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ALTERNATIVE FILTER EQUIPMENT FOR VENTILATION
AIR OF SEPARATIONS PLANTS

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I. INTRODUCTION

At the start of Hanford Works' operations, the discharge of particulate contamination from the Separations Plants' stacks, as contrasted with the evolution of radioactive gases such as iodine, xenon, and krypton, was not an anticipated problem. Measurements performed by the Regional Survey group of the Radiological Sciences Department in the latter part of 1947, however, demonstrated the presence of radioactive particles in the 200 Areas environs. A subsequent investigation by personnel of the Stack Gas Disposal group of the Technical Section established that the particles emanated from the Separations Plants' stacks. A program was immediately undertaken for the purpose of providing corrective action. Various possible techniques and types of equipment for the removal of the aerosol from the ventilation gases were evaluated and it was determined that the most promising method immediately available involved the filtration of the gas stream through a deep-bed sand filter¹. The sand filter unit was suggested by Mr. C.E. Lapple, at the time a consultant from the duPont Company, and was designed in a manner similar to the deep-bed coke filters employed for the removal of sulfuric acid mists. Plant sand filters were accordingly installed in the T and B Plant ventilation systems in the fall of 1948. These filter units have performed in a highly satisfactory manner to the present time.

The Stack Gas Disposal Program, however, was continued to define the source and nature of the radioactive aerosol and to attempt the development of more efficient and economical methods for the intensive removal of this contamination from gas streams. The subsequent investigation established the following pertinent factors:

1. The radioactive aerosol was generated within the process vessels (by operations such as centrifugation, air sparging, and jet gassing) and was discharged to the ventilation air stream through the vessel vent lines.
2. There is no progressive increase in the radioactive content of the ventilation air in the canyon buildings downstream from the process cells. The particulate contamination present in this air stream is rather a function of the process operations currently in progress.
3. Deep bed units employing Fiberglas as the filtration media could be designed having the advantages of higher removal efficiency, lower flow resistance, greater filtration life, and lower installation cost than a sand filter for the same application.²

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This information was incorporated into the design of the Redox ventilation system to the extent that a separate vessel vent system was provided to permit the removal of the contaminated aerosol at its source. This was accomplished by manifolding the vessel vent lines and passing the composite off-gases through a deep-bed, high efficiency, Fiberglas filter. A sand filter was provided for the filtration of the main ventilation air stream.

The objectives of this report are to review the performance of the Redox air filtration facilities and to present recommendations, resulting from this survey, which could improve the ventilation systems of future Separations Plants.

II. SUMMARY AND CONCLUSIONS

The inclusion in the Redox Plant of both high-efficiency Fiberglas units for the separate filtration of the vessel vent gases and a sand filter for the decontamination of the main ventilation air stream, together with appropriate monitoring facilities, has made it possible to assess the relative contributions of the two systems to the particulate decontamination of the effluent stack gases. A continuous monitoring of the Redox ventilation gases upstream to the sand filter has been performed during the months of October and November by personnel of the Regional Survey group of the Radiological Sciences Department. The monitoring measurements have established that the average radioactivity content of the Redox ventilation air stream prior to its passage through the sand filter is less than the activity present in the air streams downstream from the B and T Plant sand filters. In an effort to substantiate these values an activity traverse of the Redox sand filter was made. This was accomplished by lowering the ionization chamber of a "TP" instrument into the monitoring tube which extends throughout the depth of the sand filter. There was no detectable radioactivity in the sand bed. Similar activity traverses performed at the B and T Plant sand filters during their operating histories have revealed that the units achieved their maximum, or equilibrium radioactivity level after approximately six months operation. The fact that there was no detectable activity in the Redox sand filter after 11 months operation confirmed the very low activity measurements of the air stream and demonstrated that this condition has been normal throughout the period of Redox operation and was not merely coincidental with the gas stream activity measurements.

This information, which indicated that the activity level of the Redox ventilation air was not high enough to warrant the continuous use of a sand filter, has led to the consideration and proposal that alternative filtration equipment be used in future separation plants for the particulate decontamination of the effluent gas streams. The proposed equipment consists of separate systems for the process and ventilation gas effluent wherein the process gas streams are passed through small, high-efficiency, deep-bed Fiberglas filters (as used in the Redox installation); and the main ventilation air stream is discharged

directly to the stack, with a standby air filter provided in case of emergency.

Comparative cost estimates for a standby Filterglas filter and a sand filter, each having a capacity of 100,000 cfm, have been prepared by the Estimating group of the Project Services Unit. The bare costs have been given as \$750,000 for the sand filter and \$100,000 for the emergency filter unit.³ Since the cost figure for the standby unit represents a "high spot" estimate, this value has been arbitrarily doubled to provide a conservative bare cost differential of approximately \$850,000. When the respective design and construction cost additives are considered, the actual or "out-of pocket" cost differential is estimated at approximately \$750,000.

III. RECOMMENDATIONS

It is recommended that exhaust air be treated in a manner appropriate to its content of radioactive material. From the information available this would indicate a two-part system for separations processing facilities. One part of the system would be installed to accommodate process equipment vent gases and to comprise equipment for the removal of true vapor contaminants by chemical means (cf. silver reactor for iodine removal) combined with a high efficiency glass fiber filter for removal of particulate matter. The second part of the system would serve to accommodate the ventilation air drawn through the building and discharge it to an exhaust stack. From the most conservative viewpoint the latter system would contain a high efficiency filter with provision for by-pass or in-line operation as the conditions justify. Realistically it appears that the provision of inlet and outlet nozzles together with by-pass valving which will permit the future installation of a filter unit would provide adequate insurance and the opportunity to take further action if future results deviate from those obtained to date, which indicate the absence of a contamination problem.

IV. DISCUSSION

A. Background

The field of engineering concerned with the removal of objectionable aerosols from air streams has evolved and crystallized a general approach to these problems. This policy consists of removing the contamination from the ventilation system as near to the point of origin as is possible. The logic and validity of this technique are generally accepted. If for health hazard control, or other reasons, it is necessary to remove a certain fraction of the pollutants from the ventilation gases, the cost of the decontamination equipment becomes primarily a function of the volume of air requiring treatment. Treating at the source, wherein the contamination is confined in a relatively small gas

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volume, and the analyzer equipment and pronounced in tallies, operation, and replacement of batteries.

The philosophy of decontamination removal at its origin was adopted in the design of the Redox ventilation system and it is assumed that this will be employed in future plant installations. Since the stack gas investigation performed at B and T Plants had established that the process vessel vent constituted the primary source of the radioactive aerosol in the effluent ventilation gases, the Redox ventilation system provided for the manifolding of the individual vessel vent lines and the filtration of the components off-gases by a small, high efficiency Fiberglass unit. At the time the Redox plant was designed, however, specific information regarding the possible effects of solution spills or maintenance operations upon the contaminant on level of ventilation air streams was not available and both vessel vent filters and a sand filter for the main ventilation air stream were provided. The inclusion of both systems, together with the necessary sampling facilities, has made it possible to assess the relative contribution of these equipment pieces to the decontamination of the effluent stack gases.

B. Activity Measurements Of The Redox Ventilation System

1. Activity Level of the Ventilation Gases

A continuous monitoring of the Redox ventilation gases upstream to the sand filter has been performed by personnel of the Regional Survey group of the Radiological Sciences Department during the months of October and November. The measurements were made by withdrawing an aliquot of the ventilation air from the duct work upstream to the sand filter and passing the air sample through a CWS type 6 monitoring filter. The radioactivity present on the monitoring filters was measured with the "Cutie Pie" and "WWM" instruments.

The values reveal that the average "Cutie Pie" reading on the upstream filter monitor is less than the normal range for the monitors downstream from the T and B Plant sand filters (20 to 100 millirep per hour) for a comparable sample volume. It should be noted that on October 13 there was a spill of IAF solution in the Redox process cell and on November 12 a replacement was made of the waste neutralizer agitator. The IAF material constituted the most highly contaminated solution present in the Redox operation and the waste neutralizer is likewise of the "high activity" process vessels. Although the contamination level of the ventilation gases did experience temporary increases following these incidents, the maximum values were less than that associated with the daily discharge from B and T Plants.

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TABLE I

PEDOX SAND FILTER
UPSTREAM RADIOACTIVITY MONITOR TESTS

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Test No.*	Date Started	Date Completed	Length of Run (Hours)	Average Flow Rate (CFM)	Filter Activity Level	
					VOM Instr. near filter (c/m)	CP Instrument (mrep/hr) (LT denotes "less than")
59	10/1	10/6	119	1.0	100	LT 5
63	10/6	10/13	170	1.5	200	LT 5
67**	10/13	10/20	180	1.5	100	LT 5
71***	10/20	10/27	173	0.5-2.0	100	LT 5
73	10/28	10/30	23.7	2.0	10,000	2 5
74	10/30	10/31	23.0	2.0	7,500	LT 5
75	10/31	11/1	23.6	2.0	7,000	LT 5
76	11/1	11/3	47.8	2.0	25,000	2 15
77	11/3	11/4	23.2	2.0	18,000	2 10
78	11/4	11/5	23.5	2.0	20,000	2 10
79	11/5	11/6	25.8	2.0	6,000	LT 5
80	11/6	11/7	24.3	2.0	7,000	LT 5
81	11/7	11/8	24.0	2.0	10,000	2 5
82	11/8	11/10	47.2	2.0	25,000	2 15
83	11/10	11/11	23.2	2.0	6,000	LT 5
84	11/11	11/12	21.7	2.0	7,500	LT 5
85	11/12	11/13	23.2	2.0	15,000	10
86	11/13	11/14	24.0	2.0	11,000	8
87	11/14	11/15	21.5	2.0	20,000	10
88	11/15	11/17	47.1	2.0	20,000	10
89	11/17	11/18	23.7	2.0	6,500	LT 5
90	11/18	11/19	23.5	2.0	3,000	LT 5
91	11/19	11/20	24.5	2.0	2,500	LT 5
92	11/20	11/21	28.8	2.0	12,000	2 5
93****	11/21	11/22	19.5	2.0	4,000	LT 5
94	11/21	11/21	47.2	2.0	60,000	75
95	11/21	11/25	41.0	2.0	75,000	92
96	11/25	11/26	23.4	2.0	25,000	30
97*****	11/26	11/28	47.2	2.0	8,500	8
98	11/28	11/29	23.1	2.0	25,000	15
99	12/2	12/2	47.6	2.0	25,000	15
100	12/1	12/1	23.1	2.0	7,500	LT 5

* Data obtained by Regional Survey, Control Unit, Biophysics Section, Radiological Sciences Department.

** 1-AF Sample spilled in 204-S sample gallery on 10/16/52.

*** Motor trouble made the flow rate questionable. Motor replaced 10/29/52.

**** Replacement of the waste neutralizer agitator was made on 11/22/52. Equipment remained in layon cell until after 11/22/52.

***** Filter repaired; reading questionable.

Notes: Average activity reading on B and T Plant downstream sand filter monitor varies from 20 to 100 mrep/hr. for a comparable sample volume. Average upstream value is approximately 10,000 mrep/hr.

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2. Activity in the Redox Sand Filter

In an effort to substantiate this information, an activity traverse of the Redox sand filter was made. This was accomplished by lowering the ionization chamber of a "TP" instrument into the monitoring tube which was provided for this purpose. The monitoring tube extends throughout the depth of the sand filter. There was no detectable radioactivity in the sand bed. The data obtained from similar sand filter probings of the T and B Plant units throughout their operating histories are presented in graphical form in Figure I. These measurements have established that the maximum, or equilibrium radioactivity level of the T and B Plant sand filters were attained after approximately six months operation. Later increases in this value were due to increased pile lower level and decreased cooling time; these effects are indicated by the inset curves. The fact that there was no detectable contamination in the Redox sand filter after 11 months operation confirmed the very low activity measurements obtained in the monitoring of the air stream and demonstrated that this condition has been normal throughout the period of Redox operations and was not merely coincidental with the air stream measurements.

C. Correlation of Ventilation Air Activity with Process Operations

A question which arises when considering the radioactive contamination present in the separations plants' effluent ventilation air is whether there is a progressive increase in the radioactive content of the ventilation gases downstream from the process cells. The extensive monitoring data, which were obtained over a period of several years at B and T Plants, have demonstrated that the particulate contamination present in this air stream is a function of the process operations currently in progress. The following data, which were obtained at B Plant approximately four years after it was placed in operation, illustrate this relationship:

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COOLING TIME FOR 1 PLANT FEED * (days)

10-31-50

4-30-51

10-31-51

MONTHS OF SAND FILTER OPERATION

PERCENTAGE OF SAND FILTER OPERATION

TABLE II

UNCLASSIFIEDCORRELATION OF EFFLUENT VENTILATION AIR ACTIVITY WITH PROCESS OPERATIONS

Date	Duration of Run (hours)	Activity Reading of Upstream Sand Filter Monitor (mrep/hr)	Process Operations
4-14-49	8	900	Normal throughout Canyon.
4-20-49	24	< 5 (No detectable reading)	First and Second Product Precipitations ("cold" end of Canyon)
4-25-49	24	4200	Dissolving, Reduction, Extraction ("hot" end of Canyon)

In all instances, a one cfm aliquot of the ventilation air was withdrawn from the ductwork upstream to the sand filter and the air sample was passed through a CWS Type 6 monitoring filter. The activity readings were made with the field instrument termed the "Cutie Pie".

D. Alternative Filter Equipment

1. General Arrangement of the Ventilation System

In view of the fact that the accumulated data have demonstrated that the Redox sand filter is not performing a useful function, it is proposed that in future separations plants (wherein the process and ventilation gas systems are, of course, separate) the ventilation air stream be discharged directly to the stack, providing only a standby filter unit in case of emergency. This system is presented schematically in Figure II. A station for the continuous monitoring of the ventilation air stream would be located upstream to the emergency filter. If the radioactivity level of the ventilation gases reached an objectionable value, the standby filter would be placed in operation. Continuous monitors of this type, for the detection of gross beta-gamma contamination, are presently in service at the Oak Ridge National Laboratory and the Brookhaven Laboratory. Personnel of the Instrument Development group of the Radiological Sciences Department have investigated the continuous monitoring equipment presently in use at the other sites and have advised that a reliable and dependable instrument could be designed with available information.⁴

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FIGURE II
SCHEMATIC DIAGRAM
SEPARATIONS PLANT VENTILATION SYSTEM

- (1) High efficiency, deep-bed Fiberglass filter
- (2) Process gas stream.
- (3) Main ventilation air stream.

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2. Proposed Emergency Filter Unit

The preliminary advantage to be gained through the use of such a standby filter unit is that it is no longer necessary to incorporate a large life expectancy factor into the equipment and an appreciable savings in fabrication and installation costs can therefore be realized. A further advantage is that the installation becomes adaptable to commercially available equipment, with only the assembly of the finished unit required at the site. Possible vendors of appropriate filtration equipment have been contacted and a filter employing the "deep-bed" units of the American Air Filter Company well satisfies the service requirements. A sketch of this type filter, for a ventilation air system of 100,000 cfm, is presented in Figure III.

The filter would occupy an area approximately 23 feet by 23 feet and containing structure would be approximately 10 feet deep. The essential components of this installation are a low-efficiency prefilter and a high-efficiency clean-up filter, the former operating at a face velocity of 250 ft/min. and the latter at 25 ft/min. The high-efficiency filter is a sealed assembly of 100 of the standard American Air Filter deep-bed filter units. The pockets of the individual deep-bed filters would be packed with a 0.25-inch depth of "B" Fiberglas, at a packing density of 1.1 lbs./cu.ft., and a 0.75 inch depth of "AA" Fiberglas at a packing density of 1.2 lbs./cu.ft. For the purpose of shipping convenience, this equipment would be supplied in the form of five sub-assemblies, each of which would be comprised of 20 complete and sealed deep-bed filter units. The sub-sections would be joined in the field and the entire assembly then lowered into position in the underground, concrete cubicle. As illustrated in a diagrammatic sketch, a prefilter section comprised of a 4-inch depth of #450 fiber, at a density of 3 lbs./cu.ft., and a 12-inch depth of 115K fiber, at a density of 1 lb./cu.ft., has been included in the design. The fore filter section has been incorporated for the purpose of removing the water droplets which would be present in the ventilation air stream during a period of operation of the fire fog system.

The proposed standby filter would have an initial flow resistance of approximately 2.2 inches of water and a contamination removal efficiency in the order of 99.6 per cent. The continuous service life of the filter, predicated upon a pressure drop increase of 4 to 5 inches of water, would be approximately 1 year. The data obtained during the first eleven months of Redox operations indicate, however, that the maximum service requirement for a standby filter unit would be 10 to 20 per cent of the plant operating time.

SHIPPED 2 UNITS WIDE
BY 10 UNITS LONG

FOUNDATION
FURNISHED BY CUSTOMER

PLAN
SCALE

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DET
SCAL

VIEW
 $\frac{1}{2} = 1'-0"$

TAIL Y-Y
 E: 3"=1'-0"

DETAIL X-X
 SCALE: 3"=1'-0"

K-X

4'-0"

PLAN
SCALE: 1" = 1'-0"

2 ANGLES >

2-10

4'-6 1/2" (REF.)

SEAL
FURNISHED BY
CUSTOMER

SECTIONAL VIEW
SCALE: 1" = 1'-0"

N VIEW

E: 1/4" = 1'-0"

BOTTOM 4 PLS.
END 8 PLS.

FURNISHED BY CU

N

DETAIL Z-Z
SCALE: 3"=1'-0"

DETAIL W-W
SCALE: 3"=1'-0"

7 CUSTOMER

CAU

HA

E

W
5

H 6

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UTION : BASES OF UNITS MUST BE FLAT AFTER ASSEMBLY.

IANFORD WORKS RICHLAND, WASH.
200-P. INSTALLATION

FIGURE III

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OF UNITS MUST BE FLAT AFTER ASSEMBLY.

3. RICHLAND, WASH.
RELATIONS

FIGURE III

-P12

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SECTIONAL VIEW

SCALE: 1" = 1'-0"

6" OR
TO SUIT

1'-4"

SCREEN WIRE

12" OF #115 K F

4" OF #450 FIBER

GRATING

FURNISHED BY CUSTO

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Y CUSTOMER

CAU

HAT

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MANFORD WORKS RICHLAND, WASH.
200-P INSTALLATION

Figure III

<p>REVIEWS</p>	<p>SOURCE The drawing is the property of The American Air Filter Company, Inc., Lehigh, and is hereby placed in the public domain. It shall not be reproduced, copied, altered or otherwise used in any manner for any purpose without the express written consent of the company.</p>	<p>TELEPHONE NEW YORK 217-5611 NEW YORK 217-1211 NEW YORK 217-1211</p>	<p>American Air Filter Co. 1415 CENTRAL NEW YORK</p>
<p></p>	<p></p>	<p></p>	<p>DEEP BED FILTER BANK SPECIAL INSTALLATIONS</p>

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OF UNITS MUST BE FLAT AFTER ASSEMBLY.

RICHLAND, WASH.
LOCATION

Figure III

<p>NOTICE: This drawing is the property of the American Air Mail Company. It is loaned to you for your use only. It is not to be reproduced, stored, or used in any way without the express written permission of the American Air Mail Company.</p>	<p>REVISED BY DATE</p>	<p>AMERICAN AIR MAIL COMPANY 1000 BROADWAY NEW YORK, N.Y. 10003</p>	<p>FIGURE III</p>
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E. Comparative Costs of a Sand Filter vs. a Standby Filter Unit for Ventilation Gases

A comparative cost estimate has been prepared by the Estimating group of the Project Services Unit for a sand filter and an emergency unit, each having a capacity of 100,000 cfm. The bare cost values have been estimated at \$750,000 and \$100,000 for the sand filter and the emergency unit, respectively. Since the figure for the emergency unit represents a high spot estimate, the estimated value has been arbitrarily doubled to provide a conservative bare cost differential of \$550,000. When the construction and installation additives are considered, however, the actual or "out-of-pocket" cost differential is estimated at \$750,000.

V. REFERENCES

1. Work, J.B., "Decontamination of Separation Plant Ventilation Air", General Electric Company, Hanford Works, Document No. HW-11529 (11-10-48).
2. Blasewitz, A.G., et al, "Filtration of Radioactive Aerosols by Glass Fibers", General Electric Company, Hanford Works, Document No. HW-20347 (4-16-51).
3. Eisenacher, P.L., Memorandum to A.G. Blasewitz (11-16-52).
4. Hallinen, J.A., Memorandum to A.G. Blasewitz (11-20-52).

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ADDENDUM

Since the time of the conception of the proposed, alternative filter equipment it has been learned that the Purex ventilation system does not provide for the filtration of the vessel vent gases prior to their discharge to the main airstream. As presently designed, the off-gases from the condenser and vessel vent systems are maintained and passed through the condenser to remove the entrained water which has been added to the individual gas streams by the motivating jets, through a silver reactor for radioactive iodine removal, and are then introduced into the air tunnel. This arrangement is presented diagrammatically in Figure I. It is recommended that consideration be given to incorporating a Fiberglas filter, or filters, into the condenser and vessel vent system to provide a particulate removal efficiency of 99.99 per cent before discharging these gases to the main ventilation air stream. It is believed that two possible techniques could be used to accomplish this equipment arrangement.

1. The present method of moving the gas streams through the equipment train could be used if individual Fiberglas filters were placed in the condenser and vessel vent systems. The filter units would be located between the respective air bleed lines and jets. The required filter for the condenser off-gases would be 2.5 feet in diameter and 6 feet in height; the vessel vent filter would be 5.5 feet in diameter with a height of 6 feet.
2. A single Fiberglas filter, 7.5 feet in diameter and with a height of 6 feet, can be placed downstream from the silver reactor. If this arrangement is used, a blower can be incorporated into the system downstream from the filter to maintain the entire decontamination system under a slight vacuum. A blower of the required capacity would occupy approximately a cubic yard of space and would be of the same general design as the ventilation fans. This type of blower can also be readily obtained with a flat operating characteristic. The latter is important to prevent any interference in the operation of the condenser and vessel vent jets. A further degree of stability in the static pressure developed downstream of these jets can be attained by installing a bleed line with a controlled damper near the fan inlet.

If the silver reactor and Fiberglas filter assembly cannot be dimensioned to fit into the available canyon area, or with a minor enlargement of the canyon space, it is recommended that the Fiberglas filter unit be placed in an underground cubicle outside the canyon. As has been discussed, the sand filter and the Fiberglas filter perform the same function by the same mechanism. Just as it would be illogical to attempt to house the sand filter within the canyon it is conversely logical to place the Fiberglas filter in the more economical underground housing. The location of this type of equipment outside the process area is made possible by the fact that deep-bed filters represent "maintenance free" equipment. Sand filters have been in operation at D and T Plants for a period of four years, four Fiberglas filter have been in operation at these plants for two years, and six Fiberglas units have been in operation at the Redox Plant for almost one year. None of these filters has required any maintenance.

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If the alterations to the present Purex design, which would be required to provide a filtration of the process vessel off-gases prior to their discharge to the main ventilation airstream, are considered to be of magnitude to affect adversely the economics of a standby fiber versus a main line filter, it is recommended that a Fiberglas filter be substituted for the proposed sand filter. The extensive development data which have been accumulated clearly indicate that the Fiberglas unit would have the more desirable operating characteristics. Comparative cost estimates for a deep-bed Fiberglas filter and a sand filter, each having a capacity of 100,000 cfm, have been prepared by the Estimating group of the Project Services Unit. The base costs have been given as \$750,000 for the sand filter and \$375,000 for the Fiberglas unit. When construction additives are considered, the actual cost differential is estimated at approximately \$500,000.

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FIGURE 1

PRESENT PUREX DESIGN FOR EFFLUENT PROCESS GAS STREAMS

END

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01/109/91