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DOCUMENT NO.
HW-69025 REV

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DATE
August 27, 1962

COPY NO.

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THE STATUS OF GASEOUS EFFLUENT MONITORING AT HAPO DECEMBER 1961

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The isotopic composition of the deposited radioactive materials is determined by collecting and analyzing vegetation samples, principally grass and sagebrush, around the project and in Eastern Washington and Northern Oregon. Locally, garden produce and milk are also purchased for analysis. A large part of the environmental air monitoring program involves the study of I^{131} because of its high volatility during dissolving of the irradiated uranium, and because of its strong tendency to deposit on vegetation and other surfaces.

The amount of radioactive contamination deposited on the vegetation is measured with a 256-channel gamma-ray spectrometer. Specific isotopic concentrations are calculated from counting rates obtained at their characteristic gamma energies, after applying corrections for compton scattering and natural background radiation. $Strontium^{89}$ and Sr^{90} concentrations are determined by radiochemical separation and beta particle counting. The majority of radioisotopic measurements made on milk and produce samples are below their respective detection limits of about 10^{-7} μc per gram. Higher isotopic measurements are obtained for the grass samples because of the higher surface to weight ratio of grasses.

Figure 7 illustrates the annual average deposition pattern of I^{131} on grasses and sagebrush, based on an emission rate of one curie per day(1). This pattern shows the influence of the prevailing winds and the frequent inversions which tend to carry the plume to long distances before it reaches the ground.

Deposition of I^{131} and particulates from the atmosphere can be followed by performing radiological surveys of the ground. These surveys are made with portable transistorized equipment employing a gamma sensitive scintillation crystal, five inches in diameter by five inches thick. The equipment can be carried by car, boat, or airplane. In the event that unusual ground contamination is detected, more detailed surveys can be made with hand portable instruments and by collecting supplemental vegetation samples.

SUMMARY

The air monitoring program at Hanford employs a variety of equipment and techniques for measurement of air-borne and deposited radioactive materials. Some of the instruments used were developed at Hanford for specific applications. The measurements made are complicated by the presence of naturally occurring radioactive materials and of radioactive fission products from nuclear detonations. Present methods are adequate to ensure that exposures of humans and grazing animals to air-borne or deposited radioisotopes are well below applicable limits; however, refinements in air monitoring techniques are constantly being made.

THE STATUS OF GASEOUS EFFLUENT MONITORING AT HAPO DECEMBER 1961

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THE STATUS OF GASEOUS EFFLUENT MONITORING AT HAPO DECEMBER 1961

I. INTRODUCTION

This report is a comprehensive survey of the methods used for sampling radioactive materials emitted from plant stacks and a compilation of results from the various sampling programs for 1961. Routine sampling of radioactive wastes released to the atmosphere from all major production facilities is performed primarily by the Environmental Monitoring Group.(1) In addition, the effluent gases from some facilities are monitored by Radiation Monitoring personnel and personnel of various operating departments.

For convenience, each major production area is treated individually and sampling methods and results of facilities within a given area are grouped together.

II. 100 AREAS

Table I summarizes sampling information about the principal stacks in the 100 Areas.

A. Production Reactor Buildings

Extensive monitoring of the exhaust gases is conducted at each reactor building (105), both upstream and downstream of the ventilation Filter Building (119). In addition, the build-up of radioactive materials on the ventilation filters themselves is monitored by a pair of gamma sensitive ionization chambers connected to recorders in the sample buildings (117).

1. Upstream of the Filter Buildings

An in-line monitor is maintained by IPD to measure and record concentrations of I^{131} in the exhaust gases upstream of the 119 Filter Buildings. In addition, the monitor alarms and activates the Rear-Face Fog Spray system when concentrations exceed a preset amount. The gas being monitored is drawn through a cylindrical can at ~ 5 CFM by an electrically driven vacuum pump. The 0.36 Mev photons from I^{131} are measured by a scintillation counting system whose NaI crystal is recessed into the can. Interference from Compton scattered radiation (mainly from A^{41}) is reduced by automatically subtracting a fraction of the counting rate at higher energies from the reading at 0.36 Mev. Iodine-131 is not detectable in the gases under normal conditions but a fuel element rupture may release several curies of I^{131} to the exhaust system.

TABLE I

SUMMARY OF STACK SAMPLING INFORMATION

100 AREAS

Stack	Location	Height	Flow (10^3 CFM)	Sampled By	Analyzed For
Main Vent Stack, all Reactor Buildings	117-B, C, KW, KE, D, DR, H & F	200'	100	IPD	Filterable Gross Beta, I^{131}
"	Upstream of Filter Buildings	-	-	IPD	Filterable Gross Beta, I^{131}
"	"	-	-	EMO	Filterable Gross Alpha & Beta, C^{14} & S^{35}
"	"	-	-	IPD	Radioactive Gases via Kanne Chamber
"	Within Filter Building (119)	-	-	IPD	Build-up of Gamma Emitters on Filter Beds
Biology Laboratory Vent Stack	108-F	50'	45	HLO, RM	Filterable Gross Alpha Gross Beta
Experimental Animal Building	Exhaust Air	15'	-	Not Sampled	
"	Within Cages	-	-	HLO, RM	Pu^{239} & Ce^{141}
Tissue Preparation Building	Exhaust Ducts	15'	-	HLO, RM	Gross Alpha as Pu

A second in-line monitor is also maintained by IPD to obtain a qualitative estimate of the concentrations of radioactive gases in the exhaust stream. This Kanne Chamber measures and records the ionization current produced as the gas flows through the chamber. Since gamma radiation originating outside of the chamber as well as any ionizing radiation from the complex mixture of gases within the chamber will be measured, the Kanne Chamber cannot be calibrated for quantitative measurements.

IPD also maintains a Victoreen automatic strip filter monitor and recorder on the upstream side of the filter buildings. An isokinetic gas sample is drawn at ~5 CFM through a moving strip filter where the particulate material is collected and monitored for gross beta emitters by a mica-window GM tube. A record of the counting rate is drawn on a strip chart recorder and alarm lights are activated for high reading, flow failure, or filter tape breakage. No laboratory analysis is performed on the strip filter samples.

An "integrated" weekly sample of particulates in the air entering the filter building is collected on H-70 filter paper at a rate of 0.5 CFM. These filter samples are removed by EMO personnel and counted in the radiochemical laboratory for gross beta and gross alpha emitters after a few days delay to permit decay of natural emitters. The results of these analyses are summarized in Table II and are listed in more detail in Tables A-1 and A-2 of the Appendix.

Until January of 1962, 0.5 CFM samples of the reactor stack gases were passed through caustic scrubbers for ~4 hours once a month. The scrubber solution consists of 6 grams of NaOH in 1500 cc of water.(2) After exposure the scrubbing solution was analyzed for C^{14} and S^{35} by chemical separation and beta counting. This scrubber sampling program will be resumed as soon as EMO moves its sampling station to the downstream side of the Filter Buildings. A summary of results obtained from C^{14} and S^{35} monitoring is given in Table II and detailed data are given in the Appendix as Tables A-3 and A-4.

2. Downstream of the Filter Buildings

Strip filter monitors, identical to those upstream of the filter buildings, are maintained by IPD to measure and record the particulate radioactive materials which penetrate the ventilation filters and enter the stack. In addition to measuring stack emissions, the downstream monitor aids in evaluating the efficiency of the ventilation filters.

An I^{131} monitor is also operated by IPD on the downstream side. About 0.5 CFM of exhaust gases from the filter building is passed

TABLE II

AVERAGE EMISSIONS OF VARIOUS RADIOACTIVE MATERIALS

FROM THE REACTOR STACKS

1961

Millicuries Per Day

Reactor	Filterable Gross Alpha	Filterable Gross Beta	C^{14}	S^{35}
105-B	1.1×10^{-5}	2.5×10^{-2}	15	0.19
105-C	1.8×10^{-4}	0.47	5.0	0.08
105-KW	1.2×10^{-5}	9.7×10^{-2}	12	1.1
105-KE	9×10^{-6}	0.11	30	0.18
105-D	8×10^{-6}	2.9×10^{-2}	41	0.36
105-DR	6×10^{-6}	3×10^{-4}	12	0.04
105-H	1×10^{-4}	3.4×10^{-2}	12	0.05
105-F	8×10^{-6}	2×10^{-4}	0.3	0.05
Total	3.3×10^{-4}	0.77	130	2.1

through a charcoal cartridge centered in a NaI crystal.(3) Halogens collected in the charcoal are monitored by the scintillation counter set to record the counting rate at the 0.36 Mev gamma energy of I^{131}.

EMO does not sample downstream of the Filter Buildings at present. Plans are being made to move the upstream sampling equipment downstream, and also to resume the C^{14} - S^{35} sampling program.

B. Biology Laboratory Facilities

1. Biology Laboratory Building

All the air in the Biology Laboratory Building is drawn through the hoods of the building into a main ventilation duct from which it is exhausted directly to the atmosphere. A 10 CFM sample from the main duct is drawn through a 4" x 8" H-70

filter by a vacuum ~~steam jet~~ pump. The sampler is operated by the radiation monitoring group at the Biology Laboratory Building and all results are compared with the mask limits of 2×10^{-12} μc/cc Pu and 1×10^{-9} μc/cc mixed FP.(4) Results of effluent stream samples which exceed the above concentrations are logged in a "positive air sample report". During the period 1958 through 1961, no positive results were noted for the exhaust air samples.

2. Experimental Animal Building

The experimental animal building contains laboratories in which Pu^{239} and Ce^{144} inhalation studies are conducted. The air from animal cages used for these studies is passed through absolute filters and exhausted separately from the general building air. None of the exhaust air of the building is routinely sampled, but contamination is carefully controlled by room air samples and smear surveys. Although Pu concentrations in the cages range from 10^{-7} to 10^{-3} μc/cc for periods of 15 to 45 minutes, surveys of the experimental animal building roof have failed to reveal any contamination.

3. Tissue Preparation Building

The solutions for the inhalation exposures are prepared at the tissue preparation building. Tissue samples are also prepared for radioanalysis at this facility. Plutonium contamination has been found on the laboratory hood filters of this building but to date none has been found in the exhaust ducts or on the roof.

III. 200 WEST AREA

Table III summarizes information about various stacks sampled within the 200 West Area.

A. Redox Separations Plant

1. Main Ventilation Stack, 291-S

Two sampling systems are maintained by EMO at the 291-S stack sampling house -- the Stack Analyzing Monitor (SAM) and a "fixed" filter and scrubber sampler(1, 2, 3). Both systems operate from a manifold sample line which circulates ~30 CFM of effluent gases drawn from the twenty-foot level of the stack with a vacuum steam jet. Two 0.3 CFM samples of the circulating gas are passed through the SAM which consists of a strip filter in parallel with a counter-current flow caustic scrubber and associated instrumentation.

The first sample passes through a rotometer and then through the strip filter where the particulate material is removed. The

TABLE III

SUMMARY OF STACK SAMPLING INFORMATION

200 WEST AREA

Stack	Location	Height	Flow (10^3 CFM)	Sampled By	Analyzed For
Main Vent Stack Redox Plant	291-S	200'	Rated at 35 to 40	EMO	I^{131}, Ru^{103}, Ru^{106}, Zr-Nb^{95}, Gross Beta
Redox Technology Laboratory	222-S	75'	90	RM, CPD	Filterable Gross Alpha and Beta
$PuNO_3$ Concentration Facility	233-S	100'	45	" "	Filterable Gross Alpha
North Sample Gallery	Roof Vents 202-S	10' Above Roof	3.5	" "	Filterable Gross Alpha & Beta
South Sample Gallery	"	"	"	" "	"
Decontamination Room SWP Lobby Regulated Shop	"	"	6.1	" "	"
Main Vent Stack, 231-Z	231-Z	60'	11.0	RM, HLO	Filterable Gross Alpha as Pu
Main Vent Stack, 234-5-Z	291-Z	210'	240	RM, CPD	"
3 Roof Vents	224-U	10' Above Roof	Total of 14	RM, CPD	Gross Alpha as Uranium
Main Vent Stack, U-Plant	291-U	200'	~40	EMO until 1959	Filterable Gross Alpha & Beta
Main Vent Stack, T-Plant	291-T	200'	~20-30	Not sampled	

exposed filter paper moves between a beta and a gamma scintillation crystal. The scintillation counters are calibrated to yield one digit on a register for each 0.01 curie of Ru^{103} or Ru^{106} emitted from the stack. The strip filter is not taken to the laboratory for analysis unless some unusually high emission is noted on either register. A strip chart recorder installed in the Operating Gallery of 202-S Building provides a continuous record of the emission rate. Normally emission rates of particulate material are $\leq$0.01 c/day of Ru^{103} and Ru^{106}.

The second sample passes through an orifice meter where the flow rate is measured and recorded, and then into the caustic scrubber. The scrubbing liquid (0.2 Normal NaOH) is pumped from a storage reservoir at a constant rate of 5 cc per minute. As the gas sample rises through the column, the caustic solution collects I^{131} and then drains from the bottom of the column into a monitoring chamber. The scrubber solution is continuously monitored by a NaI scintillation crystal, connected to a count-rate meter, integrator, and chart recorder. The spent solution leaving the monitor is collected, and daily aliquots are taken to the radiochemistry laboratory where the I^{131} is measured by gamma energy analysis. The chart is changed weekly and filed for future reference. The integrator is calibrated, semi-quantitatively, in units of one recorder register for each 0.01 curie of I^{131} emitted from the stack.

The "fixed" scrubber monitor consists of a filter and a 1500 ml scrubber solution in series through which a sample of the effluent gases from the 20 ft. level of the stack is passed at the rate of approximately 0.2 CFM. The filter used in this sampling system is Hollingsworth-Vose H-70 filter paper (18 mils thick), which has a collection efficiency of over 99.5 per cent for particles larger than 0.2 micron. The activity passing through the filter is assumed to be in the gaseous phase. The scrubber solution consists of 375 ml of 10 N NaOH diluted with water to 1500 ml. The filter and scrubber solution are changed daily and analyzed for I^{131}, Ru^{103}, Ru^{106}, and $Zr\text{-}Nb^{95}$ by gamma energy analysis.

A summary of emission rates of selected radioisotopes from the Redox plant stack during 1961 is given in Table IV. Monthly average and maximum daily emissions are presented in Table B of the Appendix.

TABLE IV

EMISSION OF FISSION PRODUCTS FROM THE REDOX STACK

1961

Millicuries Per Day

Sampling System			$Zr\text{-}Nb^{95}$	Ru^{103}	Ru^{106}	I^{131}
SAM[a]	Filter	Average[b]	-	$\leq$ 0.01	$\leq$ 0.01	-
		MDL[b]	-	(0.01)	(0.01)	-
	Scrubber	Average	-	-	-	170
		MDL[c]				0.7
Fixed	Filter	Average	8.7×10^{-2}	8.2×10^{-2}	0.21	5.4
		MDL	6×10^{-3}	4×10^{-3}	0.1	4×10^{-3}
	Scrubber	Average	0.62	2.3	2.4	210
		MDL	0.4	0.2	2.0	0.3

(a) Stack Analyzing Monitor

(b) The SAM strip filter is not analyzed in the laboratory. The associated electronic equipment is calibrated to yield one register for each 0.01 curie of Ru^{103} and Ru^{106} emitted.

(c) Minimum detection limit via laboratory analysis. Actually detection limit varies with length of sample run, aliquot analyzed, and counting crystal used.

The agreement between the I^{131} emission rates as measured by both the SAM and the "Fixed" scrubber is expected since both systems sample the gas from the same circulating manifold. The "Fixed" scrubber I^{131} results are obtained as part of the gamma energy analyses for other fission products. They are used to confirm the results from the SAM and as a substitute in case the SAM fails.

At the Redox plant, samples of the particulate material contained in the dissolver vent air streams and the canyon air exhaust are collected by CPD RM personnel with H-70 filters by means of a vacuum steam jet. These filters are changed daily and counted with a GM instrument. No attempt is made to convert the results to μc/cc or μc/day, since the samples are used for the purpose of identifying trends in the amounts of radioactive material that penetrate the sand filters. Readings are also taken on these filter samples with a "poppy" to estimate the amount of plutonium released to the atmosphere. Usually, the results are less than 500 d/m per sample or approximately $< 2 \times 10^{-4}$ μc/day. On a few occasions, the amount of plutonium released has approached 3 μc/day.

2. Roof Vents, 202-S Building

Filter samples of the air exhausted from various roof vents at 202-S Building are routinely collected by CPD RM personnel. At the Pu concentration facility (233-S), daily filter samples are collected for gross alpha counting. Results range from 0.1 to 10 μc/day with an average emission of ~2 μc/day. When the filter in the process exhaust system is being changed or is otherwise out of service, the maximum amount of Pu emitted may reach 50 μc/day or 2.2×10^{-10} μc/cc.

Spot filter samples are taken at the exhausts of the north and south sample galleries. They are counted both for alpha and beta-gamma activity with the indicated air concentration normally staying below recommended mask levels of 2×10^{-12} μc/cc Pu and 1×10^{-9} μc/cc mixed FP.(4) Spot samples of the exhaust air from the decontamination room, regulating shop and SWP lobby collected with an H-70 filter have failed to reveal any detectable amounts of either alpha or beta-gamma contamination.

3. Redox Technology Laboratory, 222-S

Weekly filter samples of the exhaust air from the Redox Technology Laboratory stack are collected by CPD RM personnel. The samples are counted in the 222-S laboratory for both gross alpha and beta emitters. The results normally average less than 2×10^{-12} μc alpha per cc (< 7 μc/day) and 5×10^{-10} μc beta per cc (2 mc/day).

B. Plutonium Metallurgy Building

A 2.5 CFM sample of the exhaust air from the 231-Z Building is drawn through a 4" x 8" H-70 filter paper by means of a steam jet. The filter is changed weekly by HLO RM personnel and the collected materials are allowed to decay for one week before being counted for gross alpha radioactivity. Although Pu^{239}, Np^{237}, U^{238} and other alpha emitters may be present, all of the alpha emitters measured one week after collection are assumed to be plutonium.

The average rate of discharge per week for 1961 was 6.8×10^{-13} μc/cc equivalent to 2.1 μc of plutonium released weekly. The results for 1961 are given in Table C of the Appendix.

C. Plutonium Metal Fabrication Building

CPD RM personnel collect a daily sample of the exhaust gases from the 291-Z stack. A vacuum steam jet draws the 5.0 CFM sample through a 4" x 4" H-70 filter. After a 24-hour period to allow for decay of natural air-borne alpha emitters, the sample is counted with an alpha scintillation detector. Any activity found is assumed to result from plutonium.

The average emission rate of plutonium for 1961 was 20 μc/day (2×10^{-12} μc/cc). The daily results are summarized in Table D.

Hydrogen fluoride corrosion of both the primary and secondary filters occasionally causes increased plutonium emission. Under these conditions, a maximum release on the order of 10^3 μc/day (10^{-10} μc/cc) of plutonium can probably be expected.

D. Uranium Oxide Facility

Air from the process tanks in the Uranium Oxide Facility (224-U) is discharged to the atmosphere by means of three vents, each of which extends approximately 10 feet above the roof of the building. The total discharge capacity of the three vents is 14,000 CFM. The general building air itself is routed to the 291-U stack.

A 24-hour sample is taken from each vent by CPD RM personnel using a 4" x 4" H-70 filter which is located about 5 feet from the discharge end of the vent. The sampling rate is 2 CFM. The samples are counted for alpha activity and the daily emission from the three vents in μc/day is calculated as though all the activity were due to uranium. For 1961, the average daily emission of uranium from the three vents was 23 μc/day. The average monthly emissions are listed in Table E.

The main 291-U stack is not being sampled at present. Up until 1959, EMO collected semiweekly filter samples from the ten foot level of this stack by means of a vacuum pump. Results of the direct counts made on the filters averaged about one microcurie gross alpha and about one millicurie gross beta emitted per day.

E. Miscellaneous Facilities

1. Decontamination Facility - T-Plant

No samples are being collected at present from the Waste Handling and Decontamination Facility main ventilation stack at 291-T. Past spot sampling revealed no significant emission of any isotope.

IV. 200 EAST AREA

Table V summarizes the information relating to sampling of the principal stacks and vents in 200 East Area.

A. Purex Separations Plant, 202-A

1. Main Ventilation Stack, 291-A

Environmental Monitoring presently has three sampling systems in operation at the 291-A stack - a constant I^{131} monitor, a strip filter sampler, and a fixed filter sampler.(1, 2, 3)

TABLE V

SUMMARY OF STACK SAMPLING INFORMATION

200 EAST AREA

Stack	Location	Height	Flow (10^3 CFM)	Sampled By	Analyzed For
Main Vent Stack, Purex Plant	291-A	200'	120	EMO	Ru^{103}, Ru^{106} I^{131}, Zr-Nb^{95}, Gross Beta
Sample Gallery Hoods	Roof Vent 202-A	50'	4.5 & 6	CPD RM	Filterable, Gross Alpha as Pu, & Gross Beta as F.P.
PR Room & N-Cell Hood	"	50'	6	CPD RM	Filterable, Gross Alpha as Pu, & Gross Beta as F.P.
Main Vent Stack, Hot Semiworks	291-C	200'	20	EMO	Total Sr, Ce-Pr^{144} Gross Beta
"Patio" Stack Hot Semiworks	271-C	50'	8.3	EMO	" "
Pu Critical Mass Lab.	209-E	33'	5	EMO	Filterable, Gross Alpha, as Pu
Main Vent Stack B-Plant	291-B	200'	~20 to 30	(Will be monitored by EMO when Sr^{90} recovery begins)	
Tank Farm Vent	242-BY	20'	4.5	HLO RM	Filterable, Gross Beta, Gross Alpha
"	241-CR	20'	4.2	CPD RM	" "
"	241-A	20'	4.2	CPD RM	" "

The constant I^{131} monitor consists of a counter-current flow scrubber column through which 0.6 CFM of effluent gases from the 200 ft. level of the stack is passed. The scrubbing liquid, 0.2 normal NaOH, is pumped from a storage reservoir to the top of the scrubbing column at a constant rate of 5 cc per minute. As the gas sample rises through the column, the caustic solution collects I^{131}. The caustic solution drains from the bottom of the column, and through a counting chamber where it is continuously monitored by a GM tube connected to a count-rate meter and chart recorder. The calibration of this detection system is only semiquantitative

and the monitor is used to indicate trends and to relate I^{131} emissions to time of day and process operations. The spent solution drains from the monitoring chamber to a collection flask and each day an aliquot of the scrubber solution is taken to the laboratory for I^{131} analysis by gamma spectroscopy.

The strip filter sampler continuously monitors and records the concentrations of gross beta particulates emitted from the Purex stack. A 1.0 CFM gas sample from the 50 ft. level of the stack is passed through a moving strip of H-70 filter paper. After exposure the filter paper passes under a beta-sensitive anthracene scintillation crystal connected to a count-rate meter and chart recorder.

The fixed filter samples 0.5 CFM of the effluent gases from the 200 ft. level of the stack. H-70 filter paper, 2 inches in diameter, is used in the filter holder. After a 24-hour exposure period, the filter is changed and analyzed for I^{131}, Ru^{103}, Ru^{106}, and Zr-Nb^{95}, by gamma energy analysis.

A summary of the emission rates of various fission products from the 291-A stack is given in Table VI. The monthly average and maximum daily emissions are summarized in Table F of the Appendix.

TABLE VI

EMISSION OF FISSION PRODUCTS FROM THE 291-A STACK

1961

Millicuries Per Day

Sampling System		I^{131}	Ru^{103}	Ru^{106}	Zr-Nb^{95}	Gross Beta
Constant I^{131} Monitor	Average	530	-	-	-	730
	MDL*	1.0	-	-	-	0.5
Strip Filter Monitor	Average	-	-	-	-	19
	MDL*	-	-	-	-	0.47
Fixed Filter Monitor	Average	0.95	1.2	4.6	0.66	-
	MDL*	0.004	0.004	0.1	0.007	-

* Minimum Detection Limit

Daily filter samples of the exhaust air are also taken immediately downstream of the final glass wool filter and at the 291-A stack house by the Purex Radiation Monitoring Group.

Average results of gross beta analysis on samples of the exhaust air collected downstream of the glass wool filter are ~20 millicuries per day.

2. Roof Vents, 202-A

Filter samples are also taken by CPD RM personnel on a weekly frequency at the two stacks that exhaust the sample gallery hoods and the stack that vents the PR room and N-cell hood. All samples are analyzed for gross alpha activity which is assumed to result from Pu^{239} and gross beta emitters which consist of a mixture of fission products.

Up to November of 1959, all results were reported in millicuries per day. After that time, only counts per minute were recorded unless the concentrations exceeded 10^{-13} μc/cc alpha or 10^{-10} μc/cc beta activity. If the results exceed these concentrations, they are recorded in a "positive air sample report". The recorded results are usually on the order of 10^{-12} μc alpha/cc and 10^{-9} μc beta/cc. The results cannot be accurately averaged over a given period of time since only those results which exceed specified concentrations are recorded.

B. Hot Semiworks Facility

1. Main Ventilation Stack, 291-C

The Hot Semiworks has been reactivated as a pilot plant for the recovery of Sr^{90} from the first cycle dissolver waste of Purex. Operations began in the Spring of 1961 and are scheduled to continue into 1967. After this time, B plant may assume the isotope recovery program on a larger scale.

A 1 CFM sample of the effluent gases from the Hot Semiworks process stack (291-C), is drawn through a 2" diameter millipore filter by means of a vacuum pump. The gross beta activity accumulated on the filter is continuously monitored and recorded by a bioplastic scintillation counter. The filter is changed daily and analyzed for total beta, total strontium, and Ce-Pr^{144}. Other analyses may also be performed if the total beta measurement is unusually high.

2. "Patio" Roof Stack, 271-C Building

Portions of the process cell air and general building air are exhausted through the "Patio" stack. This stack is normally sampled by operations personnel. EMO sampled the stack temporarily during the period May to October, 1961, following an

unusually high emission caused by a rupture of the air filter in this ventilation system. After the ruptured filter was replaced, emissions were reduced considerably and operations personnel resumed sampling of this stack. Normally, approximately 2 μc beta/day are emitted from the "patio" stack. A summary of the average emissions for 1961 from the Hot Semiworks is presented in Table VII. More detailed data is given in Table G of the Appendix.

TABLE VII

EMISSION OF FISSION PRODUCTS FROM HOT SEMIWORKS STACKS

1961

Millicuries/Day

Stack	Total Beta	Total Strontium	Ce^{144}-Pr^{144}
Process Stack (291-C)	1.1	0.42	0.55
"Patio" Stack	0.11	0.079	0.0004
Total	1.2	0.50	0.55

The experience gained in monitoring the exhaust air of the Hot Semiworks will be applied to B plant should similar operations begin there. It is expected that sampling methods will essentially be the same as those presently used at the Hot Semiworks.

C. Plutonium Critical Mass Laboratory

The Critical Mass Laboratory started operations during the Spring of 1961. The main contaminant in the exhaust air is particulate plutonium nitrate. A 1 CFM sample of the effluent stream is passed through an H-70 filter. The filter is changed weekly and counted for plutonium with a scintillation detector in the radiochemical laboratory. Results of exhaust air samples taken to date have indicated an emission rate below the detectable limit of 2×10^{-3} μc/day.

D. Miscellaneous Facilities

1. 241-BY Tank Farm

The 241-BY Tank Farm stack has been sampled occasionally because of its suspected contribution to excessive contamination found

in the immediate area. Table VIII gives the results of three filter samples that were taken between February 25, 1955 and March 10, 1955. The samples were collected at a rate of 5 CFM out of a total stack flow of 4500 CFM. No routine samples of the exhaust air are presently taken.

TABLE VIII

EMISSION OF FISSION PRODUCTS FROM THE 241-BY TANK FARM STACK

February and March, 1955

Average of 3 filter samples

	10^{-10} µc/cc	mc/Day
Total Beta	38	0.7
$Zr\text{-}Nb^{95}$	0.8	0.01
RE+Y	28	0.5
Total Strontium	7.5	0.1
$Ru^{103}+Ru^{106}$	1.8	0.03
Cs^{137}	4.5	0.08

2. 241-CR and 241-A Tank Farms

Spot samples of exhaust air from the 241-CR and 241-A Tank Farm vents have been collected occasionally by CPD RM personnel. The results of these samples indicate that these facilities contribute negligible amounts of contamination to the environs.

V. 300 AREA

Table VIII is a summary of stack monitoring information related to 300 Area facilities. The 306, 309, and 327 Buildings are the only ones in the 300 Area where EMO is presently monitoring the exhaust gases. Personnel of the HLO RM group are operating a fixed filter monitor on the main exhaust duct between the 325-A Hot Cells and the 325 Building main stack. EMO is planning to install stack sampling equipment at the latter stack in the near future.

TABLE VIII

SUMMARY OF STACK SAMPLING INFORMATION

300 AREA

Stack	Location	Height	Flow (10^3 CFM)	Sampled By	Analyzed For
Stack and Roof Vents, Thorium Process	306 Bldg.	~5' above roof	0.4 to 30	EMO	Thorium & daughters
3 Stacks Pu Fuels Pilot Pl.	308	40' ea	146 Total	Not Sampled	
PRTR	309	150'	6.7 Normal (11 Purge)	EMO	Gross Beta I^{131}
Cold Semiworks	321	-	-	Not Sampled	
Radiochemistry	325	50'	132	HLO RM Main ducts only	Gross Beta
Physics	326	40'	67	Not Sampled	
Radiometallurgy	327	50'	50	EMO	Gross Beta, I^{131}
Misc. FPD Facilities	303 Area	-	-	FPD	Uranium

A. Thorium Processing Facilities

EMO maintains filter samples on each of the roof vents of 306 Building which exhaust air from the thorium processes within this facility. A summary of the exhaust vent sampling program is given in Table IX.

TABLE IX

SUMMARY OF EXHAUST SAMPLING PERFORMED BY EMO
306 BUILDING

Exhaust	Location	Exhaust Flow (10^3 CFM)	Sample Flow (CFM)	Analyzed For
Chemical Processing Exhaust Stack	Main Stack	30	2.5	Filterable Gross Alpha and Beta as Th^{232} and Ac^{228}
Electron Beam Weld	Roof Vent	17.5	2.0	" " "
Machine Shop	" "	23	1.5	" " "
Arc Furnace	" "	2.16	1.0	" " "
Vacuum Furnace	" "	21.2	1.5	" " "
Storage Room	" "	0.4	0.5	" " "

Samples are collected on Gelman polypore filter paper during and shortly after the operation of the thorium processes. The filters are counted in the laboratory for gross alpha and beta radioactivity. The alpha activity is assumed to be due to thorium-232 while the beta activity is assumed to be due to actinium-228. All sample analyses to date have indicated an emission rate below the MPC_a of Th^{232} and Ac^{228} (2×10^{-12} μc/cc).(5)

B. Plutonium Recycle Test Reactor

EMO collects three types of samples from the 50' level of the Plutonium Recycle Test Reactor (PRTR) stack. The equipment is located in the stack sampling pit at the base of the stack. A strip filter monitor operating at 5.0 CFM collects particulate material, monitors the exposed filter paper for gross beta emitters by means of a scintillation counter, and records the counting rate. No laboratory analysis is ordinarily performed on the filter paper from this monitor.

An integrated, weekly sample of particulate material is collected on a fixed filter sample operated at 0.2 CFM. The exposed filter is taken to the laboratory for gross beta and gross alpha counting. Stack emissions as monitored by this method indicate average releases of approximately 10^{-8} c/day of alpha emitters and 10^{-6} c/day beta emitters.

The gas which has been filtered by this fixed filter sampler is next passed through a charcoal cartridge centered in a NaI crystal where the 0.36 Mev photons from any I^{131} trapped in the charcoal is monitored and recorded.

After final system check-out and calibration the chart recorders and alarms associated with both the strip filter and the charcoal halogen monitor will be moved from the stack sample pit to an occupied location within the PRTR Building.

C. Radiochemistry Building

The main exhaust stack at the Radiochemistry Building is not sampled at present. EMO plans to establish a stack monitoring station at this location during the latter part of 1962. Exhaust air is sampled by HLO RM personnel at each hood where the possibility of radioactive contamination exists. The sampling is done between the hood filter and main air stream. For the most part, samples have indicated concentrations of less than 1×10^{-10} μc/cc beta - gamma activity. One exception to this is the exhaust from the 325-A Hot Cell additions which is monitored with a fixed filter installation maintained by HLO-RM personnel in the duct between 325-A and the exhaust stack. This sampler collects a continuous sample downstream of the ventilation filters for the Hot Cells and monitors the filter with both alpha and beta sensitive scintillation crystals.

D. Radiometallurgy Building

A 2 CFM sample of the exhaust gases is drawn from the base of the stack at the Radiometallurgy Building (327) and passed through an H-70 filter paper and then through a caustic scrubber. The scrubbing solution consists of 1500 mls of 3N NaOH. The samples are normally changed on a weekly frequency and analyzed in the laboratory for gross beta radioactivity. The average daily emission for 1961 was 0.29 millicuries per day, filter and scrubber results combined. The analytical detection limit is ~ 0.01 millicurie/day. Monthly average and maximum results obtained from monitoring this stack are given in Table H of the Appendix. Occasionally in the past I^{131} could be detected in the scrubber solutions as a result of operations on fuel elements with cooling times of only a few days. Charcoal filter beds installed in the main ventilation ducts ahead of the stack have essentially eliminated emission of radioiodine from the 327 Building stack.

E. FPD Facilities

Exhaust stacks and vents from miscellaneous FPD facilities in the 303 Area are not routinely monitored. FPD RM personnel occasionally spot check exhaust ducts, stacks, and roof vents for uranium. Very little contamination has been found at any of these locations. Momentary concentrations of 10^{-10} μc/cc of uranium have been found in the exhaust from the uranium scrap incinerator building (303-L) during one operation with a ruptured ventilation filter. Replacement of the facility filter reduced concentrations by an order of magnitude.

VI. BIBLIOGRAPHY

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APPENDIX

TABLE A-1

EMISSION OF FILTERABLE GROSS ALPHA EMITTERS FROM THE REACTOR STACKS - 1961

Nanocuries Per Day

Month	105-B	105-C	105-KW	105-KE	105-D	105-DR	105-H	105-F
January	4	57	7	2	9	7	33	2
February	33	260	40	37	4	3	14	12
March	8	79	8	7	7	2	17	7
April	12	55	2	5	2	4	77	2
May	7	61	33	2	12	8	26	5
June	7	47	1	5	11	12	66	17
July	7	-	4	4	7	-	110	-
August	12	-	6	9	1	8	42	-
September	7	-	13	12	7	4	71	-
October	12	890	10	7	20	8	440	-
November	8	40	7	10	12	2	220	-
December	11	100	12	11	4	7	120	-
Average	11	180	12	9	8	6	100	8

TABLE A-2

EMISSION OF FILTERABLE GROSS BETA EMITTERS
FROM THE REACTOR STACKS - 1961

Millicuries Per Day

Month	105-B	105-C	105-KW	105-KE	105-D	105-DR	105-H	105-F
January	0.014	0.57	0.40	0.19	0.0019	0.0021	0.032	0.0001
February	0.040	0.72	0.15	0.14	0.0077	0.0002	0.0039	0.0003
March	0.021	0.43	0.26	0.035	0.0036	0.0001	0.028	0.0002
April	0.018	1.1	0.13	0.10	0.0065	0.0002	0.040	0.0001
May	0.024	0.76	0.083	0.064	0.0033	0.0001	0.026	0.0001
June	0.019	0.33	0.021	0.075	0.0038	0.0001	0.028	0.0001
July	0.021	-	0.025	0.037	0.0038	0.0001	0.033	-
August	0.029	-	0.0062	0.074	0.0027	0.0001	0.036	-
September	0.013	0.065	0.013	0.065	0.050	0.0001	0.031	-
October	0.047	0.15	0.014	0.10	0.23	0.0001	0.073	-
November	0.023	0.26	0.035	0.39	0.024	0.0001	0.041	-
December	0.033	0.35	0.024	0.095	0.013	0.0001	0.033	-
Average	0.025	0.47	0.097	0.11	0.029	0.0003	0.034	0.0002

TABLE A-3

EMISSION OF C^{14} FROM REACTOR STACKS - 1961

Millicuries Per Day

Month	105-B	105-C	105-KW	105-KE	105-D	105-DR	105-H	105-F
January	-	-	-	-	-	-	-	-
February	4.8	8.3	-	-	40	16	1.2	-
March	16	4.7	17	17	23	8.3	3.2	0.50
April	12	5.2	5.8	8.1	12	2.9	21	0.10
May	20	6.1	3.7	2.4	31	16	12	-
June	26	6.1	7.7	23	33	13	8.8	-
July	17	-	43	110	77	16	14	-
August	-	-	-	29	-	-	-	-
September	32	0.38	5.7	40	28	2.4	16	-
October	5.5	6.7	12	36	14	29	-	-
November	-	-	-	-	-	-	-	-
December	0.59	2.3	2.0	7.9	110	4.8	18	-
Average	15	5.0	12	30	41	12	12	0.30

TABLE A-4

EMISSION OF S^{35} FROM THE REACTOR STACKS - 1961

Millicuries Per Day

Month	105-B	105-C	105-KW	105-KE	105-D	105-DR	105-H	105-F
January	0.05	0.05	-	-	-	0.03	0.01	-
February	0.13	0.10	0.17	0.10	1.4	0.05	0.11	0.10
March	0.48	0.02	0.15	1.2	0.36	-	0.02	0.03
April	0.24	-	0.11	0.03	0.05	0.01	0.03	0.03
May	0.32	0.05	-	0.11	0.58	0.11	-	-
June	0.37	0.07	0.02	0.05	0.46	0.06	0.02	-
July	0.16	-	0.03	0.04	0.10	0.04	-	-
August	-	-	-	-	-	-	-	-
September	0.06	0.27	0.03	0.02	0.02	-	0.12	-
October	0.02	0.07	7.8	0.03	0.01	0.01	-	-
November	-	-	-	-	-	-	-	-
December	0.02	0.02	0.39	0.03	0.22	-	0.02	-
Average	0.19	0.08	1.1	0.18	0.36	0.04	0.05	0.05

TABLE B

EMISSION OF FISSION PRODUCTS FROM THE REDOX STACK - 1961

Millicuries Per Day

	SAM		FIXED SCRUBBER							
	I^{131}		I^{131}		Ru^{103}		Ru^{106}		$Zr\text{-}Nb^{95}$	
Month	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
January	0.75	1.0	0.14	0.24	0.11	0.2	1.2	2.4	0.22	0.39
February	9.9	50	7.8	46	0.19	1.7	1.6	2.6	0.26	0.42
March	120	340	130	900	0.28	2.0	5.0	49	0.37	1.2
April	95	390	82	310	0.84	18	2.7	30	0.29	0.81
May	13	85	26	320	0.15	0.57	0.62	2.5	0.047	0.40
June	52	280	56	690	0.25	1.1	1.0	3.7	0.23	1.3
July	180	800	210	870	1.1	6.1	3.8	27	0.94	4.7
August	300	720	250	840	2.5	13	2.2	3.9	0.52	3.0
September	190	540	360	1100	2.1	8.0	2.1	3.4	0.64	4.0
October	460	1000	470	1000	11	110	2.5	3.1	1.3	11
November	450	1800	620	3100	6.5	72	3.6	17	1.7	20
December	180	690	310	1200	2.5	14	1.9	3.2	0.88	3.6
Average	170	-	210	-	2.3	-	2.4	-	0.62	-

TABLE B (Continued)

	FIXED FILTER							
	I^{131}		Ru^{103}		Ru^{106}		Zr-Nb^{95}	
Month	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
January	0.0048	0.051	0.0040	0.10	0.27	2.9	0.25	3.5
February	0.10	0.80	0.0039	0.017	0.085	0.31	0.040	0.43
March	1.9	13	0.020	0.34	0.086	0.47	0.039	0.20
April	2.4	47	0.036	0.24	0.13	1.3	0.13	0.88
May	0.50	2.9	0.019	0.14	0.10	0.71	0.032	0.19
June	0.79	8.0	0.0094	0.07	0.14	0.83	0.019	0.075
July	5.5	66	0.029	0.61	0.16	1.6	0.12	1.7
August	4.5	18	0.037	0.19	0.08	0.20	0.03	0.12
September	14	76	0.23	1.1	0.35	2.5	0.12	0.77
October	8.0	42	0.11	0.41	0.37	2.0	0.074	0.43
November	15	110	0.24	1.2	0.42	2.5	0.094	1.2
December	12	95	0.25	1.9	0.27	4.0	0.097	1.3
Average	5.4	-	0.082	-	0.21	-	0.087	-

TABLE C

EMISSION OF PLUTONIUM FROM THE 231-Z BUILDING STACK
1961

Microcuries Per Week

Month	Average	Maximum
January	6.5	24
February	0.72	1.1
March	0.84	1.5
April	1.3	1.6
May	2.1	4.7
June	1.9	4.0
July	4.3	12
August	3.5	11
September	1.1	1.7
October	1.0	1.9
November	0.88	1.7
December	0.69	1.0
Average	2.1	-

TABLE D

EMISSION OF PLUTONIUM FROM THE 291-Z BUILDING STACK
1961

Microcuries Per Day

Month	Average	Maximum
January	23	44
February	22	62
March	15	61
April	15	29
May	11	26
June	17	31
July	20	37
August	31	61
September	29	79
October	26	54
November	17	70
December	10	28
Average	20	-

TABLE E

EMISSION OF URANIUM FROM THE 224-U BUILDING
1961

Microcuries Per Day

Month	Roof Vent Number			
	X-13	X-31-1	X-31-2	Total
January	17	1.3	4.3	23
February	17	1.8	7.4	26
March	6.2	1.4	4.1	12
April	5.4	4.7	2.3	12
May	23	1.9	1.5	26
June	35	5.4	3.9	44
July	9.1	2.6	4.8	17
August	15	3.0	11	29
September	39	4.6	2.6	46
October	22	1.8	3.8	28
November	1.4	2.5	4.2	8.1
December	2.8	2.0	2.2	7.0
Average	16	2.8	4.3	23

TABLE F

EMISSION OF FISSION PRODUCTS FROM THE PUREX PLANT STACK - 1961

Millicuries Per Day

	CONSTANT MONITOR		STRIP FILTER		STATIONARY FILTER							
	I^{131}		Total Beta		I^{131}		Ru^{103}		Ru^{106}		Zr-Nb^{95}	
Month	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
January	780	1800	11	29	1.2	5.0	0.015	0.077	0.27	2.7	0.20	0.87
February	460	1000	11	17	0.73	2.1	0.67	5.5	2.1	8.6	4.6	19
March	680	2300	16	34	2.2	26	0.40	1.5	0.96	2.9	0.86	5.6
April	560	2100	16	30	1.1	13	0.64	3.5	1.5	9.0	1.5	10
May	770	1500	13	39	1.1	2.5	3.0	10	19	68	1.3	2.4
June	860	2300	12	38	2.2	30	0.62	1.9	4.1	64	2.9	36
July	420	2500	14	67	1.7	15	0.79	4.0	4.1	41	0.94	3.4
August	660	1200	69	220	6.4	26	1.5	4.9	4.9	16	3.2	24
September	600	1800	19	52	0.87	12	0.75	3.5	3.0	20	2.5	25
October	320	1600	27	70	2.2	23	0.52	2.2	1.8	8.9	0.78	3.3
November	180	1400	7.2	7.8	0.71	2.1	0.37	1.3	1.3	7.2	0.36	1.1
December	58	230	9.0	70	0.95	9.7	1.2	8.4	4.6	20	0.66	2.1
Average	530	-	19	-								

TABLE G

MONTHLY AVERAGE EMISSION OF FISSION PRODUCTS
HOT SEMIWORKS EMISSION STACK - 1961

Microcuries Per Day

	PROCESS STACK			PATIO STACK		
Month	Total Beta	Total Sr	$Ce\text{-}Pr^{144}$	Total Beta	Total Sr	$Ce\text{-}Pr^{144}$
March	0.26	-	-			
April	4.8	0.52	5.8			
May	7100	2900	3100	650	470	0.78
June	730	2.5	1000	3.1	1.8	1.0
July	210	120	22	3.4	1.8	0.37
August	4.9	0.95	-	1.4	0.78	0.18
September	430	190	140	1.3	0.31	0.07
October	57	32	10	2.0	0.10	0.15
November	890	400	69			
December	1900	120	70			
Average	1100	420	550	110	79	0.43