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MATERIALS TESTING REACTOR PROJECT

ARGONNE NATIONAL LABORATORY

DESIGN REPORT No. 32

MTR EXTERNAL AIR SYSTEM

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1.0 Statement of Problem

The Materials Testing Reactor external air system is that group of facilities which collects, processes, and disposes of all radioactive air that requires dispersal into the atmosphere through the main stack. The greatest volume of this air comes from the reactor cooling air system. The remaining small portion comes from the contaminated air system which provides outlets for radioactive gases in the laboratory hoods and caves.

The system will consist of ducts from the reactor building and reactor building wing to the filter and fan building. If necessary, the air will pass through filters before passing into the fans or blowers. The air exhausted from the fans and blowers will be collected into a single duct leading to the stack. The stack will be high enough to assure that radiation exposure from these stack gases will not exceed tolerance anywhere on the site. The arrangement should provide for future expansion without major alterations to the existing system.

2.0 Proposed Design

The external air system consists of two separate systems which connect into one on the exhaust side of the blowers and fans. The two systems are considered separately in succeeding paragraphs and then jointly in the discussion on the filter and fan building and stack.

The reactor cooling air ducts leaving the reactor are 2.5-foot square. These will connect to a single 4-foot square duct below the basement floor of the reactor building. The 4-foot duct leads to the filter cells of the filter and fan building. Three filter cells in parallel are provided. Each cell will contain two filter beds in series. The air will first pass through a bed of American Air Filter Company Airmat deep bed filters. The filters in the second bed are Chemical Warfare Service No. 6 filter units. The air passes from the individual filter cells into a plenum chamber, which is connected to the exhaust blowers and shutdown fan. There will be three one-half capacity blowers in parallel; any two of these blowers will operate when the reactor is at normal (30,000 kw.) power level. The shutdown fan will serve to cool and provide sufficient air flow through the reactor during shutdown. The air leaving the exhaust blowers or shutdown fan passes into a common duct leading to the stack.

The contaminated air system will have 2-inch diameter openings in the hoods and caves in the laboratories of the reactor building wing. A 2-inch diameter pipe or tube will lead from these openings to a 4-inch diameter line in the basement and then to a 6-inch diameter header in the service corridor. The 6-inch diameter header will lead to the scrubber at the south end of the wing basement. The pipe from the scrubber to the filter and fan house will be 12 inches in diameter.

There will be two full capacity fans, one of which will serve as a standby. The air from the fans enters the common exit duct leading to the stack.

The filter and fan building is so arranged that the tops of the filter cells are at ground level. The blower and fan cells are above ground while all ducts are below ground level. The tops of the filter and fan cells are removable.

The stack will be whatever height and diameter are specified as design requirements. These specifications have not as yet been determined.

Drawings which show layouts of the system accompany this report.

3.0 Recommendations

It is recommended that detailed engineering proceed on the design proposed in this report. This will include building and duct layouts, selection of equipment, determination of instrumentation, and establishment of operation procedures.

Studies will have to be made to insure proper operation of the reactor air cooling system under all conditions. This applies specifically to instrumentation, operation of valves, and operation of the blowers in the event the pressure drop through the reactor air system is much less than the 50 inches of water established as the design value. Where valves and manholes are provided in the ducts and cells, care must be taken to assure that adequate shielding is provided.

Further studies of the stack height problem and the probability of omission of filters from the reactor air system are necessary. These are being continued at Argonne National Laboratory.

An alternate method for arrangement of the filter and fan building is presented in "Air Handling Facilities for High Flux Pile", H.E. Goeller, CF-49-4-147. It should be noted that the size of the system is now greater than it was at the time the above report was written.

4.0 Detailed Disclosure of Problem

The MTR external air system is a combination of the reactor cooling air and the contaminated air systems. For convenience, these are discussed separately in regard to their general requirements, and then jointly with respect to the filter and fan building, stack, shielding, and instrumentation.

4.1 Reactor Cooling Air System

The reactor cooling air system is a secondary cooling system for the Materials Testing Reactor. The design within the reactor has been covered by "MTR Report on Internal Air System," W.R. Gall, CF-49-11-208. The external part of the reactor cooling air system is that part through which the air passes after it leaves the reactor structure. The design of the external air system is largely determined by the requirements of the internal air system as given in the above mentioned report. Some corrections and changes have been made in the data taken from that report.

4.11 Capacity and Pressure Drop

The flow of air through the reactor has been set at 2,000 lb/min. The pressure drop for this flow has been set at 40 inches of water from the reactor inlet to the thermal shield exit. It is noted that this pressure drop was calculated using the Chilton-Colburn equation for the pressure drop through the graphite ball zone. Experiments conducted at Argonne National Laboratory using 1-inch diameter graphite balls, and equations by Burke-Plummer and Morcom, indicate that the actual pressure drop may be only two-thirds of the value given by the Chilton-Colburn equation. Thus, while the maximum pressure drop for a 2,000 lbs/min flow through the system is set at 50 inches of water, the actual drop for the same flow may be as low as 35 inches of water with dirty filters, 29 inches of water with clean filters, or 27 inches of water without filters.

4.12 Exit Ducts

The 2.5-foot square ducts leading from the reactor will connect to a single concrete duct beneath the basement floor. This duct will lead to the filter and fan building. The distance from the reactor to the filter and fan building is about 500 feet. The duct will be underground and will be covered with sufficient thickness of earth to provide adequate shielding against radiation. If the duct does come near or above the ground, the thickness of the duct may have to be increased above structural requirements to provide enough shielding. A drain will be provided at the lowest point of the main duct and will be connected to the effluent control system. There will be manholes provided for accessibility to the main duct at a point near the reactor building and at the filter and fan building.

4.13 Filters

The reactor cooling air may or may not require filtering before it is dispersed into the atmosphere. This matter will be investigated further. At the present time the general opinion is that filters will be necessary, and the design will be undertaken on this basis. The design will be completed on the basis that filters are necessary. The filtering media will give an efficiency equal to that obtained by passing the air through a single layer of American Air

Filter No. 25 Filterdown followed by a single layer of No. 50 Filterdown, and then through Chemical Warfare Service No. 6 filter paper.

4.14 Exhaust Blowers

The exhaust blowers for normal (30,000 kw.) operation will handle the amount of air and operate under the conditions specified in sections 4.11, 5.1, and 5.2. If (n) blowers are required for normal operation, (n + 1) blowers will be provided. This will permit the operation of the reactor to continue in the event of failure of one of the blowers or motors. The exhaust blower motors will be supplied with normal commercial electricity only. It is recommended that the impellers of the blowers be of steel. This will facilitate decontamination of the blowers in the event repair work is necessary. Since the established pressure drop of 50 inches of water may be considerably above the actual pressure drop at the normal air flow it is recommended that blowers with inlet-diffuser of pre-rotation vanes be obtained. This will permit operation with normal air flow but at a reduced head, with a resultant saving in power.

4.15 Shutdown Air Flow

During shutdown of the reactor it will be necessary to maintain a flow of air through the reactor to cool the graphite and to assure there will be no flow of air from the reactor out into the reactor building. The capacity of the fan required during shutdown has been set at 5,000 cfm. The total pressure drop through the system for this flow will be approximately 2 inches of water. The shutdown fan will receive its power from three separate sources, any one of which may be used. The three sources are: 1) normal commercial electricity; 2) site-produced emergency electricity; and 3) direct gasoline or diesel engine drive.

4.16 Operation of Reactor Air System

During normal (30,000 kw.) operation of the reactor the cooling will be provided by the exhaust blowers which will be supplied by normal commercial electricity. During a normal shutdown period the shutdown fan, powered by normal commercial electricity, will provide cooling. During an emergency accompanied by the failure of the commercial supply of electricity the operation will continue at 30,000 kw. for a period of 30 seconds. During, or at the end of this period the shutdown fan will start up automatically, being powered by either of its other two sources of power. The reactor will not be operated at any power level if the shutdown fan or its gasoline (or diesel) engine drive is in a state of repair.

4.2 Contaminated Air System

The contaminated air system removes the radioactive gases from the hoods and caves of the laboratories. There will be one off-gas line from each hood or cave. The volume of air to be handled by each off-gas opening is to be not less than 50 cfm. It has been estimated that in the present design there will be 40 hoods and that the total number will not exceed 80 in the immediate future. It can be assumed that the 80 hoods will be divided equally between chemists and physicists. Normally, only those hoods being used by chemists will require use of the off-gas openings, and it is estimated that no more than one-fourth of these will be in use at any one time. The maximum volume of air from the off-gas openings will then be 500 cfm. A scrubber will be necessary to remove acid vapors from the active gases before they reach the fan. The scrubber, and the ducts preceeding the scrubber, will be sized for 500 cfm. The part of the system following the scrubber will be sized for 1,000 cfm. This will provide an excess capacity which is then available for any unforseen sources of radioactive gases requiring dispersal into the atmosphere through the main stack. Since the amount of air through the system will be varying frequently and over a wide range, it will be desirable to keep the pressure drop through the system at a minimum.

All lines preceeding the scrubber are to be of acid resistant material, while those following the scrubber may be of carbon steel. It is believed that the scrubber will provide sufficient filtering. Therefore, filters will not be incorporated in the design of the system. However, space will be provided so they may be added at a later date if necessary; this areamay be labeled as "future". If filters are provided, they will be of the paper type only and will have a filtering efficiency equivalent to CWS No. 6 filter paper. There will be two fans provided, one of which will serve as a standby. These fans will be supplied with normal commercial electricity and also with site-produced emergency electricity. The exhaust side of the fans may connect to the same duct that conveys the reactor cooling air to the stack.

Shielding of the system will be discussed in section 4.5.

4.3 Filter and Fan Building

The filter and fan building will house the filters and fans for both the reactor cooling air and the contaminated air systems.

4.31 Filter Cells

The design will include filter cells for the reactor cooling air, but not for the contaminated air. The filter cells for the reactor cooling air will be so arranged that construction with or without them will require no major change in design. Also, if construction is without filter cells, no major alteration to existing construction should be incurred by their addition. The air flow will be through a number of parallel cells so that one cell may be shut down without requiring shutdown of the reactor. Valves will be provided at the inlets to and the outlets from the filter cells. These will be manually controlled and will require only two positions, either open or shut. The cells will be shielded against radiation. Drains will be provided in the cells; it will be necessary to use the drains only during filter changes or cleaning. These drains and others in the blower cells and ducts of the filter and fan building may lead to a tank below the building floor. The active waste may be pumped from this tank to the retention basin. Provisions should be made for the safe removal and disposition of the radioactive used filters.

4.32 Blower and Fan Cells

Each blower or fan will be housed in its own cell to facilitate repair without shutdown of the entire system. The cells will be readily accessible for inspection or minor servicing. It is not necessary to have the cell size and arrangement such that major repairs to the blowers or fans can be made within the cell. It is only required to provide for removal of the units from the cells in the event they require repair.

Valves will be provided at the entrance to and exit of the air ducts in the reactor blower cells. The valves will be such that one of them, preferably on the exhaust side, will close when the fan or blower is shut down. This will prevent circulation through the blower when it is not in use. It is not necessary for this valve to seal air tight to satisfy the above requirements. The valve on the exhaust side of the blower will be such that it can be made to seal air-tight when it is desired to repair or remove the unit. This is required to prevent radioactive air from entering the cell if such work is being done while the remaining system is in operation. A method of controlling the amount of air flowing through the system should be provided. This control may be automatic if absolutely necessary.

The valve requirements for the shutdown fan and contaminated air fans will be the same as required for the exhaust blowers, except that control of the air flow through the system will not be necessary.

4.33 Additional Requirements

The ducts of the two systems may be connected to a single duct on the exhaust side of the blowers and fans. This duct will lead directly to the stack. Where practical, ducts will be supplied with drains and manholes.

In general, construction of the ducts, filter cells, and fan cells will be of poured concrete. The thickness of the concrete should be sufficient to provide adequate protection against radiation. (See Sec. 4.5). Where additional shielding, such as earth, is present the thickness of the concrete may be reduced to structural requirements. Doors to the fan cells will be of steel and, again, thickness

[redacted]

may be determined by shielding requirements. The construction of the remaining parts of the building will be the same as that used on other buildings of similar function; there are no special requirements.

There will be an instrument room provided in the building. This room will be separate from the room containing the fan motors and fan cells. It is planned that this room will be occupied continually by at least one person. This should be kept in mind when considering construction and facilities to be provided. Toilet facilities will be provided for one man. Services to be furnished will include electricity, steam, compressed air, sewer and water. Heating and ventilating requirements have not been determined other than that there will be six changes of air per hour in the instrument room and one or two changes per hour in the motor room.

4.4 Stack

The function of the stack is to eject the radioactive gases into the atmosphere at an altitude which is high enough to make sure that exposure to these gases does not exceed tolerance anywhere on the site. The location of the stack relative to the remainder of the site is almost ideal from the standpoint of wind direction. The prevailing direction of surface winds is southwest while the next most frequent direction is northeast. For both of these directions the passage over the site is short and over an area which is only lightly populated.

The height of the stack cannot be definitely established at this time as further study of the problem is necessary. Preliminary investigations in ANL-EKF-31 indicate that a stack height of 250 feet will suffice, and that the height may be as little as 200 feet. Until supplementary studies can be completed, the height of the stack will be set at 250 feet.

The exact diameter of the stack will be determined at a later date. Among references and persons consulted, there seems to be some disagreement at to the importance of a high exit velocity. Since this will determine stack design to some extent, it seems wise to postpone setting the actual stack diameter until the matter has had more consideration. For the present we will assume that the stack should be large enough to handle 80,000 cfm at an exit velocity not exceeding 4,000 fpm. The outlet diameter of the stack is then set tentatively at 5 feet.

The stack will be poured concrete construction. A door should be provided at its base for inspection purposes. Suitable aircraft warnings will be provided. There will be ladder rungs provided from the base to the top of the stack. This will permit inspection and determination of activity at the stack exit.

[redacted]

4.5 Shielding

The ducts and cells of the external air system must be shielded to keep exposure to radioactivity below tolerance. It is necessary to base the shielding calculations on some specified conditions. For this reason, the shielding specifications given are for the designs proposed in other sections of this report. These specifications, with slight modification, can be applied to any similar design. In any event, the final design will require a thorough shielding check. The tolerances listed below are applicable to any design.

Shielding Standards

Maximum permissible dose	0.3 r/week
Tolerance for areas continuously occupied	0.005 r/8 hr
Tolerance for areas not continuously occupied, but occupied frequently	0.05 r/8 hr
Tolerance for areas visited infrequently	0.1-0.2 r/8 hr
Tolerance for emergency maintenance, 30 minutes to one hour periods	0.3 r/8 hr

4.51 Reactor Air

The shielding thicknesses given below are taken from ANL-EKF-32, in which calculations are based on the proposed design for the reactor air system. In regard to the small thickness of shielding required for the blower and fan cells, it is pointed out that a point source of strength equal to the activity contained within the blower or fan was assumed to be two feet from the inside wall for the blower cells and one foot for the fan cells.

Shielding for Reactor Air System

	Tolerance, r/8 hr.	Shielding, cm.	
		Concrete	Steel
Ducts in reactor building	0.005		
2.5 ft. square		28.5	---
4 ft. square		36	---
Ducts outside	0.05		
4 ft. square		19	---
Filter cells on top or inside	0.1	30	---
Blower cells			
on top	0.1-0.2	S	S
inside motor room	0.1	S	S
outside building	0.05	3.5	1.5
within cell (blower shutdown)	0.3 (at wall)	S	S
Shutdown Fan cell			
inside motor room	0.1	S	S
outside building	0.05	1	0.5

(S - structural requirements only are sufficient.)

The tolerance within the instrument room of the fan and filter building will be 0.005 r/8 hr. It will not be necessary to provide shielding at the inside wall as structural requirements and geometry will assure that tolerance will not be exceeded.

If it is desired to substitute earth shielding for concrete, the thickness of the earth should be approximately twice that of the concrete.

4.52 Contaminated Air

The shielding calculations are reported in ANL-EKF-35. The assumptions are similar to those used in the reactor air shielding calculations. The shielding thicknesses based on the proposed design are given below.

Shielding for Contaminated Air System

	Tolerance r/8 hr	Shielding Material	Shielding Thickness, in.
Ducts in reactor building wing	0.3 at pipe, 0.005 at 1 ft.		
2-inch diameter		steel	1/16
4-inch diameter		"	1/8
6-inch diameter		"	1/4
Ducts outside	0.05		
1-foot diameter		earth	6
Fan cells			
inside motor room	0.1	concrete	2
" " "	0.1	steel	1/4
outside building	0.05	concrete	4

If the ducts in the reactor building wing are of steel and the wall thickness meet the above requirements, no additional shielding will be necessary.

4.6 Instrumentation

A thermocouple will be provided to monitor the temperature of the exit reactor cooling air. This may be either at the reactor or at the filter cells, or there may be thermocouples at both locations. An alarm will sound if the temperature of the exit air exceeds a certain predetermined maximum. This maximum allowable exit air temperature will be around 200°F. It is necessary to provide an instrument to determine the air flow in the reactor air system.

There will be a barometric type manometer to measure the static pressure at the entrance to the filter cells. This will give the pressure drop through the system up to that point. The pressure drop across the individual filter beds and across the filter cells will also be indicated by manometers or other suitable instruments.

Ion chambers will be located about one foot from the surface of the filter frames. These will determine the activity of the dust collected on the filters. An additional ion chamber will be provided in the fan house exit duct to determine the activity of the air being passed up the stack. All ion chambers are connected to electronic recorders.

The indicators and recorders of all the above instruments will be in the instrument room of the filter and fan building. Additional instrumentation will be necessary for the operation of the blowers, fans, and valves. The extent of this additional instrumentation has not been determined.

5.0 Design Data

5.1 General

Site Elevation, ft.	4,930
Barometric Pressure, lb/in^2	12.25

5.2 Reactor Air System

Flow into bottom of ball zone	1,610 lb/min
Flow through top thermal shield	250 lb/min
Allowed for leakage around beam holes, etc.	140 lb/min
Total air flow	2,000 lb/min
Air Temperatures	
Inlet to reactor	75 - 100°F
Outlet from reactor	190 - 215°F
Maximum total pressure drop	50 inches H_2O
Pressure drop from reactor inlet to thermal shield exit	40 inches H_2O
Reactor exit ducts	
Number	2
Size	2.5 ft. square
Maximum exit volume (215°F)	41,000 cfm
Shutdown air flow	5,000 cfm
Shutdown pressure drop (total)	2 inches H_2O

5.3 Contaminated Air System

Number of off-gas openings	
in present design	40
maximum to provide for	80
Minimum flow per off-gas opening	50 cfm
Maximum flow (based on ten in use)	500 cfm
Capacity of fan	1,000 cfm

5.4 Filters

American Air Filter Co. Airmat Deep Bed Filters

Size of unit	2'-3" square x 3' deep
Weight	180 lbs.
Rating	1,000 cfm
Filtering area	50 ft.
Initial resistance at 1,000 cfm	
Two thicknesses of No. 50 FG, Filterdown media	1.0 inch H_2O
One thickness of No. 25 and one thickness of No. 50	0.6 inch H_2O
Recommended maximum resistance (dirty)	6.0 inches H_2O
Discoloration efficiency, atmospheric dust, one thickness No. 25 and one No. 50	88.6%

Chemical Warfare Service No. 6 Filter Units

Size of unit	2 ft. sq. x 1 ft. deep
Weight	46 lbs.
Rating	600 cfm
Filtering area	164 ft.sq.
Initial resistance at 600 cfm	1.1 inches H_2O
Recommended maximum resistance (dirty)	2.0 inches H_2O
Efficiency, radioactive dust	99.87%

6.0 Detailed Disclosure of Design Proposal

The two component systems and the filter and fan building are discussed somewhat in detail. The stack design, instrumentation, and operation of the system will be consistent with requirements established in sections 4.16, 4.4, and 4.6.

6.1 Reactor Cooling Air System

6.11 Exit Ducts

The 2.5-foot square air ducts within the reactor structure will join a 4-foot square duct below the basement floor. The lengths of the two 2.5-foot ducts will be approximately the same. This will assure almost equal flow out of the two corner exits of the top reactor plenum-chamber. The 4-foot square duct will be of poured concrete. Since the duct is a sufficient distance below ground, the thickness of the concrete will be determined only by structural requirements. The layout of the duct system is shown by MTR-3067-C which accompanies this report. Drains and manholes will be provided as specified in section 4.12.

6.12 Filters

The air will travel through three parallel cells of filters. Each cell will contain two beds of filters. For convenience, the filters used in the first bed will be called roughing filters, while those in the second bed will be called polishing filters. The roughing filters will be American Air Filter deep bed filters filled with a single layer of No. 25 Filterdown followed by a single layer of No. 50 Filterdown. The polishing filters will be Chemical Warfare Service No. 6 units. General data on these filters are given in section 5.4. There will be 16 units of AAF filters and 25 units of CWS filters in each cell. The layout and filter cells are discussed in section 6.31. Experience at the ORNL X-10 pile indicates that the lives of the filters will be about 12 months for the roughing filters and 18 months for the polishing filters. However, since the air entering the MTR is subjected to a finer degree of filtering than that which enters the X-10 pile, these lives may be greatly exceeded.

6.13 Exhaust Blowers and Shutdown Fan

There will be three one-half capacity exhaust blowers and one shutdown fan. The blowers will be powered by commercial electricity supply. Two blowers will be used for normal operation while the third will serve as a spare. Each blower will be capable of delivering 20,500 cfm at 215°F against a head of 50 inches of water. The shutdown fan will be a conventional fan capable of handling 5,000 cfm at 70°F against a head of about 2 inches of water. The fan will be supplied with commercial electricity and with site produced emergency electricity. The fan will also be driven directly by a 5 HP gasoline engine. For normal shutdown the commercial electricity supply will be used. The control will be such that the fan will automatically start by either the site produced emergency electricity or the gasoline engine when normal commercial electricity fails. The exhaust sides of the fans and blowers connect to a 6-foot square duct leading underground to the stack.

In section 4.16 it has been specified that the reactor will not be run when the shutdown fan is down for repair. To keep reactor down-time to a minimum it is recommended that spare parts for the shutdown fan and drives be kept on hand.

6.2 Contaminated Air System

This proposed design for the contaminated air system is intended to inform the reader as to what thoughts have been prevalent at ANL in regard to this problem. It is believed to be a workable solution, but it is by no means the only solution. An endeavor was made to keep the pressure drop low for the maximum expected flow. The total pressure drop through the system for a flow of 500 cfm up to the scrubber and 1,000 cfm after the scrubber is about 14 inches of water. Calculation of this pressure drop is given in ANL-EKF-37. A general plan of the ducts for the system is shown on MTR-3067-C.

6.21 From Hood to Scrubber, Inclusive

The gases that the system will handle will contain acid vapors, and the system requires use of acid resistant material up to the scrubber.

The off-gas opening provided in the hood or cave will be the open end of a two-inch diameter line. The off-gas openings will be provided with hinged covers. The two-inch line from the hood will run along the service strip and connect to a four-inch diameter duct where the line goes through the floor into the basement. The four-inch line will connect to a six-inch diameter header in the service corridor of the reactor building wing basement. The six-inch header will convey the gas to the scrubber. Acid resistant material will be used for the two- four- and six-inch lines. The scrubber will be located at the south end of the service corridor in the reactor building wing basement.

6.22 From Scrubber Through Fans

The line from the scrubber to the filter and fan house will be a 12-inch diameter pipe. It will not require acid-resistant material and may be of carbon steel with suitable soil protective covering. The line will be underground and will be adjacent to the reactor air exit duct as shown by MTR-3067-C. Depth underground will be sufficient to waive shielding of the duct.

Filters are not provided for this system. The area marked "future" adjacent to the contaminated air fan cells is provided for them if they are needed.

There are two fans provided for the system, are of which will serve as a spare. Both of these will be connected to commercial electricity and site produced emergency electricity. Each fan will deliver 1,000 cfm against a head of about 14 inches of water.

The exhaust sides of the fans connect to the six-foot square duct leading to the stack.

6.3 Filter and Fan Building

The design proposed for the filter and fan building was arrived at after careful consideration of the requirements of section 4.31 in regard to modifications. The general plan of the building is shown by drawings MTR-3065-C and MTR-3066-D which accompany this report. The cells, ducts, and servicing are discussed thoroughly in succeeding sections. The instrument room, facilities, and construction will agree with requirements of section 4.33.

6.31 Filter Cells

The filter cells provided for the reactor cooling air are in the ground, with the tops protruding about six inches. This is an ideal arrangement since it eliminates shielding of the sidewalls and facilitates filter changing. The filters of each cell are arranged in two horizontal beds. The first bed contains 16 units of the AAF filters; the bed is four units wide and four units long. The second bed contains 25 units of the CWS filters; the bed is five units wide and five units long. The filter units in these beds must be sealed at their edges to prevent by-passing of air around the filters. The tops of the cells are made up of removable slabs of poured concrete. These slabs will be one foot thick and will be designed so they can be sealed water tight by the use of suitable packing. Construction of the filter cells will be of reinforced concrete. The walls between cells will be a minimum of one foot thick. Other wall thicknesses are determined by what is required for shielding of the adjacent air ducts or by structural requirements. Each cell will have a three-foot diameter butterfly valve at each end. These butterfly valves will be controlled by manually operated hand-wheels at the top of the cells. The cells will be provided with drains and cell vents. The cell vents permit flushing the cells with outside air before they are opened for inspection or filter changing.

6.32 Blower and Fan Cells

The blowers and fans receive their air from plenum chambers beneath the cells and discharge to the six-foot square exit duct which is also below the cells. Butterfly valves which satisfy the requirements as given in section 4.32 will be provided on the inlets and outlets of the blowers and fans. The cells will be of reinforced concrete. The floors of the cell will be one foot thick. The walls of the exhaust blower cells will be of reinforced concrete and of thickness that will satisfy structural requirements only. The exhaust blower cells extend the full height of the building and have tops of removable concrete slabs similar to the filter cells. The cells containing the shutdown and contaminated air fans will be within the building proper and will be only three feet high. The walls of these cells will be a minimum of two inches thick poured concrete. The tops of these fan cells will be steel doors which are hinged at one side and can be swung upward when servicing is necessary. These doors will be a minimum of 1/4 inch thick. Entrance to the exhaust blower cells for servicing will be through conventional size steel doors; the minimum thickness of steel in these doors will be 1/8 inch. There will be drains in all cells.

6.33 Plenum Chambers and Exit Duct

The plenum chamber which receives the reactor cooling air from the filter cells is extended east out beyond the building. A manhole is provided at the top of this extension to provide access to the chamber. The plenum chamber beneath the contaminated air cells does not have an access port. The exit duct to the stack has a manhole at the east side of the building. This duct has its top at ground level and this side of the duct will then have to be approximately one foot thick concrete.

6.34 Maintenance

The only major maintenance to be considered is the changing of filters and the removal of exhaust blowers. In either case there is no permanent installation to facilitate the operations. A motor crane will be used for both operations.

The changing of the filters is the only maintenance which will take place at regular intervals and a definite procedure is necessary. The cell will be closed off in such a manner that a slight negative pressure is maintained. The filters will then be sprayed with "G.E. Special Cocoon" or similar protective coating to fix the radioactive dusts on the filters. After this coating is dry the filters will be removed. The CWS filters are housed in expendable wooden frames which may be buried or burned. The AAF units are not expendable. They will require removal to a decay storage area and after the activity has decayed enough the filtering media is removed and the protective coating stripped from the frame. An extra set of AAF filter frames will be available so that they may be ready for loading the cell when a filter change is necessary. After removal of the filters the cells will be washed down with water, and personnel outfitted with protective clothing and either supplied-air or self-contained masks will enter the cell and install the new filters.

C.F. Leyse
C.F. Leyse

CFL:rw

Approved by:

John R Huffman

[redacted]

APPENDIX I
Bibliography of Design and Development Reports

CF-49-4-147, "Air Handling Facilities for High Flux Pile", H.E. Goeller, 4-14-49

A proposed design for the external reactor air system based on information available at that time.

CF-49-11-208, "MTR Report on Internal Air System", W.R. Gall, 11-21-49

Summarizes the requirements for and design of the reactor internal air system.

ANL-JRH-20, "Heat Transfer and Pressure Drop Experiments", C.F. Leyse, 9-29-49

Report on experiments conducted at Argonne on a packed column of one-inch diameter graphite balls.

ANL-EKF-19, "Argon Activity from the Materials Testing Reactor", C.F. Leyse, 11-17-49

Calculation of radioactivity due to argon in the reactor cooling air.

CF-49-11-180, "Argon Activity in Reactor Cooling Air," J.A. Lane, 11-17-49

Argon activity and radiation at the ground from stack gases.

CF-49-11-219, "Air Cooling System", J.A. Lane, 11-23-49

Short discussion of the bases for the design of the reactor cooling air system.

ANL-EKF-28, "Maximum Temperature Rises in Graphite During Reduced Air Flow", C.F. Leyse, 1-6-50

The rates of heating up of graphite during 30,000 kw. power level and shutdown when there is no air flow.

ANL-EKF-29, "Cooling Requirements of Graphite After Shutdown", C.F. Leyse, 1-6-50

Determination of volumes of air required to cool graphite during shutdown period.

ANL-EKF-30, "MTR Shutdown Air Requirements", C.F. Leyse, 1-10-50

Shutdown air requirements based on an air velocity of 150 ft/min past plugs during plug removal.

ANL-EKF-31, "Preliminary Investigations of Stack Height", C.F. Leyse, 1-17-50

Determination of stack height necessary to assure adequate dispersion of the radioactive stack gases.

[redacted]

ANL-EKF-32, "Shielding of the External Reactor Air System", C.F. Leyse, 1-26-50

Shielding calculations for the proposed design of the reactor cooling air system.

ANL-EKF-35, "Shielding of Contaminated Air System", C.F. Leyse, 2-7-50

Shielding calculations for the proposed design of the contaminated air system.

CF-49-12-84, "MTR Shutdown Cooling Requirements", J.A. Lane, 12-16-49

The shutdown cooling requirements of both the water and air cooling systems.

ORNL-500, "Evaluation of Filtering Efficiency and Operating Life of FG Material Used in Pile Cooling Air Filter House", H.G. Savage, 12-1-49

Covers the experimental investigations of the relative efficiencies and operating life of three combinations of American Air Filter Company's FG filter media as used in the pile cooling air filter house at ORNL.

ANL-EKF-36, "Reactor Air System Pressure Drops", C.F. Leyse, 2-8-50

Pressure drop calculations for normal and shutdown air flows through the reactor air system.

ANL-EKF-37, "Pressure Drop Through the Contaminated Air System", C.F. Leyse, 2-9-50

Pressure drop calculations for a proposed design of the contaminated air system.

APPENDIX II
Reference Drawing List

DRP-50	Pile Structure - Outlet Air Ducts - Fundamental Dimensions, 7-20-49
DRP-69	Reactor Structure - Air and Water System - Fundamental Dimensions, 11-9-49
DRP-60	Reactor Structure - Pictorial View
DRP-62	Reactor Structure - Plan View
MTR-3065-C	Vertical Section Through Filter and Fan Building, 1-31-50
MTR-3066-D	Plan View of Filter and Fan Building, 2-3-50
MTR-3067-C	Reactor and Contaminated Air Ducts, 2-7-50

APPENDIX III
Reference Personnel

Argonne National Laboratory (External Air System)

J.R. Huffman - Design Development
Bldg. 10, Room 22, Extension 147-146

E.K. Falls - Design Calculation
Bldg. 10, Room 21, Extension 147

C.F. Leyse - Design Calculation
Bldg. 10, Room 26, Extension 79

Oak Ridge National Laboratory (Internal Reactor Air System)

W.R. Gall
R.M. Jones
J.R. McWherter

[redacted]

APPENDIX IV
Alternate Design Studies

The design proposed for the filter and fan building was developed through a series of changes of the original plan. The general plan of the building has not changed much from the original layout. The major changes are: (1) the filter cells and ducts have been placed below ground level; (2) the cells for the shutdown and contaminated air fans have been made smaller.

There is also a previous report on the external reactor air system, CF-49-4-147 by H.E. Goeller of ORNL. The present design has been chosen because it is more susceptible to modification than that presented in CF-49-4-147 and also because it is a neater layout.

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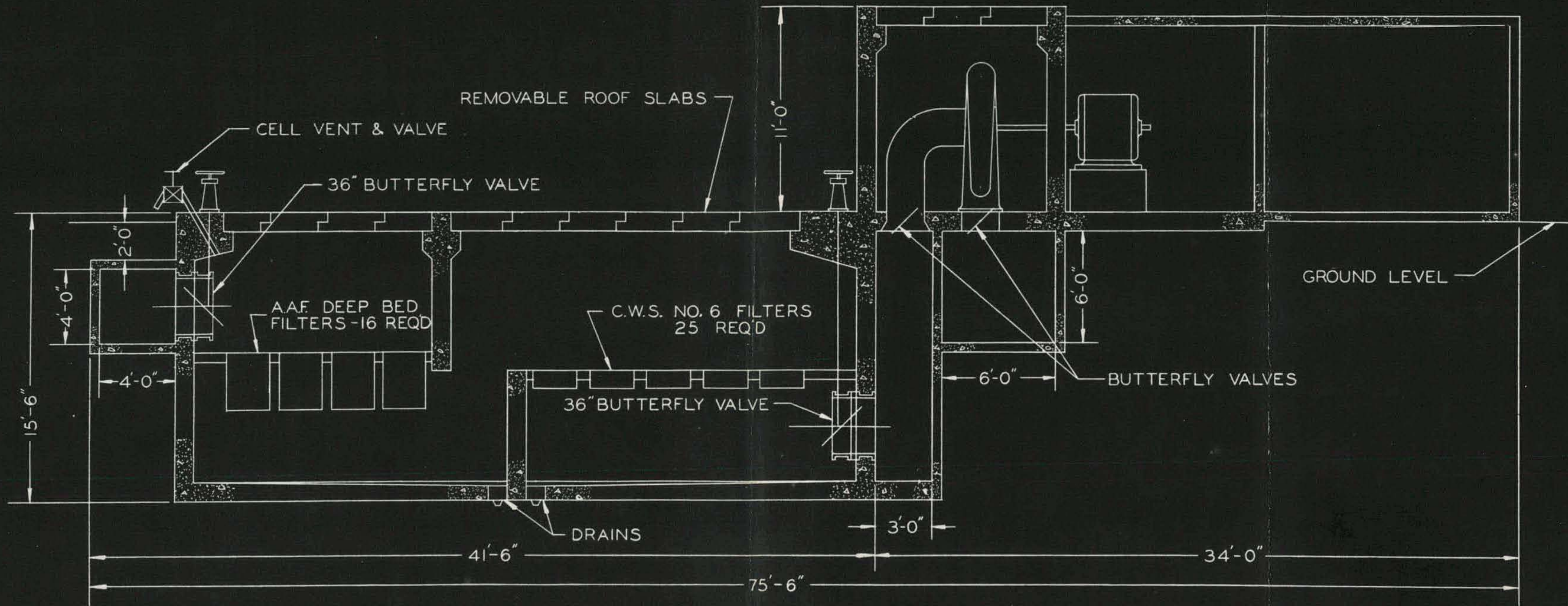

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DECIMAL TOL. ± .005
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CHIEF ENG. EGF 13 Feb 50
CHIEF DRAFTSMAN COR 2/13/50
CHECKED GN 2-3-50
DRAWN S.V.B. 1-31-50
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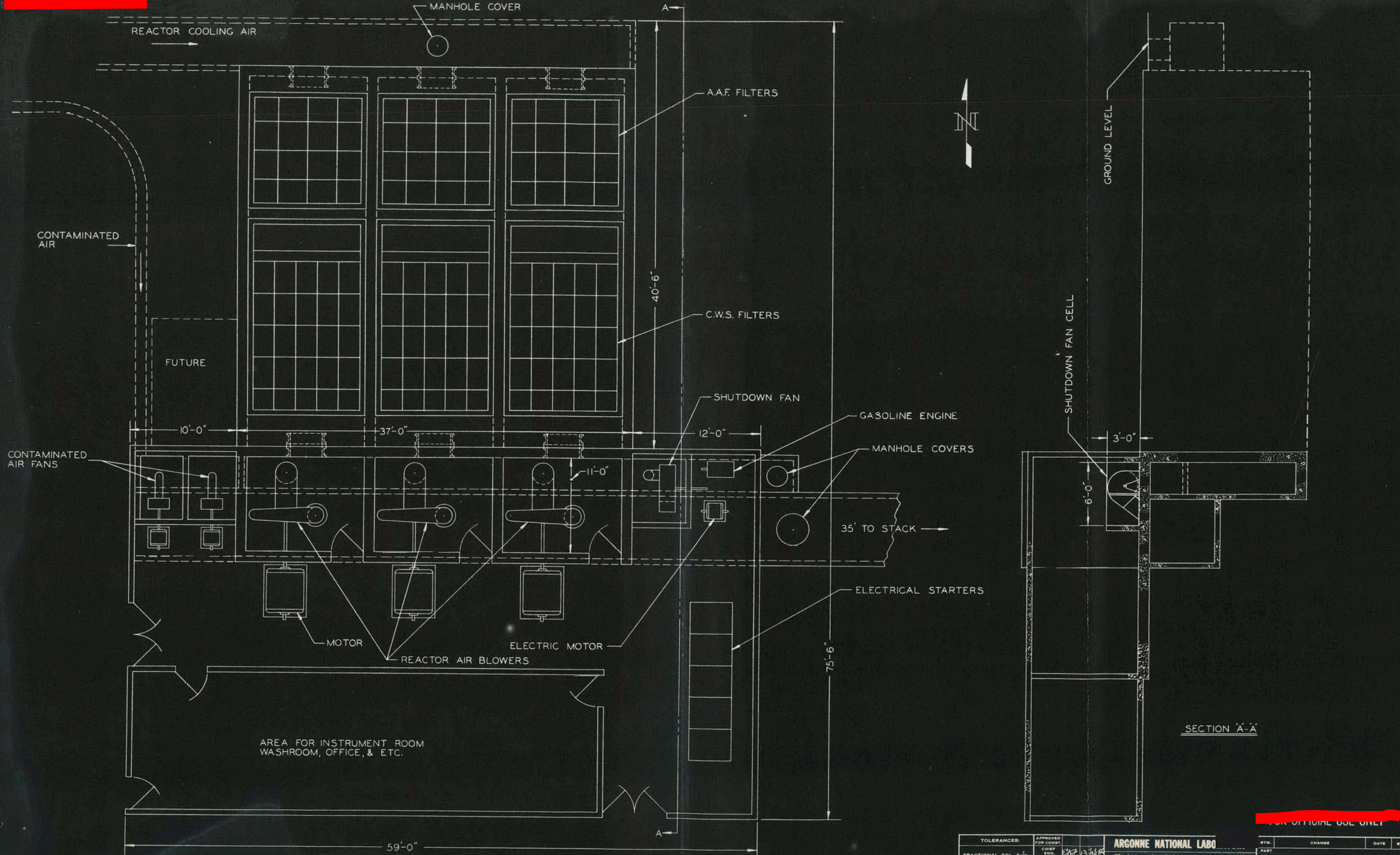

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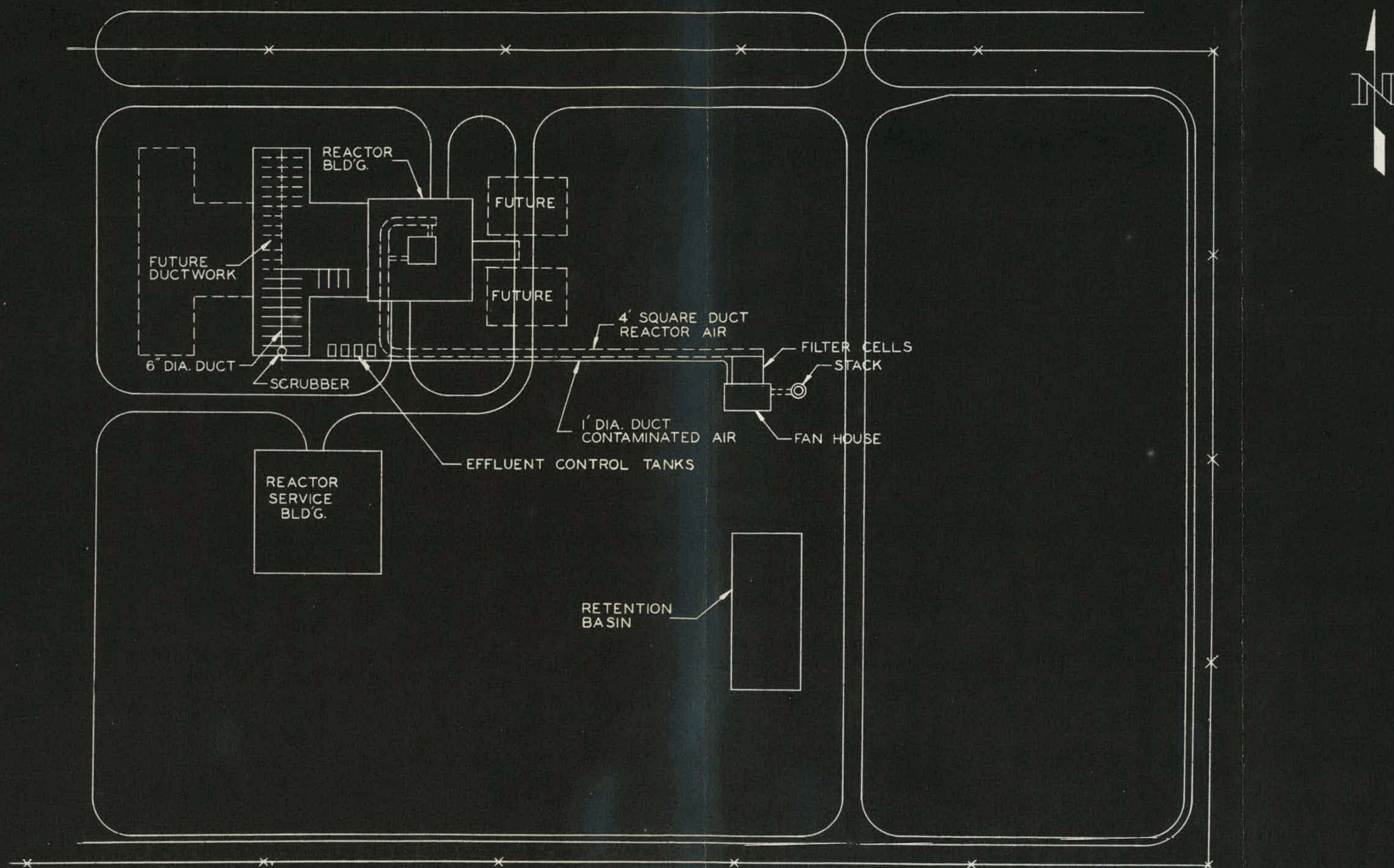

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ASSEMBLY REACTOR & CONTAMINATED AIR DUCTS

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