Engineering Building. The test model for this unit was discussed two years ago at Los Alamos. Since then, the final unit has been installed and tested. It has been designed to scrub continually, using a concurrent flow of caustic, all the air from a cell containing up to 500 pounds of interhologens and in so doing, guard against the possibility of a break in a line and the subsequent dumping of the gases to the outside.

Efficiencies of this system with a loading of 250 PPM $Br F_5$ and 800 PPM $Br F_3$ were 98 and 100% respectively with a flow through the scrubber of approximately 6000 CFM. If anyone would like further information on this scrubber, ANL Report No. 5429 covers it completely or if you are interested, I could arrange for a discussion with Messrs. R. C. Liimatainen or W. J. Mechan of the Chemical Engineering Division who designed and tested this unit.

300 Area

In the 300 Area is located the Argonne incinerator, now inoperative, which W. A. Rodgers and D. C. Hampson discussed in a paper incorporated in the record of the 1953 Air Cleaning Conference. The caves for studies of highly active materials are also located in the 300 Area. Exhaust from these caves is cleaned by pre-filters and AEC filters much the same as the exhaust from the hoods in this, the Chemistry Building.

Of particular interest as far as air cleaning is concerned is Facility 350 which is now under construction and which will be discussed by Mr. A. B. Shuck of our Metallurgy Division.

AIR CLEANING COST FOR CHEMISTRY BUILDING 200

By R. W. Van Valzah
Argonne National Laboratory

In order to present air cleaning cost trend data for the Chemistry Building 200, which is considered representative of other 200 Area buildings, a brief description of the ventilating systems appears in order. There are six main laboratory wings to the building interconnected by transverse corridors at the front and rear of the wings. Each laboratory wing is provided with a separate supply system delivering a minimum and maximum of approximately 17000 and 22000 cfm of air respectively. The supply air systems for all six wings with the exception of E Wing normally operate during the eight hour work day at maximum capacity while E Wing operates at near minimum capacity. All supply air is taken into the building through fresh air intakes and filtered with primary and secondary filters. The primary filters are Airmat Type P1-24 with five ply paper and the secondary filters are the same type with ten ply paper, both papers being fire resistant. The static pressure characteristics of the supply systems limit the total pressure drop across both banks of filters to .75" w.g. which in turn limits the maximum pressure drop across each bank of filters to approximately .5" w.g. When this limit is reached the bank of filters having the highest pressure drop is due for a change. The supply system is shut off, the dirty filters are removed, the plenum is thoroughly cleaned and spare filters with new media are put back into the filter frames. The dirty filters are then cleaned, rethreaded with new media and made ready for reinstallation in the supply systems.

One roll of five ply paper which will make up into twelve filters costs \$7.25 and one roll of ten ply paper which will make up into nine filters costs \$6.80. According to the maintenance records the average life of the primary filters is three months and the average life of the secondary filters is ten months. There are twenty-four filters in each bank per wing. The filter material cost per year per wing amounts to the following:

$$\frac{24 \times 4 \times 7.25}{12} = \$58.00 - 5 \text{ ply material}$$

$$\frac{24 \times 1.2 \times 6.80}{9} = \underline{\$21.80} - 10 \text{ ply material}$$

$$\$79.80 \text{ Total}$$

Supply filters are changed by the building maintenance crews. The labor required for a complete change of one bank of filters per wing is sixteen (16) man hours. On a yearly basis the primary filters are changed four times and the secondary filters are changed 1.2 times making a total of 5.2 changes. The man hours required per year are therefore 5.2 × 16 or 83.2 total hours. Assuming a labor charge of \$4.00 per hour, the labor cost per year is calculated to be \$332.80. Adding the material cost to the assumed labor cost, the total air cleaning cost of supply air per wing per year is \$412.60. The above computations are based on an air flow of 830 cfm per filter and an average maximum resistance drop of .5" w.g. This in terms of maintenance cost per 1000 cfm per year for supply air cleaning is (412.60/24) × (1000/830) = $20.70.

It is realized that increased life of these filters could be obtained with a greater pressure drop allowance. The present modifications to the ventilation systems in the building will provide for this. The procedure to be followed in changing filters also has a bearing on the life of the filters particularly when design limitations are imposed. Instead of changing an entire bank of filters as has been the practice, changing only portions of the bank on a staggered schedule basis is being developed. By following such a procedure it is hoped to reduce the total pressure drop across the entire bank of filters while allowing the loading of the individual filters to increase therby increasing the over-all life of the entire bank of filters.

The next phase of the air cleaning cost deals with the exhaust ventilation. All the hoods as well as the laboratory by-passes and the vacuum frame hood runouts are equipped with prefilters. The vacuum frame hoods have dust stop intake filters in addition to the prefilters. All of the prefiltered exhaust air taken from the laboratories is passed through the final AEC filters. Since the final filter costs may be considered of foremost interest, the analysis will start with them.

The original design of the exhaust ventilation systems was based on the use of 24" × 24" × 12" CWS filters with a rated air flow of 500 cfm at 1" w.g. resistance clean and 2" w.g. resistance dirty. CWS filters were used at the start of operations and then replaced with the same size AEC filters having a rated capacity of 800 cfm at 1" w.g. resistance clean and 2" w.g. resistance dirty. Some CWS filters are still in use as a quantity of them were received from surplus.

The exhaust systems are intaled on a modular basis serving the number of hoods operating in each laboratory. Not more than three hoods are connected to a runout which is exhausted through one fan at a rated capacity of 1000 cfm. The number of hoods per laboratory vary as do the number of fans. In one-fan modules all of the air is exhausted through the AEC filters so that the flow rate per filter is established at 500 cfm. In two-fan modules the minimum exhaust is 1000 cfm and the maximum exhaust is 2000 cfm making an average of 1500 cfm. With four AEC filters installed, the flow for each filter would be 375 cfm. In three-fan modules the minimum exhaust is 1400 cfm and the maximum exhaust is 3000 cfm with an average of 2200 cfm. With six AEC filters installed the flow for each filter would be 366 cfm. In accordance with the above flow rates per filter, the average life of the filters taken over a period of four years was found to be as follows:

	Flow Rate	Average Life
CWS	500 cfm	12 months
	375 cfm	16 months
	360 cfm	17 months
AEC	500 cfm	22 months
	375 cfm	30 months
	360 cfm	32 months

Inasmuch as CWS filters are considered obsolete, only a cost analysis will be made for the AEC filters. The cost per AEC filter in 1952 was $44.50 but it is understood the latest bid on these filters was $40.00 each. On the basis of the average life shown above the cost of AEC filters per year per 1000 cfm amounts to 40 × (1000/500) × (12/22) = $43.63.

The exhaust filters are changed by the Reclamation group. The man hours required to change each filter is 1.6 hours with an additional charge for materials and trucking. On an assumed labor rate of $4.50 per hour plus other miscellaneous charges the changing cost may be considered to be approximately $8.50. The total material and labor cost is therefore indicated to by $52.13 per 1000 cfm per year.

The life of the AEC filters indicates that for general scientific operations, there is not much variation between system applications. The prefilters do a good service in prolonging the life of the final filters. The exception to the above is where a large amount of acid fuming is done in the hoods. The final filters in these instances become saturated with acid fume condensation and have to be changed oftener than the average indicates. Fume hoods are being given special study for the treatment of the exhaust air which offers not only an air cleaning but a duct corrosion problem.

The prefilters generally used are 16″ × 20″ in size with steel frame and pleated wire backing which is covered with 25 FG media. The rated capacity is 250 cfm at a clean maximum pressure drop of .2″ w.g. The static pressure characteristics of the exhaust system necessitate changing them at a maximum pressure drop of .8″ w.g. These prefilters are located in three positions in the exhaust systems namely; in the hoods, in the laboratory by-passes, and in the vacuum frame hood runouts. A cost analysis of prefilters for each location will be given.

The laboratory by-pass prefilters take air only from the laboratory and the quantity varies from a minimum of 150 cfm to a maximum of 1000 cfm. There are four prefilters for each laboratory by-pass, four prefilters for each vacuum frame hood runout, and four prefilters for each hood. All hoods are set to exhaust a minimum of 150 cfm. All air removed from the laboratory is either taken out through the hoods or through the laboratory by-passes.

On the basis of the average operating conditions and the tabulated average life of individual prefilters, the life of all laboratory by-pass prefilters checks out to be approximately four months at the rated air flow and maximum resistance. The cost of these prefilters is $3.92 each so that the laboratory by-pass prefilters cost per 1000 cfm per year amounts to 12/4 × 4 × 3.92 = $48.04. The man hours required to change each filter is .4 hour with an additional charge for material and trucking. At an assumed labor rate of $4.50 per hour plus the other miscellaneous charges the changing cost may be considered to be approximately $1.83. The total material and labor cost may therfore be considered to be $49.87 per 1000 cfm per year.

The above filtration cost is obviously high for laboratory air where the possibilities of contamination are rather remote. This air is passed through the AEC filters anyway so that the primary purpose of the prefilters is to remove the room dust and prolong the life of the final prefilter. There is some doubt as to how effective this prefilter may be because of the particle size of the room dust. In view of this fact a type G fiberglas media, cardboard frame filter having a rated capacity of 500 cfm and a clean resistance of .2″ w.g. is being used to replace the present 25 FG laboratory by-pass prefilter. This change represents a considerable savings to the Laboratory particularly since the air flow to the laboratories is now being increased.

The maintenance records for the vacuum frame hood prefilters which are also the 25 FG type disclosed that the average life is eight (8) months. This longer life can be attributed to the fact that when the vacuum frame hood doors are closed the air is taken in through Dust Stop filters. The cost of the vacuum frame hood prefilters per 1000 cfm per year therefore amounts to 12/8 × 4 × 3.92 = $23.52. The labor cost is the same as for the laboratory by-pass prefilters so that the total indicated cost for the vacuum frame hood prefilters adds up to be $25.35 per 1000 cfm per year.

The survey of the laboratory hood prefilters which are also type 25 FG discloses that the average life at the rated air flow and maximum resistance is four months. Moderate use of various chemicals with the exception of perchloric acid and the interhalogens does not seem to materially affect the prefilters. A-Lum-O-Aire prefilters are used for the interhalogens and hand packed fiberglas with no binder prefilters are used for perchloric acid. These filters have to be changed at about the same time interval as the type 25 FG apparently due to the resistance drop which indicates similar dust loadings. The cost of the A-Lum-O-Aire prefilters is $6.95 each and the cost of the perchloric prefilters is $6.03.

The cost of the type 25 FG hood prefilters per 1000 cfm per year amounts to 12/4 × 4 × 3.92 = $48.04 which is the same as for the laboratory by pass prefilters. The labor and miscellaneous charges are also the same so that the total indicated cost is $49.87. This filtration cost is also high and an attempt has been made to evaluate this cost in terms of prolonging the life of the final filters. This project is under consideration at the present time. It may be stated that the hood prefilters are removing most of the contamination inasmuch as a very few of the final filters have been found hot while a certain number of the prefilters have had to be removed because of activity.

Time does not permit going into the disposal of the above mentioned filters. The disposal costs for each of the three types of prefilters as described above is about $1.73 each.

The above figure includes storing, baling and handling costs. All of the prefilters can normally be baled with the exception of those from a high alpha area or those having a surface radiation greater than 200mr/2" H & S.

Disposition of the final filters when not active is accomplished by burying them in the ground. At one time they were burned in the incinerator but this has been discontinued. The miscellaneous charges previously shown for the AEC filters also include disposition.

In summation there are a number of factors which influence the cost of air cleaning by means of filtration. Some of these have been pointed out but here is the list:

1. System design
2. Fume or dust characteristics, particle size, activity
3. Air flow
4. Efficiency requirements
5. Dust holding capacity
6. Break point in dust loading
7. Operating conditions
8. Allowable pressure drop
9. Testing procedure
10. Changing procedure
11. Initial cost
12. Maintenance cost

It may be stated in conclusion that in order to compare air cleaning costs all of the above factors should be taken into consideration.

Knolls Atomic Power Laboratory
AIR CLEANING PROGRAM
November 2, 1955

by

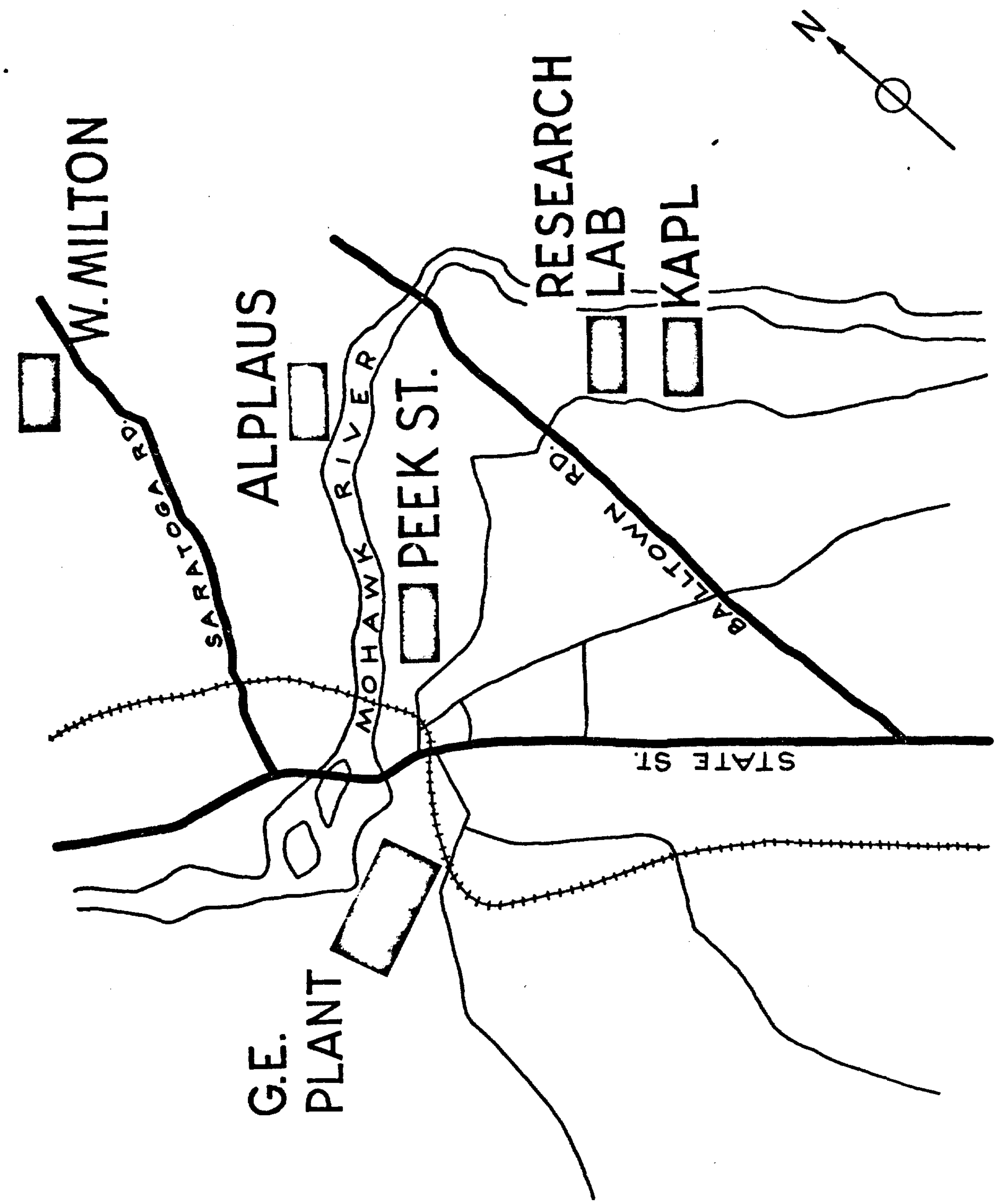
W. H. Truran

INTRODUCTION

The Knolls Atomic Power Laboratory has been principally engaged in the development of a sodium cooled, intermediate power reactor for submarine propulsion. In addition, KAPL has been responsible for assisting Hanford and Savannah River operations offices in their efforts to improve production facilities. More recently the Laboratory has undertaken the development of an advanced, naval propulsion reactor.

In Figure 1122015 the location of the Laboratory is shown near Schenectady, New York. The Mohawk River flows generally from west to east past the General Electric Company's Main Plant, the City of Schenectady, New York, the new General Electric Research Laboratory and the Knolls Atomic Power Laboratory. The location identified as Peek Street was the early home of the Laboratory. It is no longer in use. Likewise the Alplus Site, formerly employed in sodium coolant Test work, is no longer required. The facilities of both sites have been moved to the $28,000,000 Laboratory located on approximately 170 acres of land in the Town of Niskayuna, New York, about 5 miles east of the center of Schenectady and about 1/2 mile from the General Electric Company Research Laboratory. The West Milton Site, containing the prototype submarine intermediate reactor, is located to the north approximately 18 miles from Schenectady on about 4000 acres in Saratoga County.

The Knolls Site (KS-6012) consists of a main group of 9 interconnecting buildings providing space for administration, cafeteria, physics and metallurgical laboratories, manufacturing shops and engineering laboratories,



W. MILTON
SARATOGA RD.
ALPLAUS
MOHAWK RIVER
PEEK ST.
RESEARCH LAB
KAPL
BALLTOWN RD.
STATE ST.
G.E. PLANT
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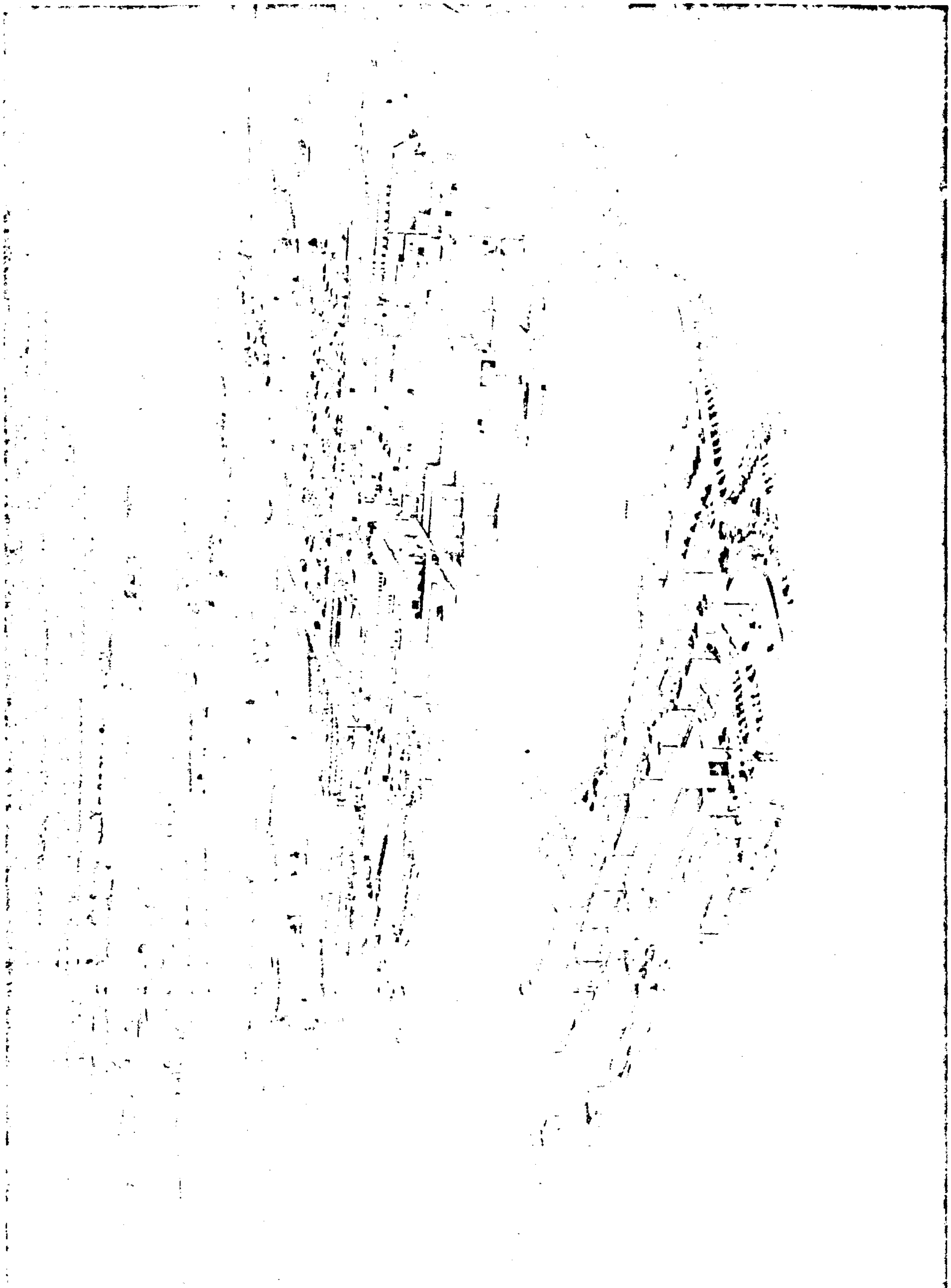


KS-6012

chemical laboratories, chemical separations process units and test cells for the examination of reactor materials. Additional site facilities include 4 critical assembly test facilities, a fuel element fabrication and reactor manufacturing area, facilities for processing liquid and solid radioactive waste and a laundry for laboratory clothing. Approximately 2000 persons are employed at the Knolls and West Milton Sites, 1800 of these being employed at the Knolls Site.

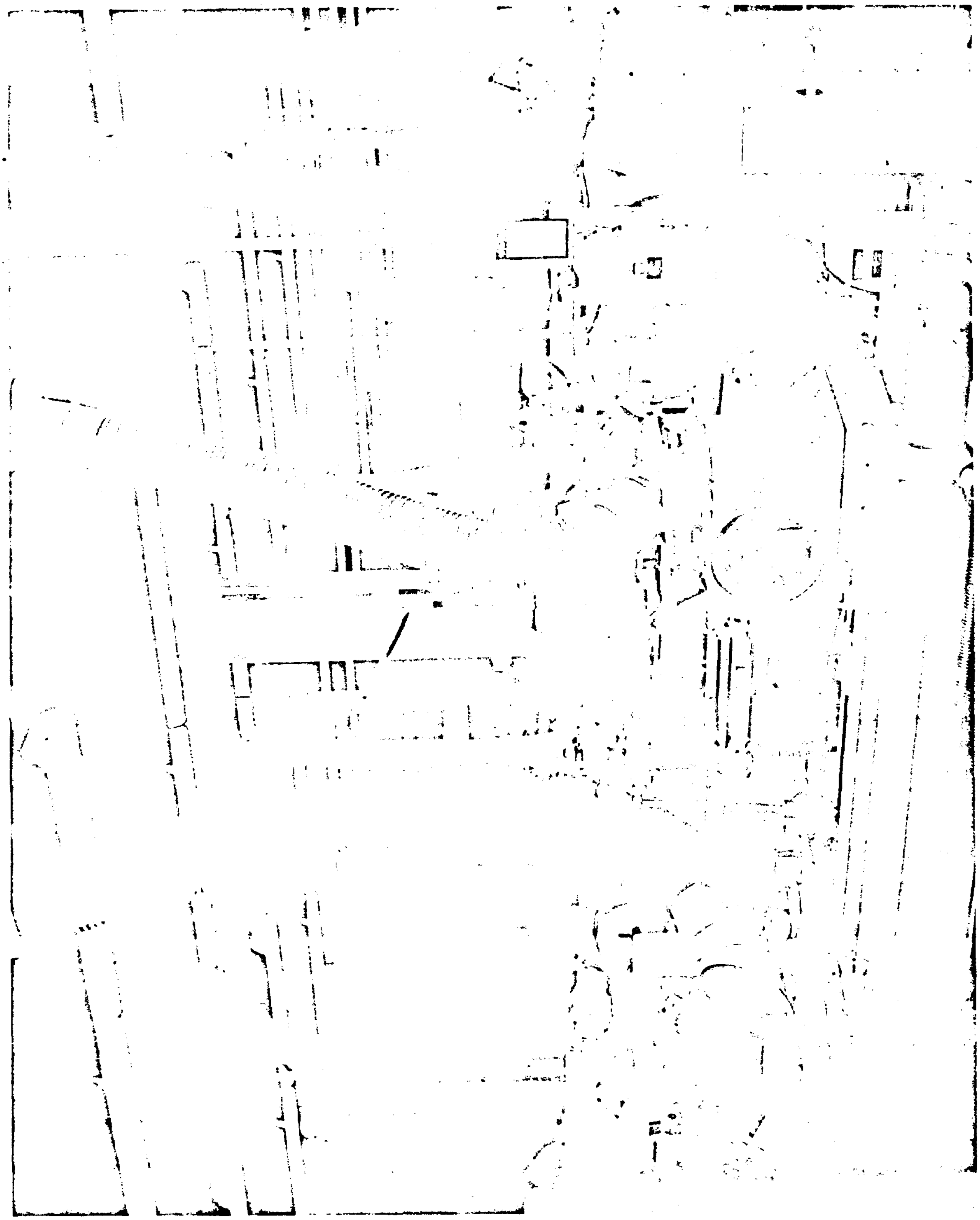
AIR CLEANING SYSTEMS - Knolls Site*

Buildings requiring processing of exhaust ventilation include approximately 2,800,000 cubic feet of space which are ventilated at a total rate of 475,000 cubic feet per minute for an average of approximately 10 air changes per hour. Design figures have ranged from six air changes per hour in laboratories to 20 air changes per hour in chemical separations process cells.

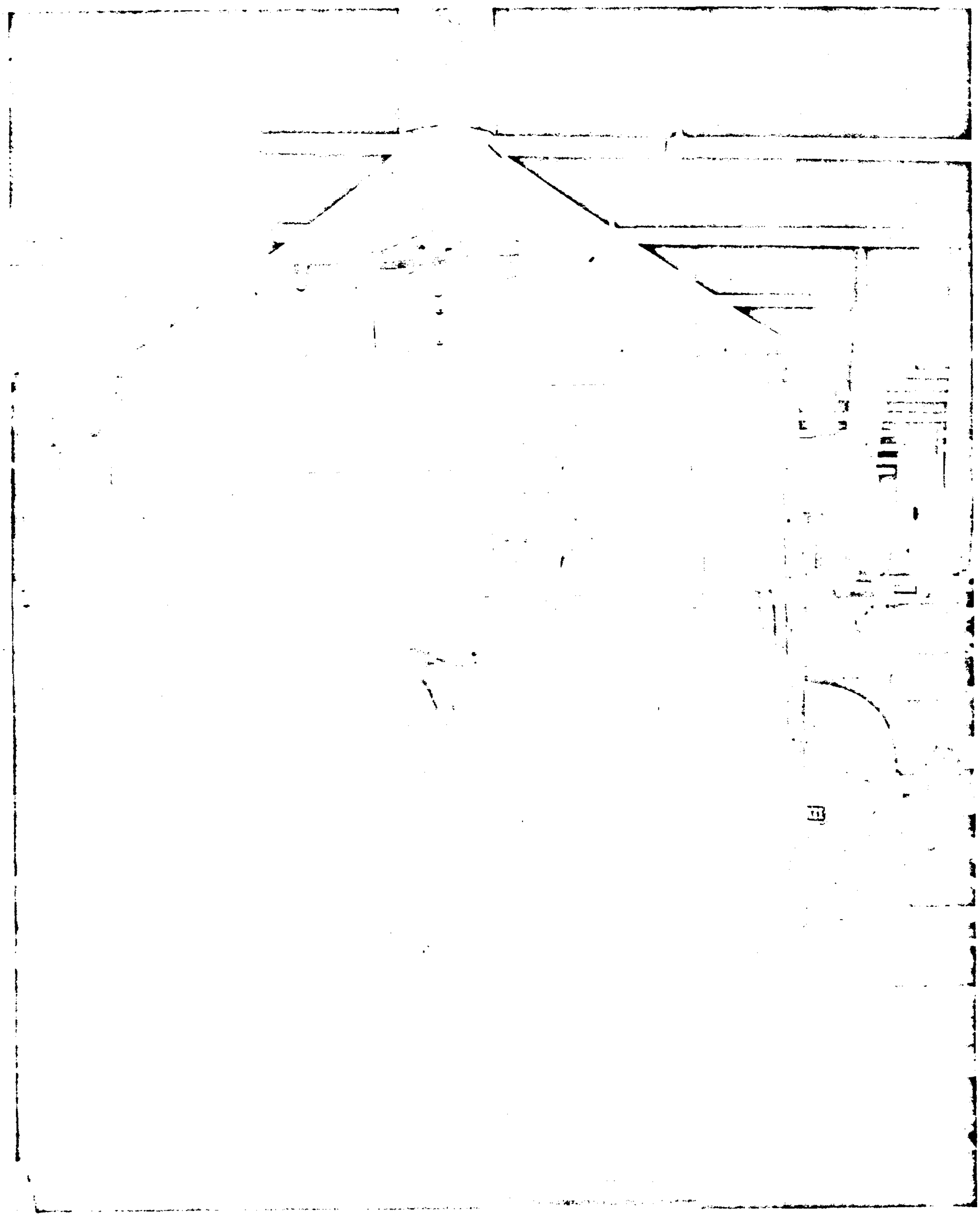
Buildings containing physical, metallurgical and chemical laboratories, and chemical separations pilot plant facilities have been provided with forced air supply, the air being prepared by self-cleaning oil filters and electrostatic precipitators in Raisler Air Conditioning Systems. These ventilating systems are non-recirculating and, together with exhaust systems, control the spread of air-borne contamination by maintaining air pressures in personnel access areas high with respect to process cells and hooded facilities.

Figure 1087050 shows ventilation exhaust applied at cutting tools in the Special Materials Machine Shop. Figure 1086998 shows a ventilation hood over a centerless grinder. Metallurgical laboratories are included in this area. Operations involve solid and powdered uranium and beryllium. The exhaust system for this area is two systems in one: a low velocity system providing air velocities of 100 feet per minute at the face of bench hoods, and a high velocity system providing exhaust velocities of from 3000 to 5000 feet per minute at cutting tools. All exhaust air passes through a roughing mat filter and an electrostatic precipitator supplied by the American Air Filter Company. The high velocity exhaust air also passes through a multi-cyclone separator provided by the Western Precipitator Company prior to filtration and precipitation. During present reduced shop

* KAPL 1014, KAPL Air Cleaning Program, L. J. Cherubin, J. J. Fitzgerald.



1087050



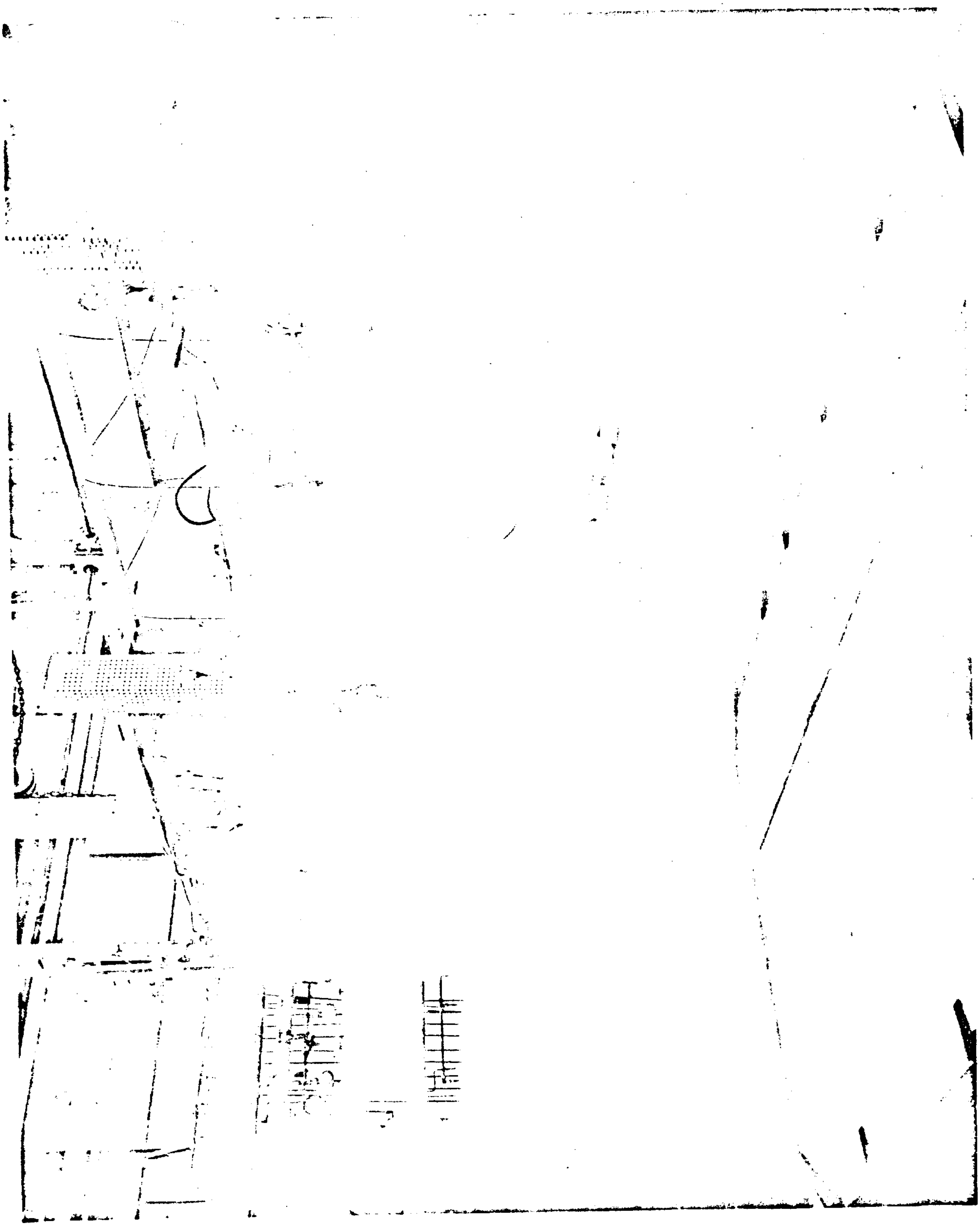
1086998

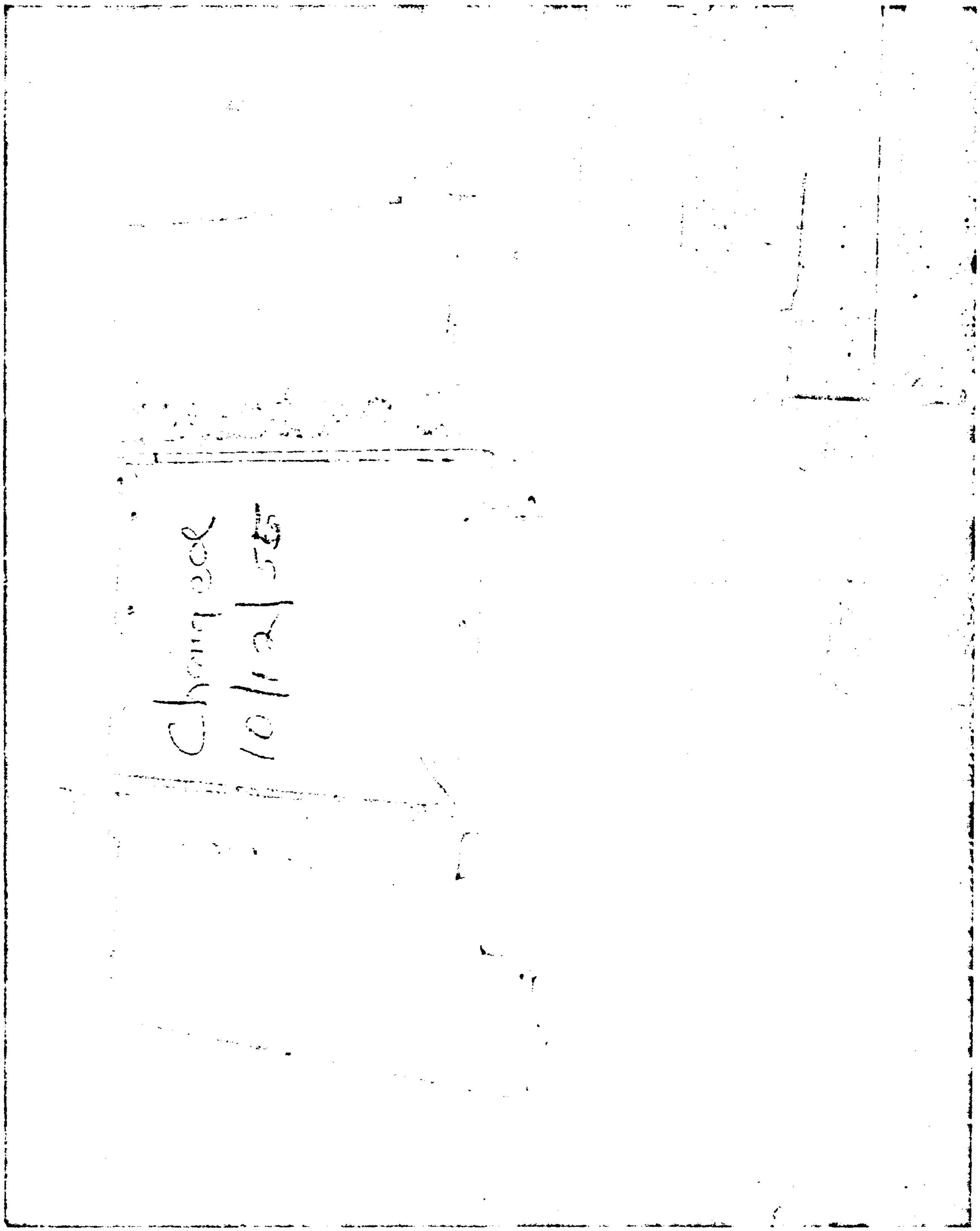
operations, the need for the electrostatic precipitator was investigated and found lacking and so is not now operated.

Figure 1104392 shows a type of hooded cell facility provided for chemistry separations process research. From all areas for which a need of reducing concentrations of plutonium, enriched uranium, or fission products in exhaust air exists, the series of glass wool and CWS or Cambridge Absolute filtration is provided (Figure 1120929). With normal laboratory dust loading, the absolute filter has lasted a year when glass wool filters are changed as often as once a month. Figure (KS-6231) shows a type of CWS filter installation used on a liquid waste process vent with the filter held in place by springs. Jack spreaders on top and bottom facilitate filter removal. The process vent system for Separations Process Research Unit in addition to filters contains a 13 foot caustic spray column for reducing radioactive iodine concentrations. This Research Unit has not been operated since February 1954.

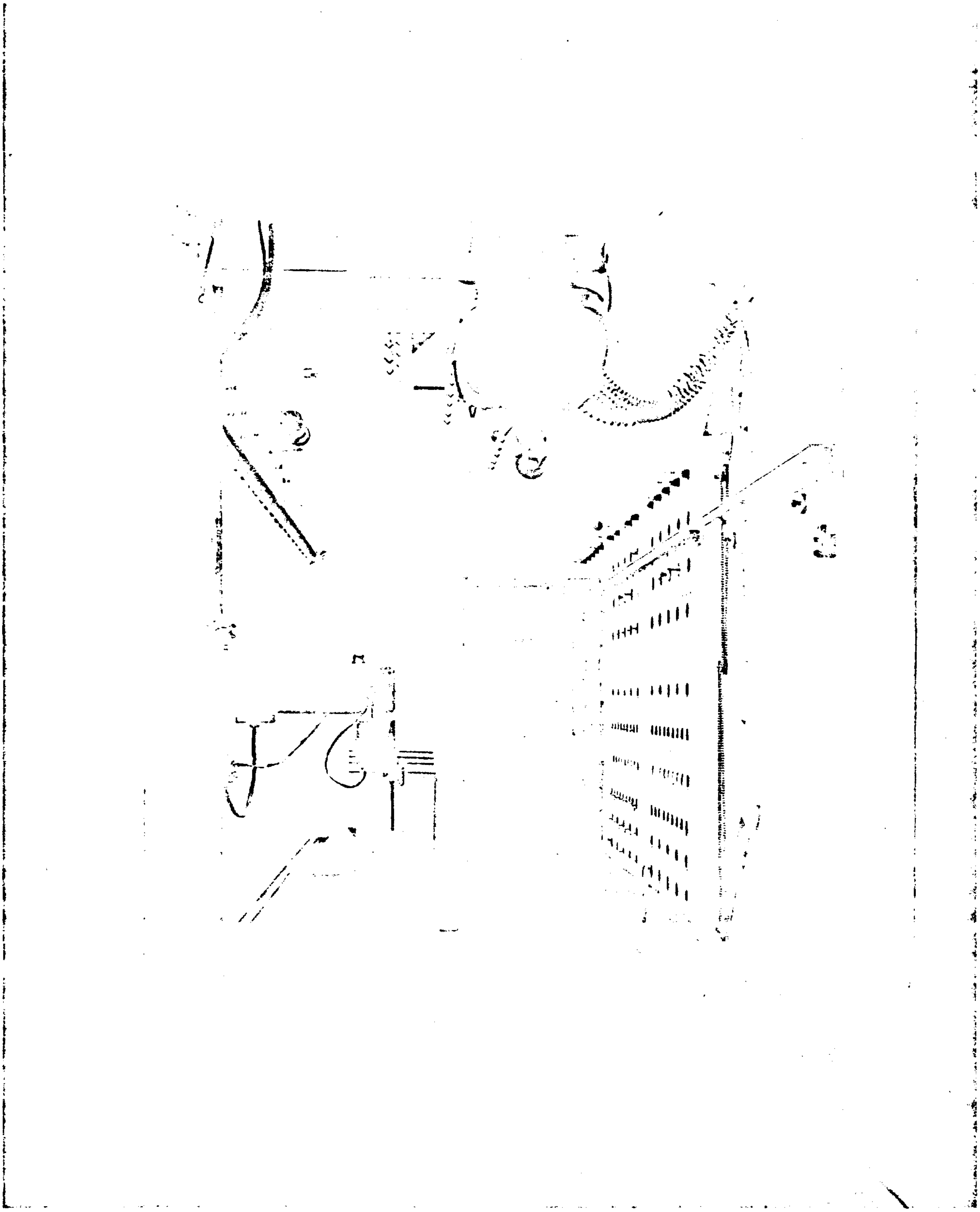
Figure 1100607 shows a cell provided for the examination of radioactive material. It may be looked upon as a cell within a cell in that all examinations are performed within an isolation box seen hanging on rails running the length of the cell. Exhaust is applied to the isolation box as well as to the cell. Figure 1092930 shows the cell exhaust systems. Figure KS-6230 shows the glass wool and CWS Filter unit servicing the cell. The filter frame forms a part of the duct work and the filter is equipped with a handle for easy removal.

Unlike systems just considered, ventilation air is recirculated in the fuel element manufacturing areas, critical assembly buildings and the laundry. In the fuel element manufacturing areas, solid fuel material, when not sealed in



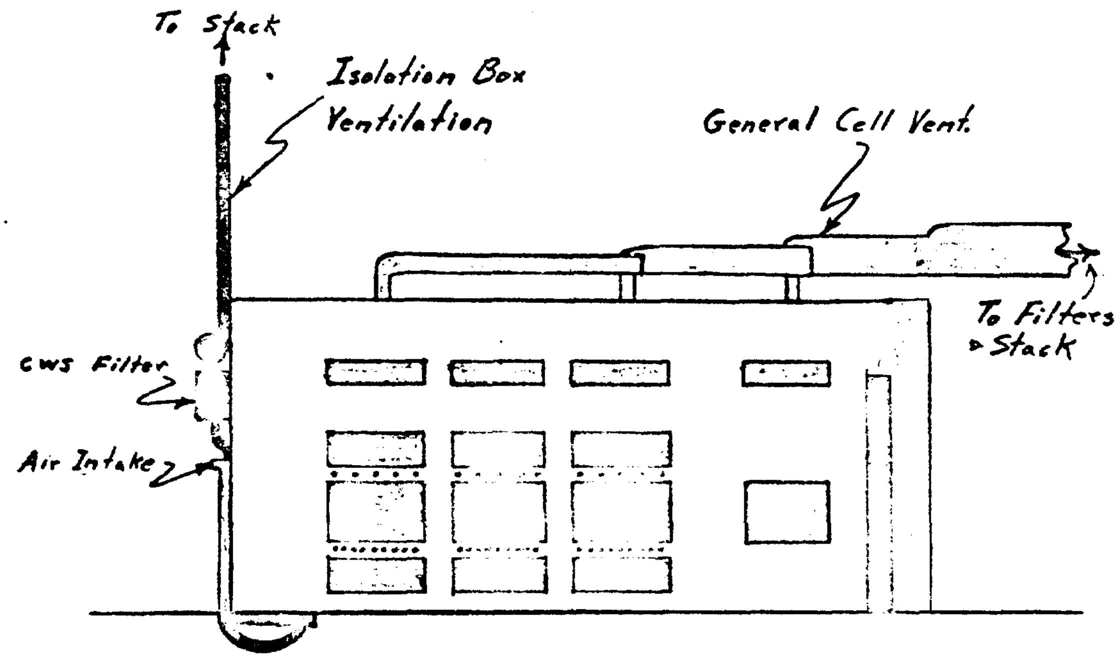


KS-6231



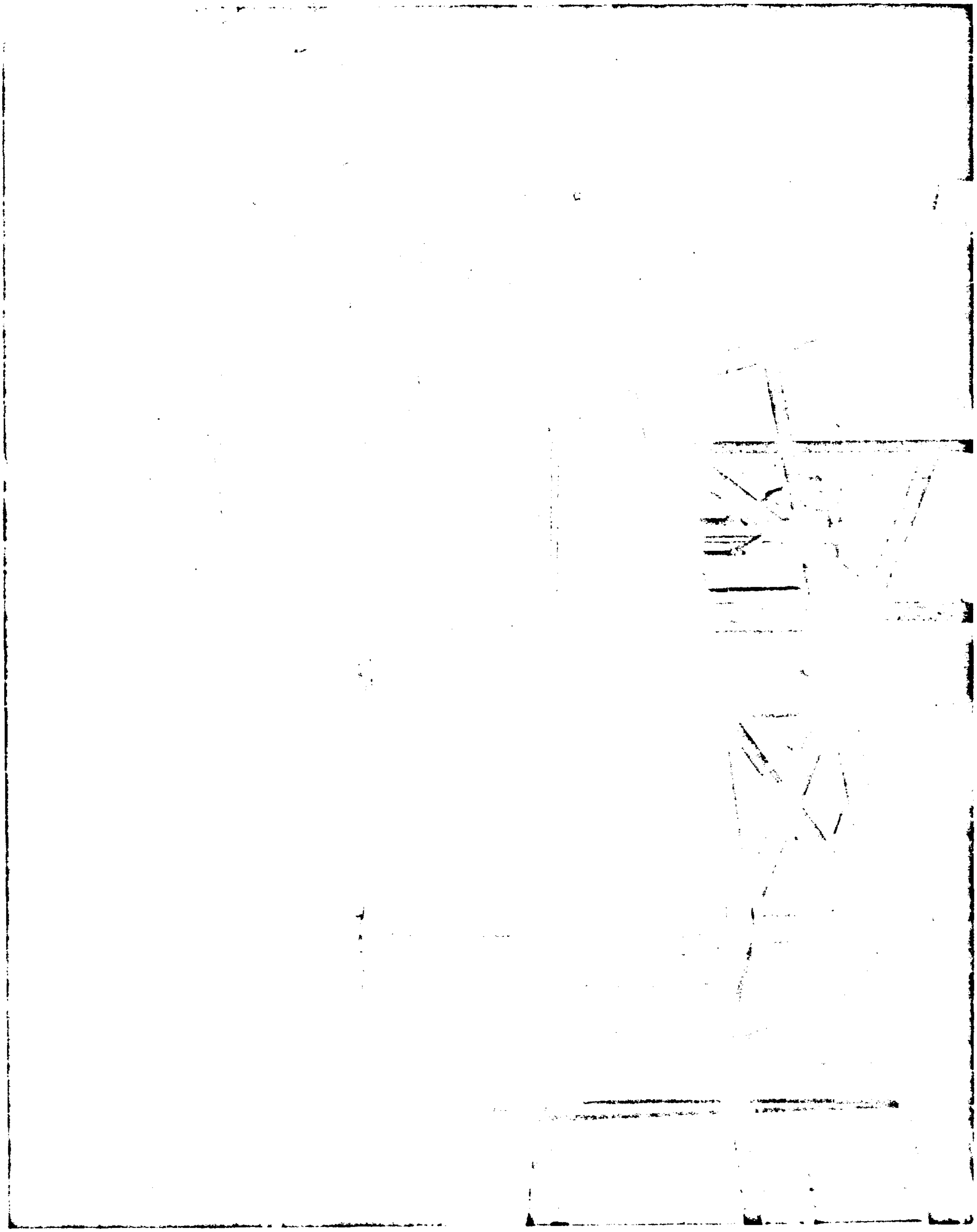
1100607

KAPL, RML, General Cell View, Isolation Box In Place



CELL VENTILATION SYSTEMS
RML

1092930



KS-6230

containers, is handled in dry boxes on a non-recirculating filter exhaust system. The remaining area exhaust air is passed through glass wool and absolute filters before being recirculated.

In critical assembly areas where reactor operating levels do not exceed a few watts, recirculated air is processed only by Kathabar or Chill Coil humidity limiting equipment.

The laundry exhaust air has been no problem when passed through paper filters provided to remove lint.

Galvanized iron and stainless steel are the two materials used in exhaust duct work, the latter employed whenever corrosive chemicals are considered a problem, such as in chemical laboratories and the Separations Process Research Unit. Periodically, filter boxes in stainless exhaust systems, which are made of soft iron are inspected and replaced, if necessary.

Stack heights for laboratories, special machine shops and reactor assembly areas range from roof vents to 25 feet above roof level. The exhaust ventilation from the liquid waste processing building is discharged at a stack height 50 feet above ground level, 25 feet above the adjacent roof. The stack associated with the area and process vents of the Separations Process Research Unit is 105 feet above ground level, 65 and 75 feet above adjacent roofs.

Table 1 shows a comparison of the nature and amounts of toxic elements emitted from laboratory stacks in 1952 and 1954 to indicate a reduction over the period reported at the previous Air Cleaning Conference. These reductions are due to changes in the nature of operations, not changes in types of ventilation processing equipment and are typical of present operations. The drastic reduction in alpha activity discharged is attributed to the elimination of the sole contributor when the Separating Process Research Unit was shut down; plus the fact that the final runs of this Unit did not involve second cycle plutonium purification steps.

Table 1

Annual Amounts of Toxic Elements Discharged into Atmosphere

Year	Beryllium, milligrams	Nonvolatile Fission Products, curies	I-131, millicuries	Radioactive Gases, curies	Alpha Activity, curies
1952	121	40	113	591	7×10^{-1}
1954	44	2	---	73	7×10^{-5}

With the shutdown of SPRU, the Radioactive Materials Laboratory in the Materials Metallurgy Section became the most important factor in the contamination of the atmosphere with fission products. The stack effluent from the Special Materials Machine Shop of the Manufacturing Sub-Section continued to be the potential source of beryllium contamination in the environment. The data indicate that the need for atmospheric dilution of stack exhaust air, though never great, has been substantially reduced.

Air Monitoring Surveys - 1954
Stack Air Effluent

		Materials and Metallurgy Section	Project Physics Section	Chemistry and Chemical Engineering Section	Manufacturing Sub-Section	Maintenance and Utilities Sub-Section
General Alpha	Total Number	563	---	408	---	693
	No. $>4\times10^{-12}\mu c/cc$	0	---	1	---	0
	Maximum ($\mu c/cc$)	---	---	6.8×10^{-12}	---	---
Fission Products	Total Number	563	---	408	---	693
	No. $>2\times10^{-10}\mu c/cc$	5	---	32	---	0
	Maximum ($\mu c/cc$)	8×10^{-9}	---	5.6×10^{-7}	---	---
Natural Uranium	Total Number	---	---	---	246	---
	No. $>5\times10^{-5}\mu g/cc$	---	---	---	0	---
	Maximum ($\mu g/cc$)	---	---	---	---	---
Enriched Uranium	Total Number	---	---	---	386	---
	No. $>3\times10^{-11}\mu c/cc$	---	---	---	0	---
	Maximum ($\mu c/cc$)	---	---	---	---	---
Beryllium	Total Number	---	---	---	456	179
	No. $>0.01\mu g/M^3$	---	---	---	9	0
	Maximum ($\mu g/M^3$)	---	---	---	0.04	---
Tritium	Number of Indications $>1\times10^{-5}$ $\mu c/cc$	---	---	395	---	---
	Maximum ($\mu c/cc$)	---	---	6.5×10^{-3}	---	---

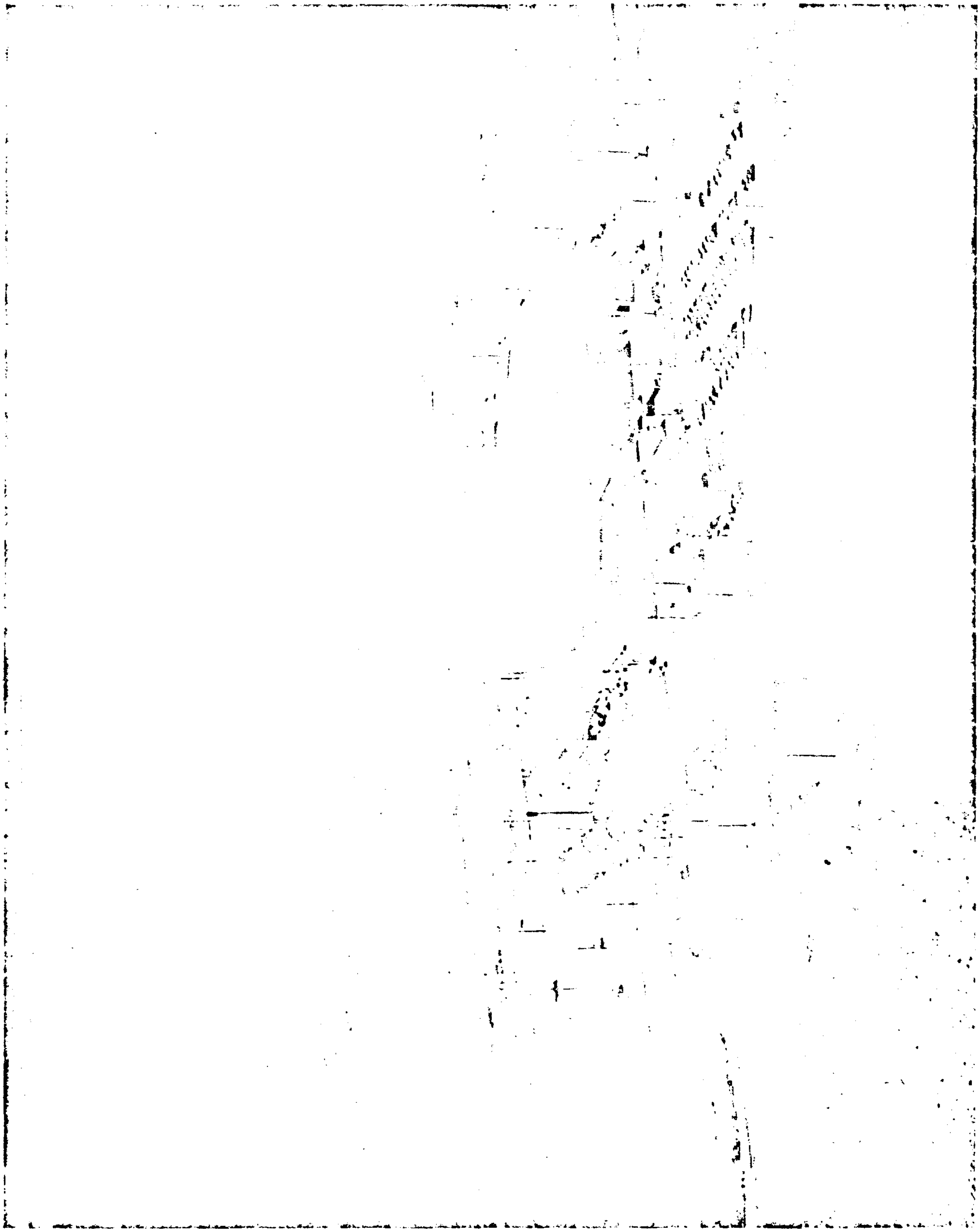
No concentration of beryllium above the prescribed limit of 0.01 $\mu g/M^3$ was detected in the environs and no significant alpha concentrations in environmental air were detected. Although fission product air-borne concentrations, a distance approximately equal to 10 stack heights downwind of the SPRU stack, were significant on a monthly average for the last two months of SPRU operations, a peak concentration of 6.0×10^{-10} µc/cc did not exceed the maximum permissible concentrations in air of 2×10^{-9} µc/cc. This MPC was determined by J.J. Fitzgerald for the quality of radioisotopes in SPRU stack effluent and reported at the Third AEC Air Cleaning Conference.* During the remainder of 1954, a single significant environmental fission product concentration attributable to laboratory operations was related to Radioactive Materials Laboratory operations involving the examination of irradiated samples.

AIR CLEANING SYSTEMS - West Milton Site

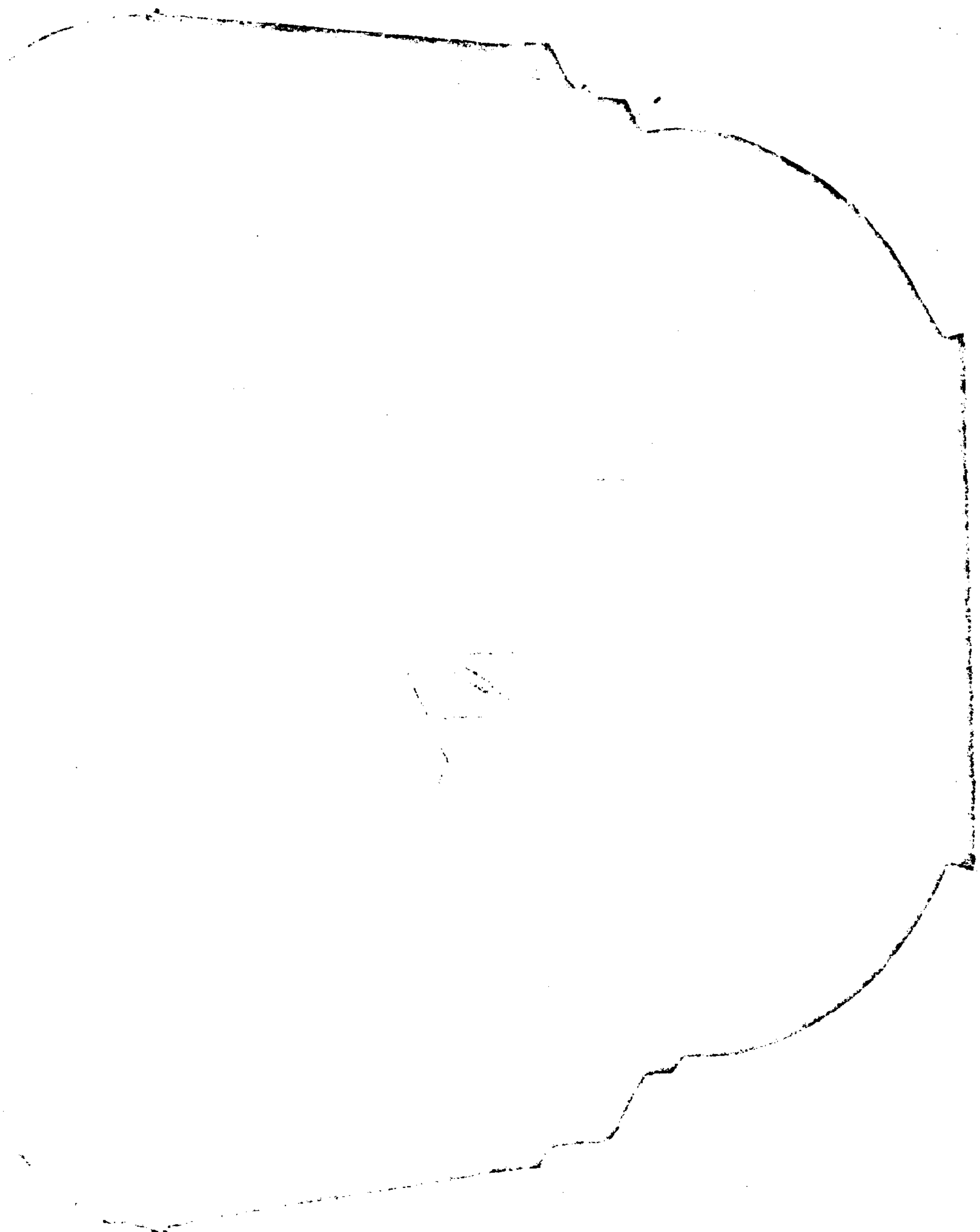
The West Milton Site consists of a main group of three interconnecting buildings providing space for engineering and operations offices, health physics and chemistry laboratories, change area, fuel element service cells and the Power Plant Building (Figure KS-6013). The Power Plant Building is a steel sphere 225 feet in diameter. Figure 1121193 is a cut-a-way view of the sphere showing the liquid metal cells and the submarine hull section containing the power reactor.

Facilities at West Milton requiring control of radioactive concentrations in exhaust air are the reactor compartment of the submarine hull and the liquid metal cells within the sphere, and the laboratories and fuel element service cells in adjoining buildings. The ventilation system supplies and exhausts 22,000 cubic feet of air per minute, of which 83% provides approximately 10 air changes per hour to the

* KAPL 1015, Evaluation of KAPL Separations Process Stack Effluent, J. J. Fitzgerald.



KS-6013



1121193

laboratories and the Fuel Element Service Building. Figure KS-6234 shows the filter room servicing the Fuel Element Service Building. Again the filter media is CWS or equivalent preceded by a glass wool filter.

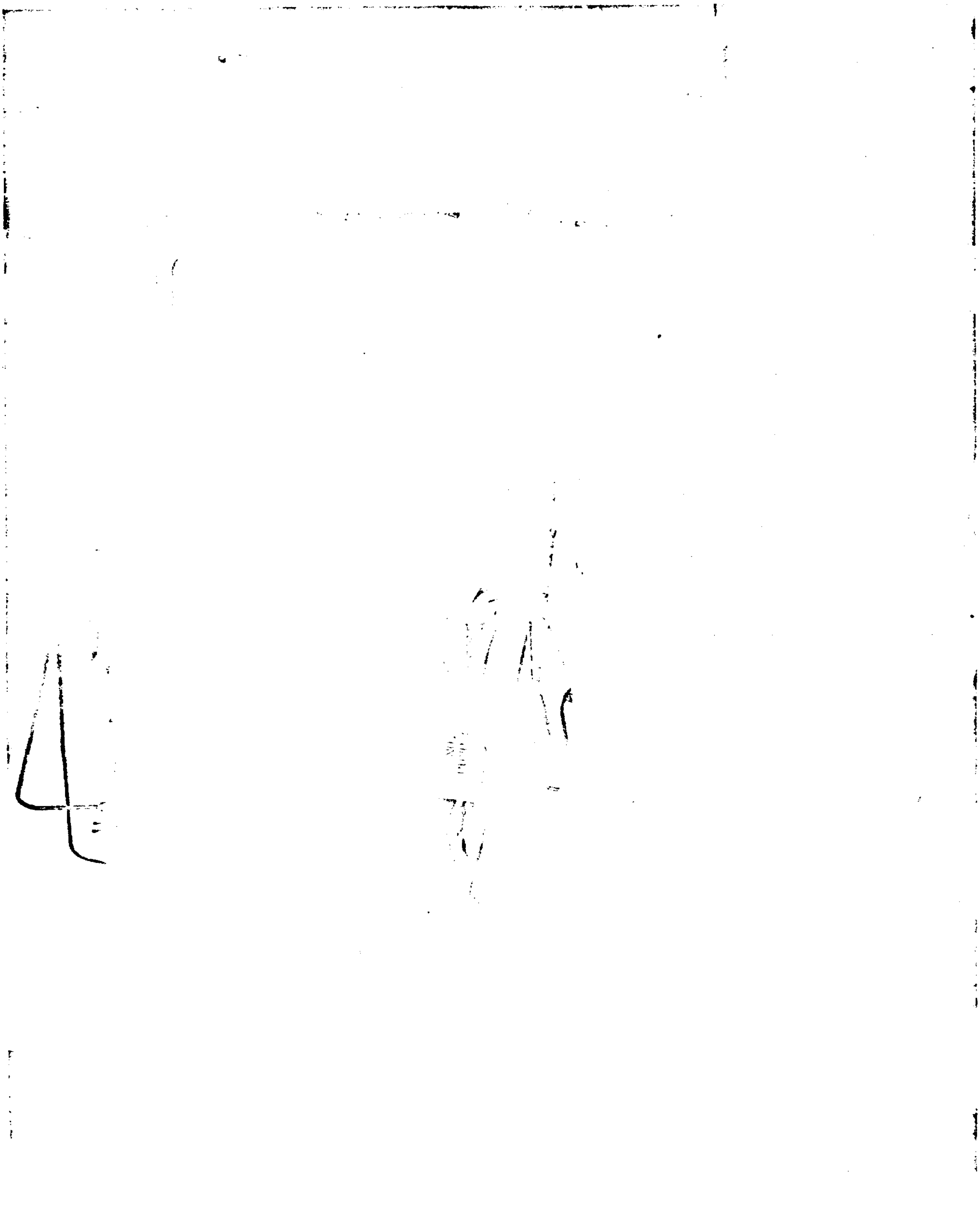
Figure KS-6233 shows the filter installation servicing atmosphere exhaust from the Liquid Metal Cells. The filter media in this case is a Cambridge B-Series high temperature Absolute Filter preceded by a glass wool filter.

The reactor compartment is normally vented to the exhaust stack without processing. However, in the event that radioactive gas monitors indicate the need, the vent gases are compressed by equipment in a shielded concrete cell shown in Figure KS-6235. The gas release can then be adequately regulated.

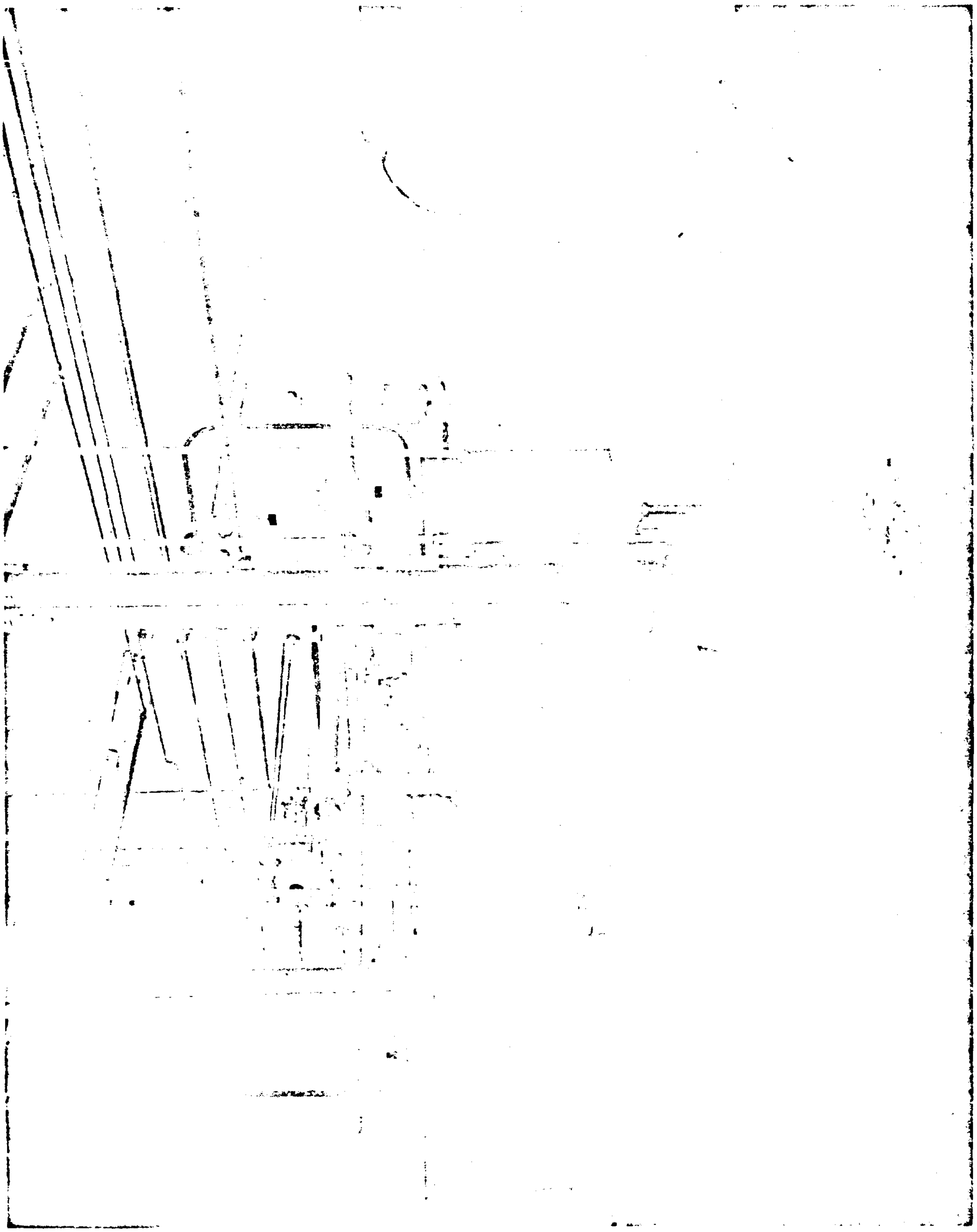
Air in the Power Plant Building is changed about once a day at the rate of 4,000 cubic feet per minute. Twenty-five percent of this air is taken from the liquid metal cells in order to maintain a negative pressure in the cells with respect to the rest of the sphere. Sphere air is filtered through glass wool filters and conditioned once each hour and a half by 10 unit air conditioners located symmetrically around the floor of the sphere (Figure KS-6232). Also, when required to prevent cloud formation and precipitation within the sphere, five blowers with a total capacity of 80,000 cfm are located in the upper section of the sphere to provide good mixing of air throughout the sphere.

Figure KS-6236 shows the base at the exhaust stack and two 25,000 cfm exhaust blowers, one in standby. The standby blower is available for stack dilution. Figure KS-6229 shows the top of the stack through which air exhausted from the Power Plant Building, laboratories, and the Fuel Element Service Building is discharged.

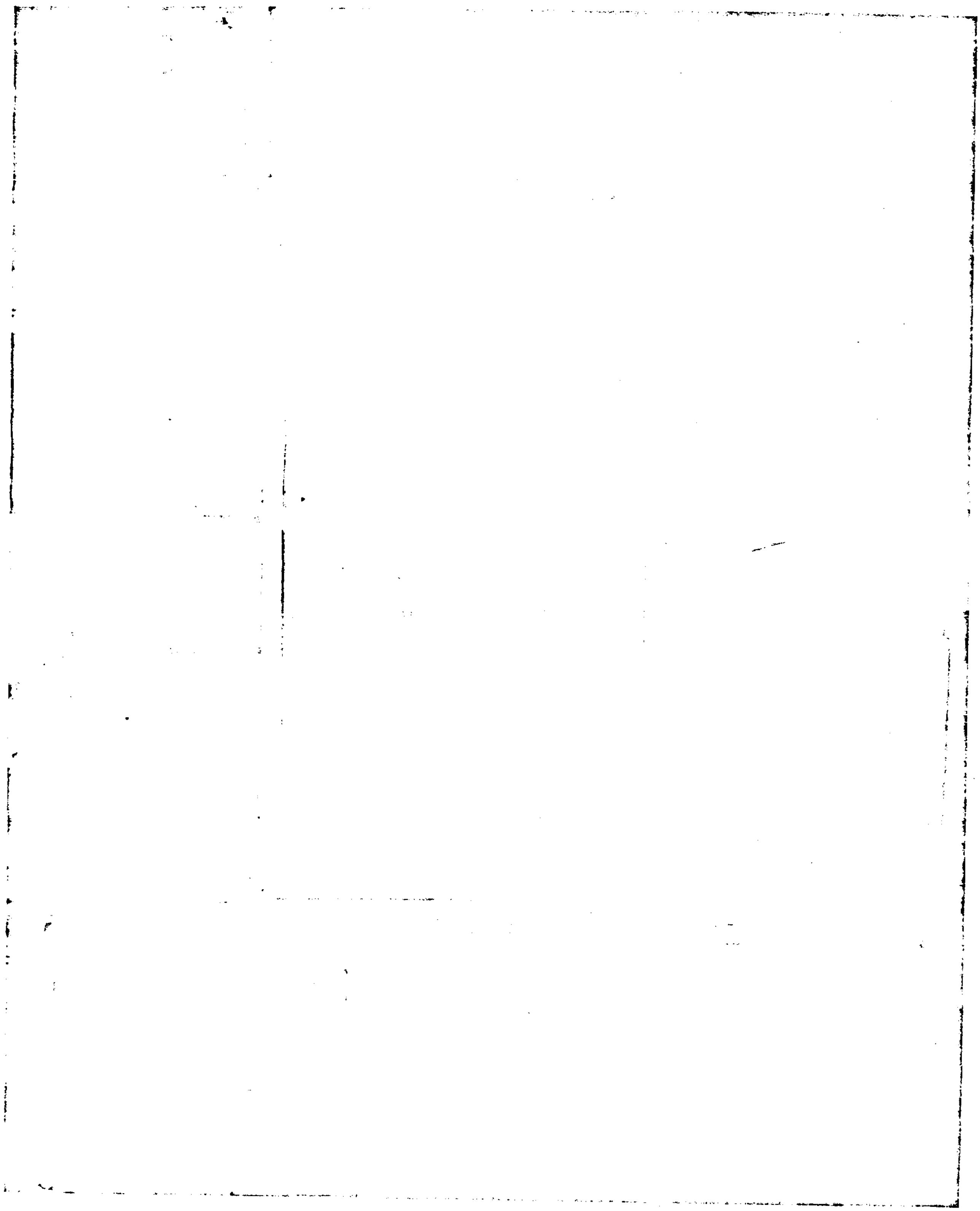
Although there has been no need to rely on atmospheric dilution of stack effluent, in an incident involving a sodium fire in the Liquid Metal Cell, concentrations of beta gamma activity in stack effluent approached 10% of the maximum permissible concentration of Sodium-24 in air. The maximum concentration detected at ground level indicated an atmospheric dilution factor of 500.



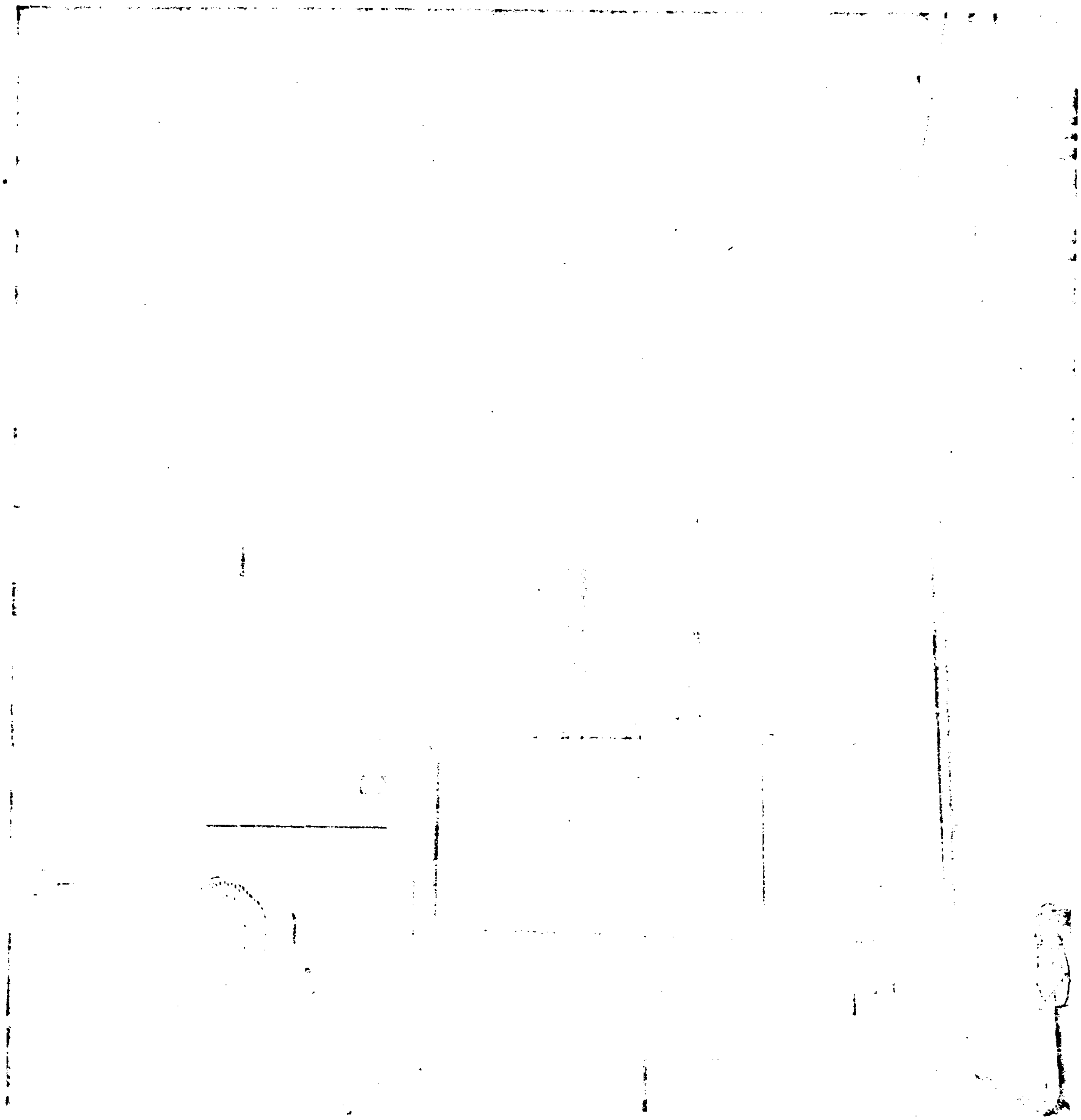
KS-6233

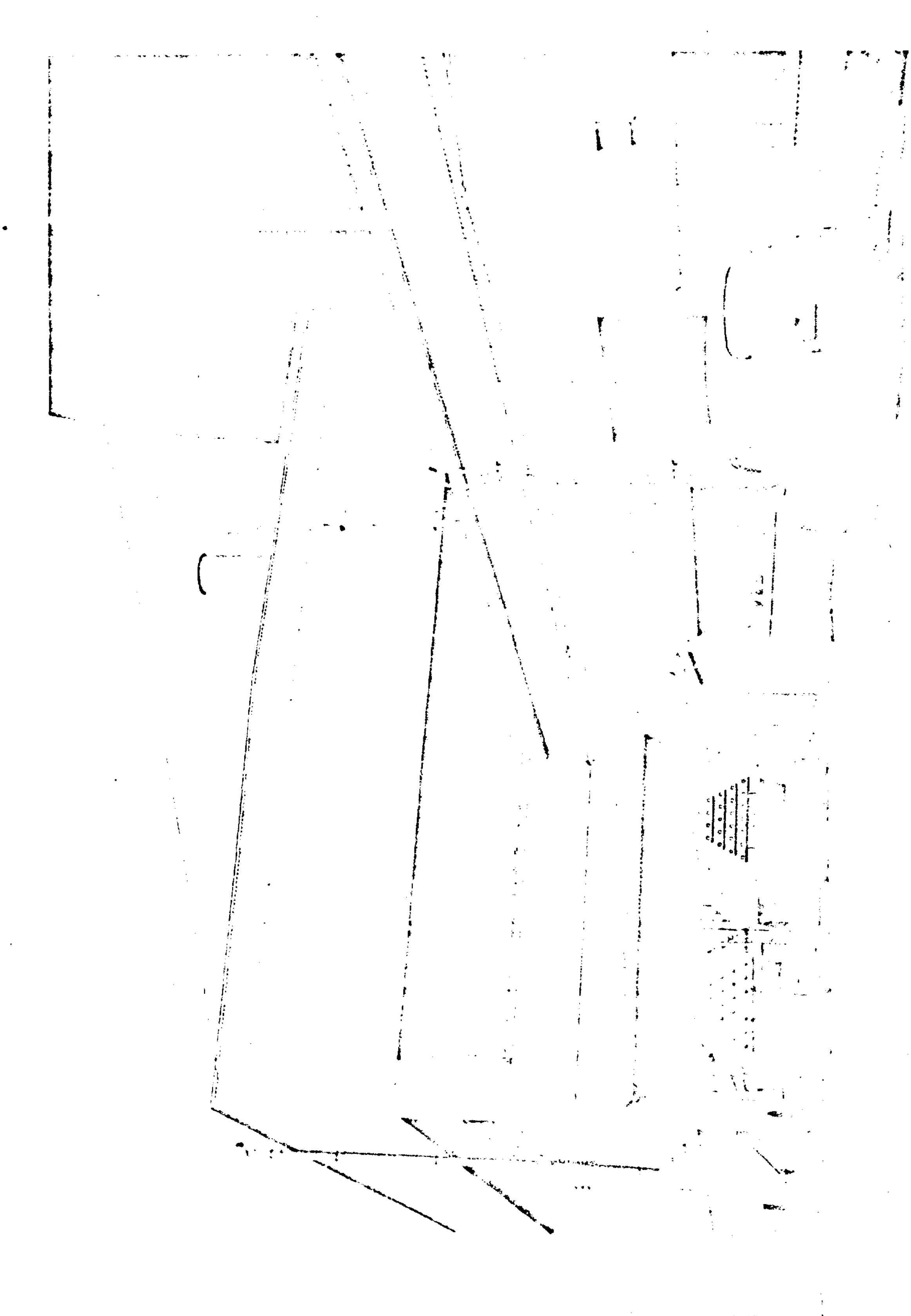


KS-6235



KS-6232





KS-6229

The efforts to combat the fire had caused the Liquid Metal cell to become pressurized with respect to the Power Plant Building and cell atmosphere was exhausted largely with the unfiltered Building atmosphere. The exhaust system has been modified to assure negative atmospheric pressures in the liquid metal cell during the use of sodium fire fighting equipment and to provide standby filtration for Power Plant Building exhaust air.

In summary, although the amounts of toxic elements released to the atmosphere at the Knolls Site have not been a problem in the past, the potential has been further reduced by changes in programs including shutdown of SPRU. The exhaust system for the Power Plant Building at the West Milton Site is now considered adequate for normal operations and for fires involving primary coolant in the Liquid Metal Cell.

AEC BETTIS PLANT AIR CLEANING ACTIVITIES

P. R. Bolton
Westinghouse Electric Corporation
Pittsburgh, Pa.

The Atomic Energy Commission's Bettis Plant, operated by Westinghouse, has certain air cleaning problems which consist chiefly of the removal of radioactive particles and acid fumes and mists from process air. Quite often, both types of contaminants are common to the process air. For this reason, the work horse of our air cleaners is a wet collector. We have in use the American Air Filter, Type "N" Rotoclone and the Schmeig Centri-merge, utility-type wet collector.

These collectors are constructed of stainless steel for use where the exhaust air is highly corrosive, such as in acid pickling operations, and of carbon steel where corrosion conditions are not severe.

The wet collector is in general use for pickling operations, in chemical laboratories, and for metal working operations where exhaust gases are hot or where pyrophoric metals are used. It is also used in some special applications as a precleaner for dry collectors to remove corrosive fumes or heavy dust loadings before the exhaust air enters the dry collector. In these special applications the collection efficiency required is greater than that which is provided by the wet collector alone.

The advantages of this type of collector for our operations are as follows:

a. Its collection efficiency is greater than 90% for particulate matter, and high for mists and fumes.

b. It can be used where there is a variety of contaminants to be removed, such as acid fumes, mists, particulate matter, and when exhaust air is at a relatively high temperature.

c. The maintenance cost is low because there are no filters to change. Waste water is piped to suitable disposal facilities depending upon the nature of the material collected. Where hazardous materials, such as radioactive isotopes, are collected the water can be changed and disposed of with a minimum of personnel exposure.

d. The exhaust rate is constant. Because the resistance of the water does not increase with dust loading, the pressure drop of the system remains constant, resulting in a constant exhaust rate. The exhaust fan does not have to be sized to provide for an increase in system static pressure due to loading of the filter medium. Resistance of the collector changes only with water level which is controlled within close limits by the automatic water-level control.

Among the other collectors in use is a deep-bed type dry collector. This is a special design which consists of a dirty plenum chamber and a clean plenum chamber separated by the filter medium supported in a horizontal plane by an expanded metal plate. The filter medium consists of two layers of FG50 Fiberglass. The media mat is held in place by a rectangular rod frame which lies on top of the mat around its perihery and by the greater negative pressure drop through clean filters of about 4 inches W.G. This high initial resistance is a compromise between the physical size of the unit and the horsepower required to provide a given exhaust rate. Needless to say, a 5000 cfm unit occupies considerable floor space, approximately 65 square feet. The filter is changed by removing the cover of the top plenum chamber and rolling up the filter, retaining the collected material inside the roll. To catch any material which might fall off during filter change a tray is inserted beneath the expanded metal filter support prior to rolling up the filter. The change is effected with a minimum loss of valuable collected material and minimum dust exposure for personnel. The filter chamber is easily cleaned, if necessary, to reclaim the material adhering to its walls.

Several deep-bed units of 500 cfm capacity are used on various uranium alloy metal working operations, such as shearing, rolling and melting charge preparations. Each of these units contains its own blower and motor in the bottom (clean) plenum chamber. They discharge into a common header wherein a constant negative pressure is maintained by an auxiliary fan to prevent blow-back through units which are not operating. These are very versatile units in that they are semi-portable, permitting greater flexibility of the exhaust ventilation equipment, a distinct advantage in a development laboratory. We also have some of these units mounted on casters and backed up by high efficiency AEC filters which permit discharge of the exhaust air back to the room, thus eliminating duct work. These units are used in a new development lab where work with powdered UO_2 is being conducted. Flexible hose on the inlet permits quick hook-up to different equipment. The collectors can be shifted to intermittent operations as required. The filters are changed when their resistance is twice that of clean filters or at the end of an accountability run, whichever occurs first.

Bag filters of the Hersey reverse-jet type are in use on powder metallurgy operations using UO_2. At present, the reverse-jet is operated manually at periodic intervals but we plan to install a differential pressure mechanism to actuate the jet. Dust loadings have been low, requiring infrequent operation of the blow ring. The lab employing these collectors is in a state of development at this time and we do not have much information on the performance of these collectors.

Electrostatic precipitators are used as the final cleaner in our hot lab operations. The air from the hot lab cells passes through a wet collector (Rotoclone) for removal of heavy dust, fumes, etc., and then through the precipitator before being discharged out the stacks. Fiberglass filters follow the precipitator to catch any blow-off from the collecting plates. The precipitators are cleaned periodically by washing the plates with a built-in water spray with an adhesive. The adhesive provides better retention of the collected material, and because it is water soluble the plates are easier to clean. The contaminated water from the precipitator is piped to the radioactive liquid waste disposal system. Continuous monitoring of the stacks has shown that performance of the precipitators has been good. In the new hot lab facilities now being constructed the air cleaning facilities will be the same with the exception that precipitators will be followed by high efficiency filters to provide adequate cleaning for the high level radioactive samples to be handled. A distinct advantage in using the precipitators for radioactive work is that they can be cleaned remotely and the waste is in a liquid form, thus minimizing direct contact by personnel. We also have some precipitators for supplying clean air to "clean" rooms. These remove only atmospheric dirt and do not handle process air.

High efficiency filters of the AEC type are in use in the hot lab for local exhaust of operations where very high levels of airborne radioactivity are contemplated. This system consists of Rotoclone followed by the high efficiency filter. The master slave cell (or shielded hood) exhaust system consists of roughing filters of FG50 Fiberglass followed by a high efficiency filter as a final filter on small portable deep-bed type collectors permitting discharge of cleaned air to the room. In installations employing the high efficiency filters upstream to prolong the life of the high efficiency filters.

DEVELOPMENTS IN AIR CLEANING AT LOS ALAMOS

By R. N. Mitchell
Health Division, Los Alamos Scientific Laboratory

Since the last air cleaning conference at Los Alamos in September 1953, there havebeen no major changes or additions to the air cleaning equipment on the project. At present, no basic research on air cleaning is being done.

Radio-Chemistry Building

The Radio-Chemistry Building at Los Alamos is now under construction. A portion of the air exhausted from one section of the building will require cleaning.

The process involved is the dissolving of the samples using fuming nitric and perchloric acids. A maximum of 400 ml. of fuming nitric and 100 ml. of 70% perchloric acids are used per sample. A maximum of 8 hours and a minimum of 3 hours are required for dissolving the samples. In addition to the acid fumes, volatile radioactive materials, principally iodine, are evolved. The total activity per sample varies from 0.3 curie to 1.0 curie. Hood stack samples indicated that approximately 9% of this is volatilized.

In the present building, there are facilities for dissolving 16 samples at one time. Each dissolving unit is in a separate hood with a face opening of 20 x 18 inches. A total of 5000 c.f.m. of air is exhausted for the 16 hoods. The air cleaning consists of a water spray in the duct in back of each hood. Of the 9% of the sample that is volatilized, 35% is collected in the water spray and 65% goes out the stack. The mass median size of the material as determined by the cascade impactor is 0.5 to 1.0 micron. A total of 200 to 700 millicuries is exhausted to the atmosphere during a run of several samples.

The new building plans have stations for 16 dissolving setups in eight standard laboratory fume hoods. Instead of attempting to clean all the air exhausted through the hoods, a separate exhaust system provides local exhaust directly over the dissolving beaker. By this method, 320 c.f.m. of air requires cleaning instead of 5000 c.f.m.

A description of the air cleaning equipment as written into the building specifications is as follows: "The Venturi scrubber and cyclone separator in the dissolving room absorption system shall be manufactured by the Chemical Construction Corporation, New York, N. Y. or approved equal, and shall be installed in accordance with the manufacturer's recommendations. Unit shall be constructed of stainless steel in such a manner as to facilitate easy dismantling for cleaning and service.

The scrubber shall be designed to remove fuming nitric acid, perchloric acid and other solvents and dissolve material from 320 c.f.m. of 80°F. fume hood exhaust air with an efficiency of not less than 98%. Cleaned air shall be discharged to the atmosphere.

A caustic solution shall be supplied to the scrubber at a rate of 10 g./m. and a pressure of 15 p.s.i."

The feasibility of this type of air cleaning was checked by testing the Venturi scrubber of the incinerator at Los Alamos built for the disposal of contaminated trash. Fumes from boiling nitric acid containing radioactive iodine were passed through the scrubber. Duct samples taken before and after the scrubber indicated an efficiency of at least 98% and above.

Beryllium Shop Air Cleaning

Cleaning of air contaminated with beryllium at Los Alamos is done on the air exhausted from the hoods in the beryllium machine shop. The only work done in this shop is machining of metallic beryllium. The types of machines used are lathes, mills, drill press and surface grinder. Each machine, with the exception of the drill press, has an enclosing hood.

The amount of air to be cleaned varies between 1500 c.f.m. and 2500 c.f.m., depending on the number of machines operating. The air cleaning equipment consists of an American Air Filter Rotoclone, Type D, Size 10, followed by an American Wheelabrator and Equipment Corporation Dustube Collector.

The seventy-two orlon filter bags in the Dustube Collector are 5 inches in diameter and 70 inches in length. Total filtering area is 550 square feet; filtration velocity varies from 2-1/2 to 4-1/2 f.p.m. The filter is divided into two sections, to be used alternately under heavy loading conditions. As used at Los Alamos, the loading is extremely light so that both sections are used at all times.

The Beryllium Shop was moved to its present location and machining started in October 1953. New orlon bags were installed at that time. The initial pressure drop across the filter bags was 0.05 inch of water. After two years of operation, the pressure drop across the bags has risen to 0.35 inch of water.

With the new bags, the concentration of beryllium in the air exhausted to the atmosphere at start up varied from 0.5 to 1.0 microgram of beryllium per cubic meter. At the end of two years' operation, the beryllium concentration averages 0.05 microgram per cubic meter.

Sigma Portable Filtering Unit

One ventilating and air cleaning problem at Los Alamos is the result of the predilection of various groups to work with radioactive material for short-term experiments in areas that have no exhaust ventilation or insufficient ventilation for the process involved. This problem has been solved to some extent by the construction of portable blower and filter units. The first unit,

has a roughing filter, one 24 x 24 x 11-1/2 CWS-6 filter, and a blower capable of exhausting 1000 c.f.m. through the filter. A suitable hood or slot exhaust is made for each job. This unit worked satisfactorily at Los Alamos and at a Kokomo, Indiana mill that was doing contract rolling of uranium.

Air samples taken at the blower exhaust showed no activity when the unit was being used to ventilate work with radioactive material.

D.P. West Air Cleaning

The plutonium contaminated air exhausted from dry boxes at DP West is filtered through CWS-6 type filters installed in the room or nearby outside the room. Efficiency tests on one set of filters ranged from 70 to 99%. Particle size measurements made on particles collected in ducts downstream from the filters ranged from a mass median of 0.4 to 1.3 microns in diameter. The median size passing through a CWS-6 filter should be less than 0.3 micron. The results indicate leakage around the filter or improper filter installation.

Changing CWS-6 filters contaminated with plutonium presents a serious potential hazard to the craftsmen. Ingenious designs have incorporated safe handling in the filter holders. Plastic bags enclose the holder in such a manner that the workmen never touch the CWS-6 filter when removing or replacing it. Perhaps these elaborate safeguards make it impossible to properly seal a new filter in place. Whatever the cause, it is believed that improved air cleaning will result if the filters can be sealed more tightly.

The method of installing CWS-6 filters for plutonium filtration will be studied and an improved method devised. In addition, a ventilation engineer should be present during the filter change to inspect the job.

Miscellaneous Installations

The reverse jet-type bag filter has been installed in two locations at Los Alamos. One is for graphite dust where a cyclone has proven inadequate. This nuisance dust will be removed by passing through the cyclone and then into the reverse jet-type filter. In the second location, it is used to remove chemical dust from sizing and loading operations.

LOS ALAMOS AIR CLEANING ACTIVITIES

S. H. Glassmire
CMR Division
Los Alamos Scientific Laboratory

At the last Air Cleaning Seminar, Mr. Barrie Graham saw fit to comment on the organization of various departments concerned with air cleaning at Los Alamos. Since we have many people concerned with various aspects of air cleaning and since we have had some organizational changes it might be desirable to review our organization.

So, to bring the record up to date -- The three (3) major organizations at Los Alamos has remained unchanged. The technical work is under the University of California which operates the Los Alamos Scientific Laboratory (L.A.S.L.). The Zia Company is the maintenance contractor for both the townsite and the Laboratory. The third organization is the Atomic Energy Commission.

The Industrial Waste Treatment Section under Mr. C. W. Christenson was reported last time as functioning under the Health and Safety Branch of the A.E.C. This group has now been transferred to the operational jurisdiction of Health (H) Division of the Los Alamos Scientific Laboratory. The function of this group remains the same and is charged with the treatment of industrial and radioactive waste.

In the Laboratory's Engineering Division, Mr. Charles Wherrit heads the Mechanical Design Section. This group is charged with the over-all design and specifications of all ventilation and filtration systems of the Laboratory. Mr. Raymond McDonald represents the Engineering Division at this meeting and any specific questions concerning the general systems and filters at Los Alamos may be directed to him. Recently another Engineering group (ENG-4 under

Mr. C. A. Reynolds) has undertaken the operation and responsibility for the main building filtration systems of the CMR Building which handles and filters some 600,000 cubic feet of air per minute. (All air entering the building and passing through the laboratories and equipment is 100% fresh make-up and, before discharging to atmosphere, it is filtered to give below tolerance stack counts.) Mr. Les Pagé and Mr. Roy Merryman have direct responsibility for the operation of these main filter towers. This group is now using various combinations of filtering media. These combinations include such media as: PF 334, 335, 336, and 105 manufactured by Fiberglass Corporation; Cambridge Aerosolve #95; and capillary air washers. Each combination of these materials cleanses with different efficiency and are still being studied. Mr. Reynolds has indicated to me that his group will advise the industry via a report sometime in the future when more data is accumulated to substantiate such reporting.

Group H-5 of the Health Division of the L.A.S.L. handles the Industrial Hydiene activities of Los Alamos and is under the direction of Mr. Harry Schulte. Mr. Schulte's group is represented at this seminar by Mr. Robert Mitchell. Mr. Mitchell is reporting separately here today and will summarize the over-all air cleaning and stack gas situation at Los Alamos. My remarks will be confined to the "process" air cleaning interest of the Chemistry and Metallurgical Research Division (CMR) of the Laboratory. CMR's research and and production lines discharge the bulk of the radioactive effluent at Los Alamos. CMR's process laboratories also discharge many varieties and types of radioactive aerosols into the air streams which obviously presents many filtration problems. Therefore, CMR Division maintains people on their staff interested in air cleaning ventilation and radioactive handling.

CMR's ventilation and air cleaning was formerly carried out by CMR-AE. However, this group has recently merged with CMR-7 under the direction of Mr. James R. Lilienthal. I represent this group here today. Our group is charged with the responsibility of "process air flow" which concerns proper air balance, quantity, and flow pattern through the individual laboratories and equipment, and local or source filtering where necessary. We now maintain filtered air flow through all our dry boxes at rates ranging from 10 - 30 cfm with a 0.5" w.g. negative pressure inside the dry boxes maintained by an inlet type edge filter. The edge type filter that we have developed for this application is shown on Drawing 11Y-31674, copy enclosed with this report. Various media have been used in this edge filter depending upon the pressure drop and efficiency desired. The media that has proven satisfactory for over-all enclosure operation is 1" thick dynel with #2 dinier with blend of #6, #12, and #24 fibers manufactured by the Fiber Bond Corporation. Discs 6" O.D. by 2-1/2" I.D. are placed in the holder, cemented together, cemented to top and bottom plate, and stretched or compressed to give the desired pressure drop.

Local exhaust filtering at the source of "hot spots" is sometimes necessary in order to facilitate recovery operations and to prevent undue contamination of the main systems. Where necessary, local exhaust filters are incorporated in the original hood or dry box design or filters are installed in the exhaust line near the enclosure. Cambridge absolute filters are generally used for this application. Types of filter boxes that we have developed for line filtration are shown on enclosed drawings 11Y-31978 and 11Y-31789.

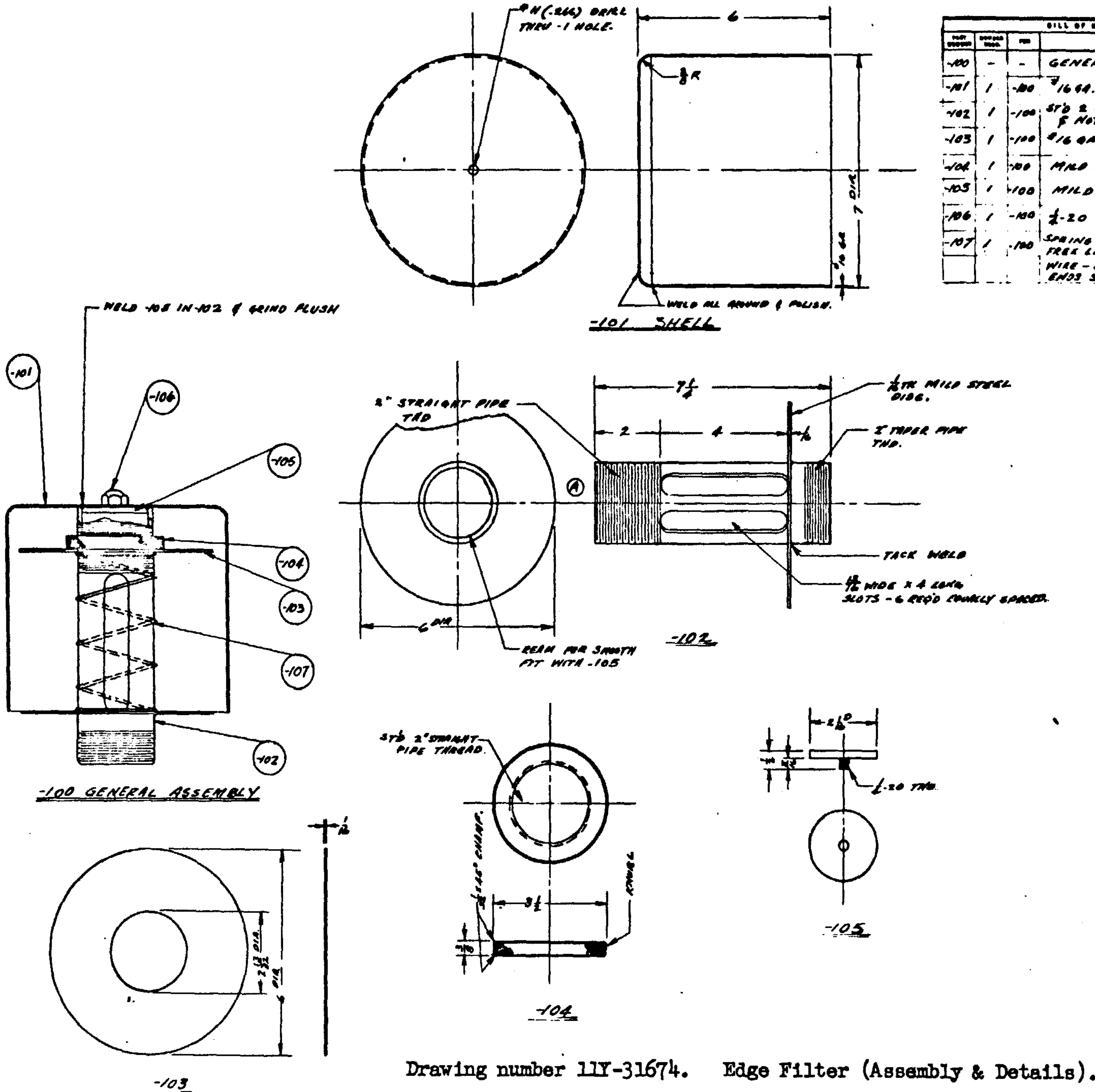
This design permits filtration of all air discharging through a single branch line. It also facilitates changing filters through the standard plastic bag and ring arrangement with a minimum spread of contamination. The design has proven very satisfactory to us if care is taken to assure a good seal around the gasketed surface of the filter.

CMR Division also operates experimental test duct sections where we test efficiencies and air flow characteristics of various media. Drawying 11Y-31798 shows one of our test ducts, the design of which is standard. The sampling ports and mechanism are not shown on the drawing. The CMR laboratory scientific personnel report to us the probable physical properties (size, shape, adhesion characteristics, etc.) of the effluent issuing from their particular operation. Similar, or sometimes idential aerosols, are then generated in our test ducts. We have found it difficult to simulate test material that exactly duplicates our radioactive effluent actually discharged into our air streams. Therefore, as far as is economically feasible, we are testing with the same aerosols that the media will ultimately be expected to filter. High efficiencies of a media using charged lead, copper, etc., and other such aerosols, ordinarily used for testing, cannot be assumed to apply nor to be equally effective on submicron plutonium, uranium, or other particles. Substitute aerosols in general do not have the same filterable characteristics as our small radioactive contaminants.

Cambridge Absolute, Cambridge Aerosolve, F.G. 50, and Fiber Glass PF 105 have performed well under out test conditions and have been adopted and operated by Engineering Division in our main filter towers. PF 334, 335, and capillary air washers are often used in series with one of the above medias. Our capillaries cleanse the air of corrosive fumed and acid mist but must be followed by efficient moisture eliminators if the capillary is operating ahead of the above medias. (Engineering Division has minimized the build up of solid concentration of the capillary spray water by proper blow down.)

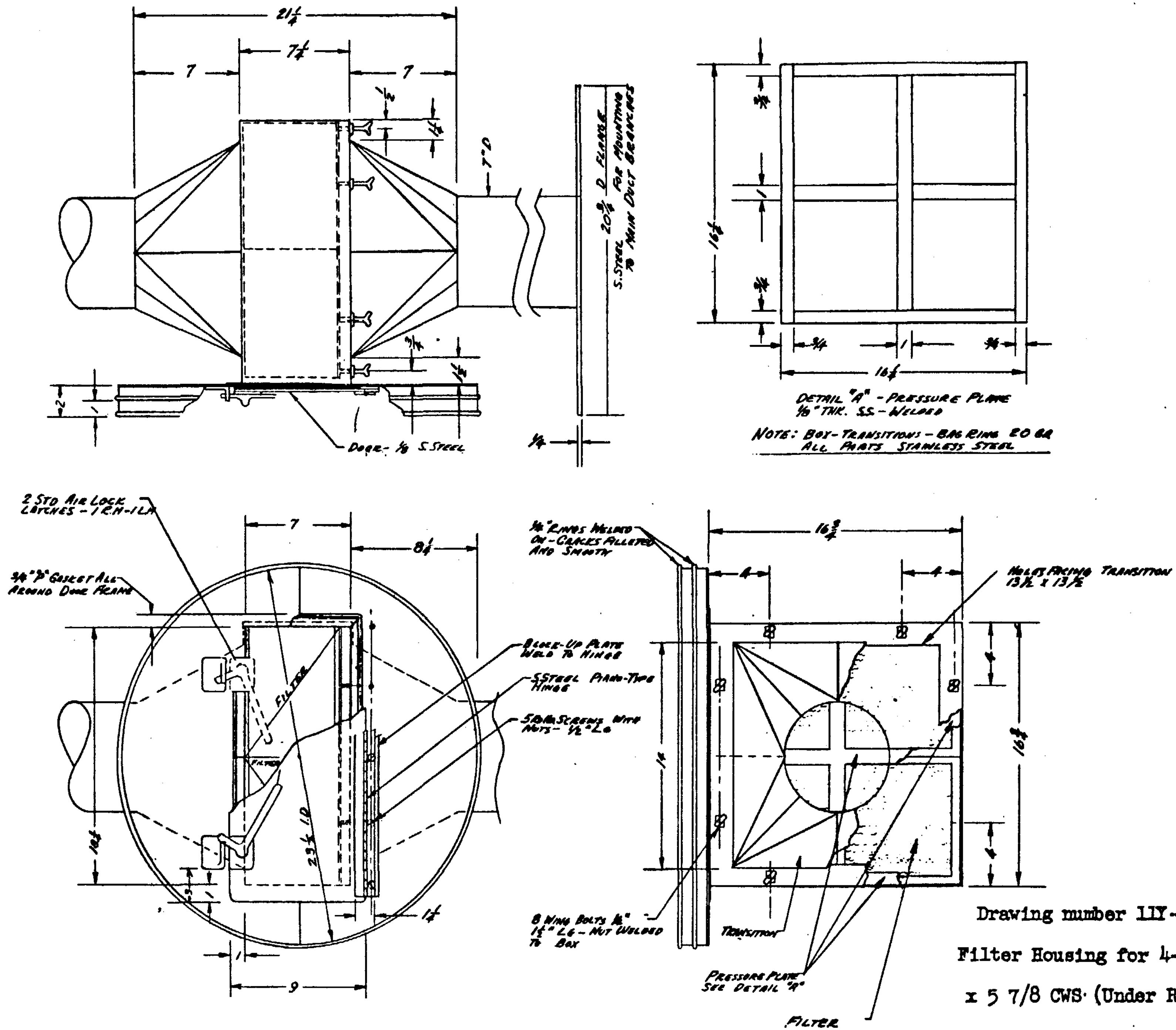
It might be of interest to this seminar to know that we have recently experimented with small capacity sand filters and have obtained good results. We are constantly searching for economical, as well as efficient, filtering media. In our effort to utilize economical and available material, we have ground volcanic tuff and used it for media. Tuff composes the bed rock at Los Alamos and is minutely vesicular in texture with apparent high adhesion properties. We have packed 8" square filters to a thickness ranging between 1" and 4" with ground tuff retained between #12 and #20 U.S. mesh wire screen. Excellent efficiencies have been obtained on particles ranging from 5 to 40 microns in size at flows up to 30 cfm across this face area. The efficiency decreases as aerosol size decreases to about 2 or 3 micron. However, from preliminary studies, the efficiency curve appears to start back up (better efficiency) somewhere in the submicron range. These sand filters probably filter on the principle of inpaction and their efficiency is probably due to the high adhesion characteristic of the tuff. They warrant further study for possible application as an ecomomical, efficient, low pressure drop, roughing filter. These sand filters were also tested with heavy metallic contaminants and were operated both wet and dry.

In connection with sand filters, I would like to mention a research problem that I started last year at the University of Kansas while on leave from the L.A.S.L. My problem concerned the vertical and horizontal travel or migration of air born radioactive contaminants after fall out on the earth's surface. Unfortunately, I had to leave before accumulating sufficient test data to warrent publication. However, I would like to take this opportunity to report that my preliminary studies suggest that once such a particle falls out on the earth's surface it tends to remain in place. Very little horizontal or vertical migration was noted. The soil covering tends to be a very effective filter in itself and there is little chance of downward washing and subsequent spread of contamination. Since I am not directly connected with such matters at Los Alamos, I am turning my data over to others that are, for further study and future reporting.



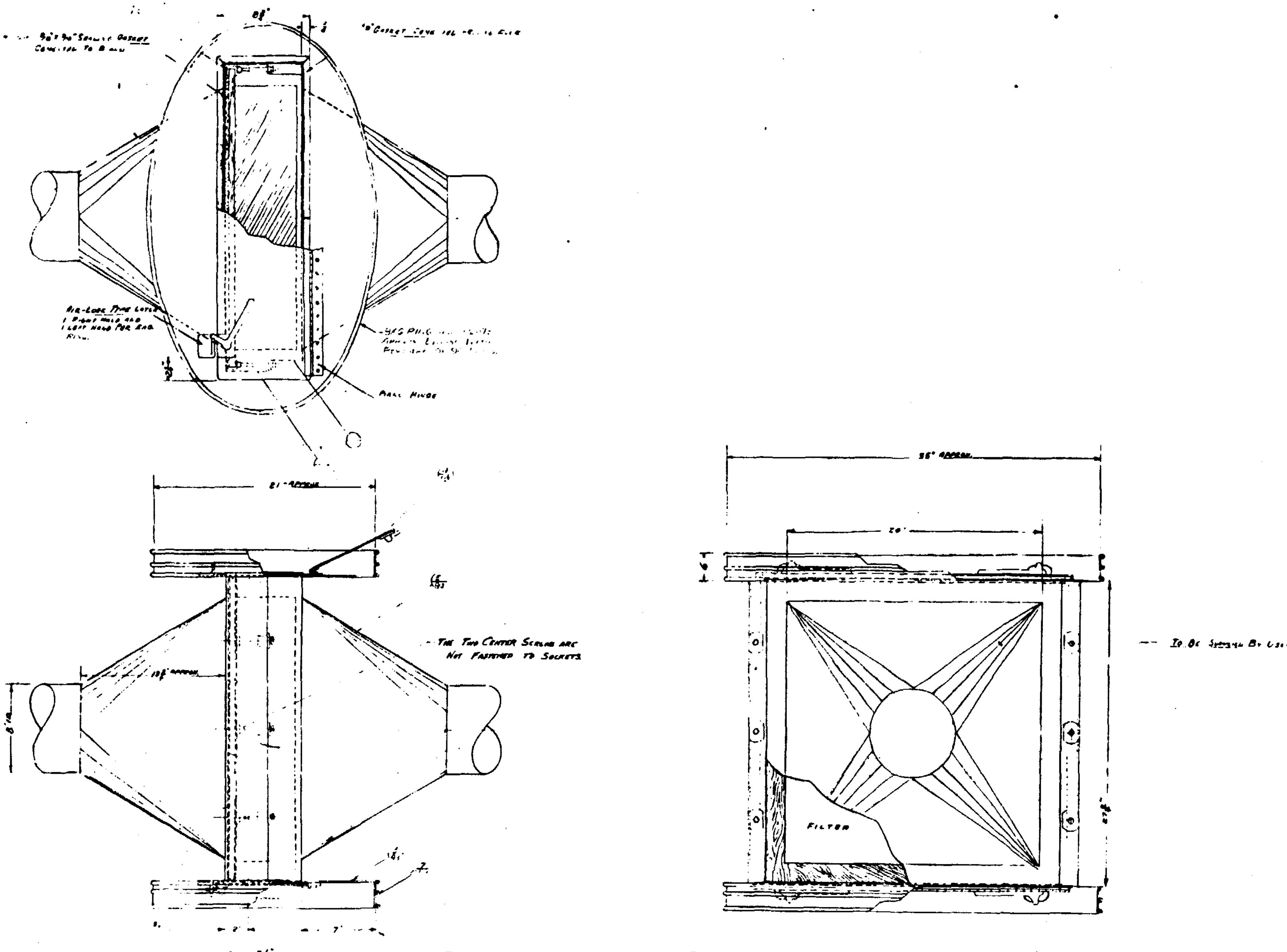
BILL OF MATERIAL			
[illegible]	[illegible]	[illegible]	[illegible]
-100	–	–	GENERAL ASSEMBLY
-101	1	-100	#16 GA. MILD STEEL
-102	1	-100	ST'D 2 GALVANIZED PIPE & NOTED
-103	1	-100	#16 GA. MILD STEEL
-104	1	-100	MILD STEEL
-105	1	-100	MILD STEEL.
-106	1	-100	¼-20 ACORN NUT.
-107	1	-100	SPRING - 2 7/16 I.D. X 5⅜ FREE LENGNT -.075 DIA MUSIC WIRE - 8 COILS - 6 ACTIVE ENDS SQUARED.

Drawing number 11Y-31674. Edge Filter (Assembly & Details).

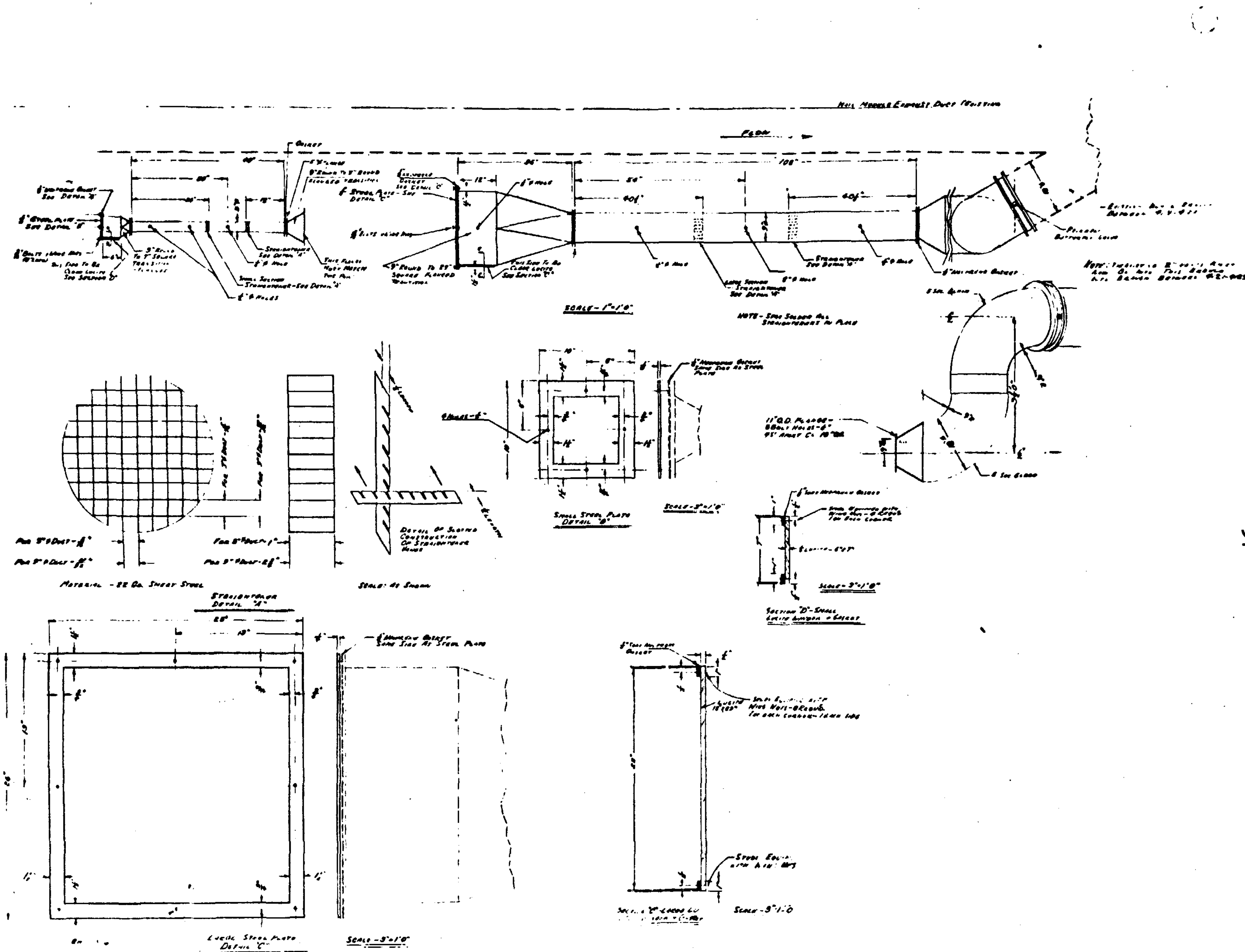


Drawing number 11Y-31978.

Filter Housing for 4- 8" x 8" x 5 7/8 CWS (Under Rm 4123).



Drawing number 11Y-31789. CWS Filter Box.



Drawing number 11Y-31798. Test Duct Section New CMR Bldg. Basement Wing #4.

SPECIAL AIR MONITORING PROGRAM AT THE BROOKHAVEN REACTOR*

By Lee Gemmell
Health Physics Division
Brookhaven National Laboratory

Whenever the BNL Reactor shield is opened up for the purpose of charging or discharging fuel, or when certain isotopes are made in a non-routine fashion in the pneumatic tube facilities, airborne contamination may accidentally escape into the reactor building in varying quantities. Most jobs can be done with a minimum of contamination. However, experience has shown that even with the greatest care in planning an operation, accidents or unforeseen problems can still happen.

To remove fuel elements from the reactor, it is necessary to reach in with long handling tools through the biological shield, across the plenum and into the reactor graphite itself. The fuel cartridges are pulled out of the graphite holes into a supporting tube suspended across the plenum and then lowered into the canal. The manipulation of items in the plenum is all done through the narrow scanner slots opening from the top of the pile into the plenum.

Even though there is supposedly negative pressure in the pile at all times (i.e. air always moving into the pile) there have been occasions during pile shutdowns when puff-backs or backdrafts have occurred and spread considerable contamination into the building by way of the scanner slots and open experimental facilities. As the handling tools are removed from the pile they are thoroughly wiped and scrubbed, however, even under the most exacting requirements for cleanliness, some contamination may get out onto the charging platform and become airborne.

The reactor building is air conditioned with only part of the air being recirculated. Air movement in the building was studied using smoke with the air conditioning both on and off. There is some mixing between the air in the north and south portions of the building (see Figure 1). However, during certain operating conditions, there is a tendency for it to circulate mostly in the part of the building from which it entered. Two air sampling systems were necessary in order to sample each part of the building promptly. Air is drawn through the sampling tubes and then through the filter paper strip at about 2 cu.ft./minute. The particles are stopped by the paper (H & V #7—9 mils thick) and counted by the mica-window GM counter that sees the dust as it is collected. The counter feeds into a ratemeter which displays the results on a recorder located in the Health Physics office. If contamination shows up on the filter paper, an associated alarm circuit lights a red light on the charging elevator showing the operators that airborne contamination is present and that the prompt use of respiratory equipment is required.

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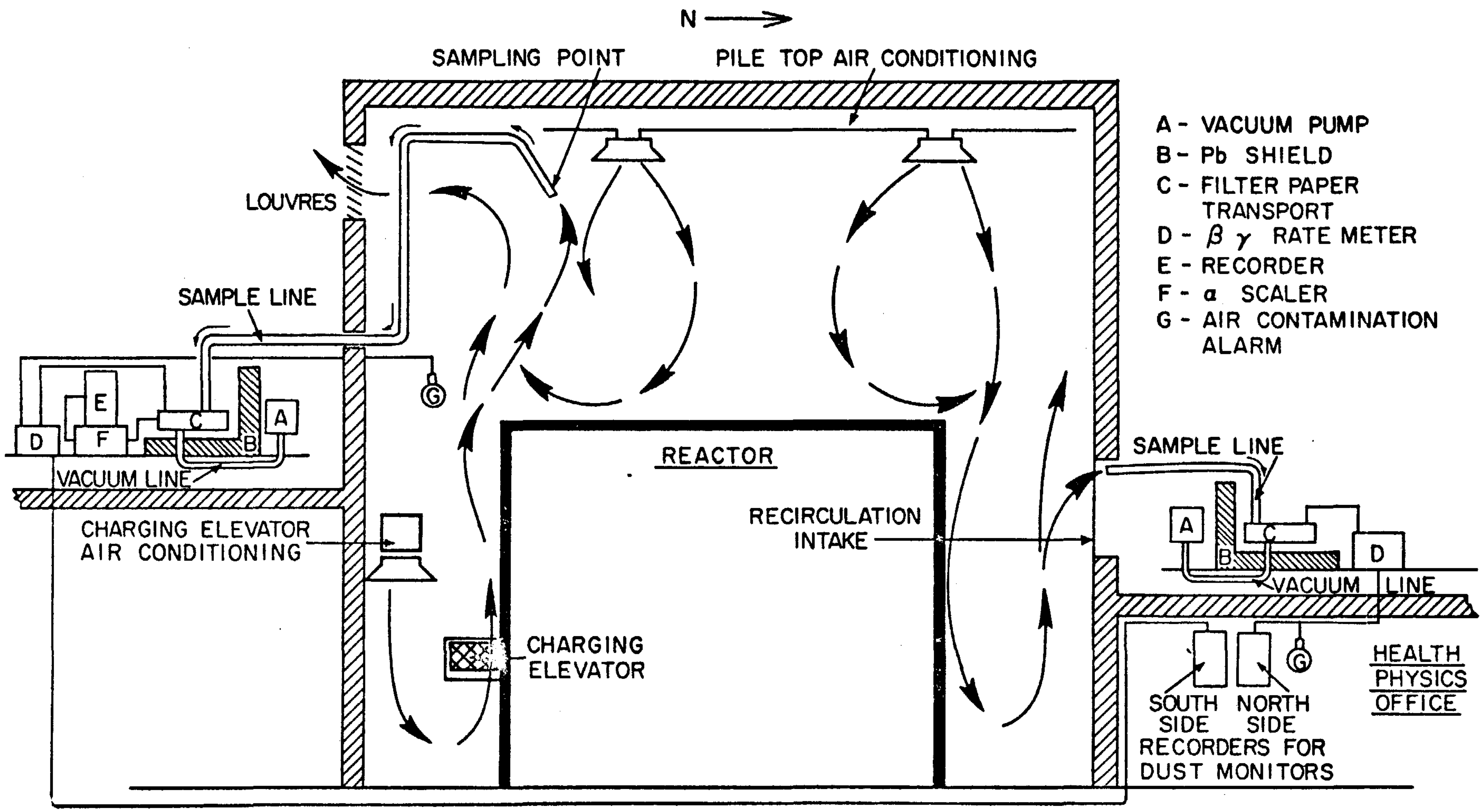
*Paper given at Air Cleaning Seminar at Argonne National Laboratory, November 2, 3, 4, 1955.

The dust collector and electronic counting equipment are surrounded by lead and are located in a room far removed from the contaminated air that is being sampled (see Figure 2). The only radiation the counter sees is the radioactive particulate matter that is pulled in from the pile room through the sampling tube and deposited on the filter paper. Because of the low background, it is possible to detect extremely low levels of airborne contamination. Increases in radiation background due to the naturally occurring radium and thorium products brought into the building during inversion conditions show clearly. Calibrations have been worked out showing concentrations of airborne activity due mostly to escaped fission products in the pile room vs recorder readings.

To carry off the more than 25 million watts of heat per hour from the Brookhaven Reactor, a tremendous amount of cooling air is needed. Approximately one million pounds of air per hour is pumped through it by four 1500-horsepower fans. The air is filtered before it enters the pile by American Air Filter FG-100 deep-pocket filters and again before it leaves the pile by Dollinger Glasstex deep-pocket filters. Most of the activity discharged up the stack is due to the radioargon. However, there is a small amount of unavoidable particulate activity.

To monitor this particulate activity, a dust collecting probe has been inserted in the air stream at the base of the stack (see Figures 3 and 4). This tremendous quantity of cooling air is sampled as nearly isokinetically as possible with the sample being pulled through a 3-inch flexible tube from the sampling nozzle and then through a flow meter and filter paper. The sampling rate is about 1.5 cu.ft./minute. Five minutes after collection, a scintillation counter sees the collected particulate activity on the filter paper, feeds the signal through a logarithmic rate meter circuit (range from $10-10^5$ counts/sec) and into a recorder.

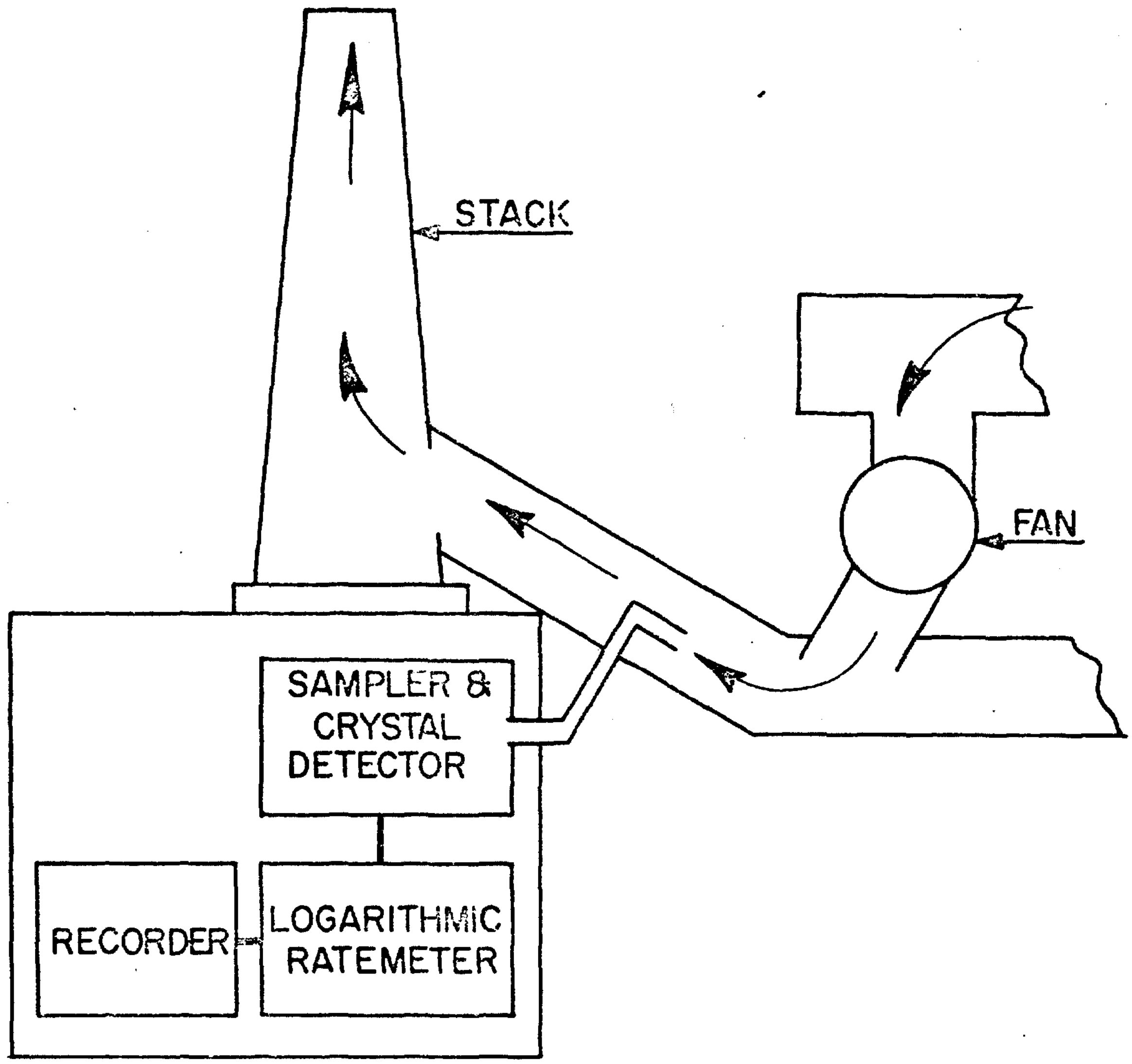
The usual air sampling and quantitative assay problems are present in both of these installations. However, both are continuous monitors, they each have good sensitivity and prompt response, so are effective as survey detectors during unusual or emergency conditions.



HEALTH PHYSICS AIR MONITORING SYSTEM
SCHEMATIC ARRANGEMENT

Figure 1

Figure 2



STACK AIR MONITORING SYSTEM
SCHEMATIC ARRANGEMENT

Figure 3

Figure 4

A REVIEW OF AIR CLEANING EXPERIENCES IN VARIOUS FACILITIES AT THE HANFORD PLANT

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The types of filtration and the maintenance, including replacement of filters used in supply and exhaust systems, is of a direct concern to the engineer in charge of maintaining ventilation balance at the Hanford plants.

In order that his problems be appreciated, it is perhaps necessary to follow the air movement through a typical building from the supply fan intake to the final discharge at the stack to the atmosphere.

First, the air is drawn into a supply unit or series of supply units, passing successively through a bank of dry filters (usually pleated media or wire maze filters), preheaters, spray washer (which may or may not include a bank of wet filters), and reheater, from which it is discharged by the fan either to a plenum or directly into a distributing duct system to various parts of a building.

As our interest at this session is mainly concerned with filtration, let us pause and discuss the filter media used for the dry filters.

When the Hanford plant first commenced operations, a commercial type filter paper airmat was used, which, although it supplied the necessary filtration, was easily torn in handling or when being pleated in the machine used for forming the replacement. Considerable fog is experienced during the fall and winter months and the paper media being very absorbent, would load up with moisture, causing the pressure drop across the filter to increase, which in turn would cause the filter media to rupture. Freezing of filters would add to this problem.

The maintenance of these filters (as many as twenty fan units in some buildings) was time consuming, inconvenient, and costly.

It was practically impossible to maintain a regular supply of ventilation air under these conditions so the ventilation balance suffered as a result. In latter years, a fiberglas media has been in use which has reduced the maintenance costs and shutdowns of the equipment approximately 75%, greatly facilitating the maintenance of ventilation balance.

The possibilities of using an electrostatic attraction filter has been investigated to some extent. It is a good dust collector, is fairly rugged, and can be rinsed out and reused indefinitely. Unfortunately, to use them, the filter bank frames of our present units would need a great deal of remodification. Another reason why we cannot use them is that all our supply fan intakes are classified as radioactively contaminated zones, and the rinse water used would have to be routed to a process sewer. It could not be turned into the sanitary floor drain within the unit.

The replacement of the filter media now in use is a nuisance job, and because of its possibly contaminated condition, has to be performed under "Special Work Permit" conditions (hereafter in this discussion will be termed SWP). This permit describes the type and number of items of protective clothing required, type of mask to be worn, and time exposure limit per man, etc. Great care must be taken to prevent the spread of dust when replacing these filters.

In some Hanford buildings, a room with a good source of exhaust has been set aside for this purpose. A layer of airmat filter is placed over the exhaust grill to prevent dust being borne to the exhaust system. This airmat has to be changed frequently as it builds up rapidly.

The filter frames are carefully removed from the filter bank, placed in fiber-board cartons, and moved to the filter changing room where the frames are refilled and the dust contained within this room.

The wet filters, where used, are fiberglas packs placed in frames and are easily replaced.

The replacement of these wet filters would be less frequent were it not for the calcium deposits picked up from the spray water. There are various additives which can be used to prevent this build up. Our experience has been such that the additives are expensive to use, and, if manually applied, not too effective.

We have found that most of the build up first occurs around the edges of the filter and gradually spreads to the center, eventually covering the entire filter. By test, we have found that this is caused by the spray nozzles only partially covering the filter and that if the nozzles are adjusted to overlap each filter, that the build up is much slower and in some cases eliminated. The entire filter must be kept wet as long as air movement is through it. Frequent inspection of the nozzles is necessary as they plug easily, resulting in a distorted spray.

Another method tried at Hanford is to proportion condensate from heating coils into the spray water. This is effective not only in preventing build up, but also to remove the deposit after it has formed. The pH value of the resultant spray water must be watched closely to maintain it slightly below neutral. A pH of 6.5 is recommended. If the pH is maintained too low, corrosion of the filter frames, spray water tank, etc., will result. Alternately lowering and raising the pH value has been found to maintain the internals in good condition.

Let us again follow the air movement. After the supply air has been filtered, washed, and tempered, it is discharged either to a plenum or directly into a distributing duct system and is delivered to the various building spaces, proportioned to requirements.

So far we have discussed problems with which ventilation engineers in all industries are familiar.

In nucleonics buildings we have to zone each area and each space within an area. The direction of air flow must always be from the clean, or noncontaminated zones towards the potentially or positively contaminated zones. This is accomplished by maintaining carefully calculated static pressure differentials between the zones. Often, as little as 0.005" w.g. is sufficient to accomplish this. It can readily be seen that careful and absolute control of the ventilation balance is necessary so that flow reversals will not occur.

The air is exhausted from the spaces, either through hoods or exhaust grills. There are usually three types of hoods: open face, sliding door face, and closed hoods. The open face and the sliding door face hoods are exhausted usually through a C.W.S. type filter at the transition between the hood and the exhaust duct system, or several hoods may exhaust into a filter box containing a series of C.W.S. type filters. A flow of from 100' to 150'/M is usually required for openings into these hoods, dependent on hood function. Most hoods receive their supply from the room spaces, through either the adjustable sliding door or other openings to the hoods.

The closed hoods as the term implies, are totally enclosed, receiving their supply through C.W.S. type filters or a regulated duct system as in the remote line systems. The filters are placed over small openings in the hood casings and are actually used to prevent or alleviate contamination spread in case of a flow reversal from the hood into the surrounding space. These hoods require very little air flow, the pressure differential between the hood and the space being the important factor.

Throw-away filters (Dustops) are in some cases placed over the faces of expensive filters to catch lint, Kleenex, etc.

Many types and designs of controllers are in use to control the quantity of air flow through these hoods and to make up for the build up of filters. We will not attempt to cover them at this time.

It can readily be seen that exhaust filters play a very important part in maintaining ventilation balance in addition to the filtration they provide. The high degree of filter efficiency demanded (up to 99.95% for submicron particles) requires a filter that is compact and capable of high collection. Thus, the filter is dense and closely woven and is easily plugged. This plugging increases the pressure drop across the filters, reduces the flow, and upsets the balance.

To give some idea of the extent to which the C.W.S. type filters are used, in one building, over a thousand of these filters of various dimensions are in constant use. Some of them have been in service for over five years and others are replaced frequently, dependent on location, usage, and durability. The condition of these filters has a direct influence on the ventilation balance of the building.

It is obvious from the foregoing that the ease of replacement, durability, and condition of filters are items of great interest to the ventilation engineer. Each time a filter is changed, or a piece of equipment is out of service, the engineer usually has to make some counteractive adjustment.

Owing to their usually highly contaminated condition, very careful methods must be employed when changing these exhaust filters. At Hanford we use the plastic bag method wherever possible. The filters are removed from their frames and, with as little movement as possible, are sealed in plastic bags. Sometimes it is necessary to erect temporary enclosures around a filter box before the plastic bags are used. In each case, the spread of contaminated dust is contained within small areas. Most filter changes are made under S.W.P. conditions, sometimes under extremely short time limits. In one case, as short as thirty seconds. The multiplicity of man power and labor cost required to cover this kind of work is terrific. The need for a filter capable of withstanding high pressure drops and still maintaining its filtration and flow characteristics is urgent. The C.W.S. filter, because of its excellent filtering qualities, was thought to be the ideal filter for our use until the inflammable nature of the media was realized.

Tests under simulated conditions were conducted which proved that, although the filters appeared hard to ignite from sparks (during the tests), once fired by direct flame were extremely hard to extinguish. Application of CO_2 and then water applied to one side of the filter failed to extinguish the fire. Water had to be applied at both sides of the filter bank and then the filters had to be torn apart before the fire was completely extinguished.

As a result of these tests, the search for an all-purpose filter was instigated. After a very short functional test because of the urgency, an absolute filter was selected because of its apparent ruggedness and fireproof qualities.

This filter, although possessing the filtration and fireproof qualities desired, was soon found to be unsuitable for our particular needs. In one building, all C.W.S. filters were discarded and replaced by the absolute filters. After a short time of service, it was noted that contamination in the stack emission had increased. Careful inspection of the exhaust systems revealed that under normal ventilation conditions, with an average relative humidity of 50%, the cement used to bind the filter media and separators to the frames, had disintegrated, permitting separation of the components, thus allowing contamination to by-pass the media. Efforts have been made by the manufacturer to overcome this difficulty by treating the frames and outside edges of the binder with a waterproof mixture. But, within the filter itself, the binder is still subject to decomposition. It was also noted that the corners of the metal frames were not airtight and that the cement would break away from the perforated sides of the frames, providing additional sources of by-pass air. It was also noted that the aluminum separators erroded rapidly under minor acid fume concentrations and if used in the horizontal position, the filter would collapse at loss of the support provided by the separators.

Since these difficulties were noted, the use of the absolute filter has been discontinued and the use of C.W.S. filters resumed, until a supplier can be found who can provide a filter that will meet with our requirements.

As moisture appeared to be the main cause of filter breakdown, several moisture tests have been conducted on various manufacturer's products which were available, using an apparatus designed for this purpose (include reports, photos, etc.).

Much of the discussion so far has been about primary filters. After the ventilation air has passed through the primary filters it is again subjected, in most cases, to further filtration before being discharged through stacks to the atmosphere. This is accomplished by several methods at the Hanford plant, including sand filters, fixed bed filters, and specially designed filter rooms containing banks of C.W.S. type filters.

No attempt is being made in this paper to discuss the merits of these final filters, however, a brief discussion of their construction and characteristics might not be amiss.

The sand filters are costly in construction, as usually a great deal of excavation and heavy concrete installation is necessary. The sand layers progress from very course at the filter intake, to fine grain at the outlet. The filter bed has to be of large area so that the velocity is kept at a minimum. High velocities would cause fluidization of the layers. The life of the filter bed is not actually predictable and the filtering sand cannot be replaced. When the sand filter has outlived its usefulness, it must be abandoned and a new one constructed. One of the advantages of the sand filter is that it requires no maintenance. Fixed bed filters consist of several layers of fiberglas in bulk of varying diameters and densities, progressing from course at the intakes, to fine at the outlet.

The beds are packed according to calculations. The advantages of this filter are that less area is needed than the sand filter and usually the initial pressure drop across the filter is less for the same amount of flow.

Both the sand and the fixed bed filters have been in use in the Hanford plant for a number of years. In one plant, the fixed bed filter had become plugged, reducing the flow to the point where something had to be done about it. Manually removing the contaminated filter bed is a tremendous job, and owing to the high degree of contamination, the very low time limits per man per day, and the number of men involved, makes it extremely costly. It was found by taking pressure drops across the four layers of varying sized fibers, that the three top layers, because of their finer texture, had collected most of the particles. It was decided to remove these three layers only. This cut the cost of replacement considerably as the time limit per man on the third layer was only three minutes and below that it would be down to seconds. The filter fiber had to be removed manually. Pitchforks were used and the material carefully placed in plastic bags for removal. Owing to the very short exposure time limits, a considerable number of men were required to perform this operation. Work of this nature is extremely costly. Very little is accomplished by each man and when exposed to the daily limit, in this case three minutes, his usefulness in any contaminated zone for the rest of the day is eliminated. In addition to the labor costs, the shutdown cost must be considered.

Prior to the above operation, the ventilation engineer had to take precautions against reversal of flows within the building affected, and also assist in preventing contamination spread in the area in which the work was being done.

The exhaust system in another building includes a set of nine large filter rooms. Each filter room has a bank of 112 or more C.W.S. filters. These filters have been in use for approximately five years. During this time, all filters in two rooms were changed. We have since initiated a program of vacuum cleaning the intake side of the filters, removing the lint collection, and thus prolonging the life of the filters. The replacement of these filters is comparatively easy. Neoprene curtains are provided to cover the intake and discharge openings, thus containing the dust particles loosened in handling in the filter room itself. The filters are removed and carefully placed in paste board boxes, sealed, and removed to the burial grounds.

The possibility of using this type of filtration, instead of sand or fixed bed filters for all final exhaust systems, is being presently investigated at the Hanford plant. This is contingent on finding a suitable fireproof filter. The filter rooms could be constructed above ground level, would be easily accessible, and means could be devised to change banks of filters by use of a crane. Standby rooms could be available so that plant shutdown would be avoided.

The ventilation engineer is vitally concerned with all types of filtration uses, as the plugging of filters, their replacement, and shutdown of systems all affect ventilation balances. Even the most insignificant filter has some effect on ventilation balance. The multitude of small filters used in closed process systems are of direct concern to him as they often control the number of air changes within a ventilated space and the differential pressures between the systems and surrounding areas.

Meanwhile, the search for the ideal filter continues.