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HANFORD LABORATORIES OPERATION

MONTHLY ACTIVITIES REPORT

SEPTEMBER 1956

Compiled by
Operation Managers

October 19, 1956

HANFORD ATOMIC PRODUCTS OPERATION

RICHLAND, WASHINGTON

Work performed under Contract No. W-31-109-ENG-52 between the Atomic Energy Commission and General Electric Company

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HANFORD LABORATORIES OPERATION
FORCE REPORT AND PERSONNEL STATUS CHANGES
SEPTEMBER 1956

FORCE REPORT

PERSONNEL STATUS CHANGES

Component	At Close of Month Exempt	Non-Exempt	Total	*At Beginning of Month Exempt	Non-Exempt	Total	Additions Exempt	Non-Exempt	Separations Exempt	Non-Exempt	Sep.Rate M	F
HLO General	1	1	2	1	1	2					2.90	2.56
Biology	29	42	71	30	43	73		1	2	1	6.97	0
Chemical Research & Development	130	92	222	132	95	227	1	4	3	5	3.37	2.73
Laboratory Auxiliaries	34	197	231	33	200	233		9		14**	2.22	7.12
Operations Research	12	3	15	13	2	15		1	1		8.33	0
Physics & Instrument Research & Development	59	20	79	59	20	79	2	1	1	1	2.85	0
Radiation Protection	40	198	238	40	196	236		3		5	.775	3.47
Reactor & Fuels Research & Development	130	84	214	133	81	214	1	8	5	2	3.82	0
Employee Relations	13	11	24	10	8	18	3	4			0	0
Financial	15	30	45	14	32	46	1	—	—	1	0	0
Total	463	678	1141	465	678	1143	8	31	12	29	2.78	

* 9/1/56 statistics subject to minor errors - Currently being reviewed

** 1 dropped

HANFORD LABORATORIES OPERATION
PERSONNEL STATUS CHANGES
SEPTEMBER 1956

DURING MONTH

Component	PROMOTIONS: Exempt(1)	PROMOTIONS: Non-Exempt to Exempt	PROMOTIONS: Non-Exempt(2)	EXEMPT TRANSFERS(3): To HLO From Other HAPO	EXEMPT TRANSFERS(3): To HLO From GE	EXEMPT TRANSFERS(3): From HLO To Other HAPO	EXEMPT TRANSFERS(3): From HLO To Other GE	NON-EXEMPT TRANSFER(3): To HLO To or from Other HAPO Depts Unless Otherwise Indicated	NON-EXEMPT TRANSFER(3): From HLO To or from Other HAPO Depts Unless Otherwise Indicated
HLO General									
Biology									
Chemical Research & Development	2		2	1		1			1
Laboratory Auxiliaries			15					4	8
Operations Research	1							1	
Physics & Instrument Research & Development	1		1						
Radiation Protection			5					2	1
Reactor & Fuels Research & Development	2	1	3				1	8	1
Employee Relations			1	2				1	
Financial	-	1	3	1		—	-	—	—
Total	6	2	30	4		1	1	16	11

(1) Promotions coincident with reorganization not included

(2) Changes in job title with no pay increase not included

(3) Does not include transfers within HLO

DEL

RESEARCH AND DEVELOPMENT ACTIVITIES

METALLURGY AND REACTOR FUELS

Uranium Metallurgy

Tensile Properties. A natural uranium tensile sample enclosed with a uranium split sleeve and canned in a NaK-filled Zircaloy-2 capsule, was examined after irradiation to determine the properties of material exposed at beta or gamma phase temperatures. The specimen was exposed six days in the MTR for an estimated exposure of 0.02 percent burnup (185 MWD/T) at an estimated temperature of 800C. The sample appearance after exposure was excellent and there was no evidence of surface irregularity or bumping. The 0.250-inch diameter of the test specimen had increased approximately 0.022 inch. The tensile data obtained from a room temperature test are given in the following table with data for the same material exposed to 0.018 percent burnup at 150C and an unirradiated control sample.

Tensile Properties of Irradiated Uranium

Exposure Percent burnup	Exposure Temperature	0.2% Y.S. 1000 psi	Ult. Str. 1000 psi	Elong. % in 1 in.
0		37.8	97.1	19 ± 1
0.018	150C	60.3	84.4	0.8
0.02 (est)	800C (est)	-	61.0	<1.0

Fracture of the sample contained bright areas typical of large grained cleavage. The low ultimate strength is probably due to some extent to the large grain size produced by heating into the gamma phase but the data indicate that high temperature irradiation does not reduce the embrittlement suffered by uranium during irradiation.

Activation Energy. A study initiated to determine the effect of cooling rate from the beta phase on the activation energy required for alpha phase recrystallization of uranium has been completed. Time-temperature relationships for recrystallization at Jominy specimen cooling rates of 4.4, 9.4, 250 and 500C/second were established for temperatures of 580, 596, 620 and 640C. Utilizing the Arrhenius rate equation ($Ae^{-Q/RT}$) the activation energies (Q) and A values were calculated and are shown in the following table.

Cooling Rate C/second	Activation Energy Cal/Mol	A Value
4.4	110,600	4.84×10^{22}
9.4	88,530	3.52×10^{18}
250	52,270	2.04×10^{10}
500	30,150	3.86×10^{5}

The activation energy decreased with increased cooling rate. This is a departure from the accepted theory that the activation energy should remain relatively constant as a function of strain.

Diffusion Studies. Diffusion in non-irradiated U/AlSi and U/Zr couples is being investigated to provide a basis for interpretation of the results from irradiated couples. Final results from seven couples are shown in the following table.

Maximum Diffusion of Uranium into AlSi and AlSi into Uranium From the Original U/AlSi Interface

Temperature C	Time Days	U into AlSi (mils)	AlSi into U (mils)
200	15	0.3	0.3
200	15	0.2	0.2
200	44	0.6	0.4
200	44	0.5	0.4
250	15	2.0	1.5
250	15	2.1	1.4
305	15	6.6	4.2

Each couple was cross sectioned six times and the maximum diffusion into the planes thus produced was recorded. The data were analyzed statistically in order to determine the maximum penetration that could be expected in each couple. Two U/Zr couples that were annealed 300 days at 500C under a pressure of 10,000 psi were cross sectioned three times in planes perpendicular to the diffusion interface. Extensive metallographic examination failed to reveal any points at which diffusion occurred. These couples will be cross sectioned another seven times.

Thermal Stresses. A method of evaluating the thermal stresses in cylindrical reactor fuels has been developed. This method utilizes a viscoelastic model with a time and radial dependent coefficient of viscosity.

Burnup. Samples for burnup determination were cut from uranium tensile specimens which had been exposed to approximately 150, 300, and 600 MWD/T at HAPO. The results of these determinations were 0.18 percent burnup of the total atoms (155 MWD/T), 0.031 percent (270 MWD/T), and 0.075 percent (654 MWD/T), which agree well with those predicted.

Plutonium Metallurgy

The responsibility for Project Whitney was transferred from the Chemical Processing Department to Hanford Laboratories Operation.

Xenon Diffusion

Data for the diffusion of Xenon in silver have been completed and are shown in the following table.

$D_{500} = 6.5 \times 10^{-11}$ cm^2/sec

$D_{600} = 4.8 \times 10^{-10}$ cm^2/sec

$D_{700} = 2.9 \times 10^{-9}$ cm^2/sec

$D_{735} = 4.9 \times 10^{-9}$ cm^2/sec

$D_{800} = 1.02 \times 10^{-8}$ cm^2/sec

These data obey the following formula for diffusivity versus temperature:

$$D = D_0 e^{-H/RT}$$

$$D = 0.036 e^{-37,500/RT}$$

Graphite

Samples of graphite irradiated in the MTR showed a physical contraction in the sample lengths of 0.04 percent. It is estimated that the samples received a Hanford equivalent exposure of 8000 MD/AT.

Measurements completed on the weight losses experienced by graphite samples exposed to high temperature water and steam showed significant attack on the samples at steam temperatures above 700C.

Plastics

Samples of plastic materials irradiated in the gamma facility at the MTR exhibited an absence of a rate effect. If this phenomena is correct, rapid material evaluation tests can be performed at high fluxes and the results applied at the lower fluxes encountered in service.

Aluminum Corrosion

Examination of corrosion data for aluminum in low flow rate deionized water at 350C has shown that corrosion is dependent on the square root of time for a longer period than literature sources indicate. A transition to a linear dependence on time appears to occur 2 to 5 months depending on the alloy.

Corrosion products formed on aluminum in water at high temperatures consists mostly of boehmite which progresses from an amorphous structure on the "metalside" to a randomly oriented crystalline state and finally to a highly oriented crystalline state on the "water-side" of the film.

A study is being made to determine which component of the reactor coolant affects the corrosion of aluminum. The strongest effect was that of pH. Corrosion was at a minimum at a pH of 5 to 7 and five times this amount at pH 4 and 8.5. Phosphate had an inhibiting effect in the region pH 4.3 to 6.6. Citrate had a definite corrosive effect, increasing corrosion about ten-fold.

Tests have been run in several of the ELMO loops to determine the effects of phosphate ion, aluminum ion and low pH on aluminum corrosion. A corrosion rate of 0.02 mils/month has been observed after an exposure of nine weeks to water of pH 4.5 at 250C. This rate is lower by a factor of 50 than rates observed in dynamic systems using neutral pure water. No inhibiting effect of the aluminum ion has been noted at a concentration of 0.01 ppm.

Examination of several aluminum alloys discharged from the out-of-pile H Loop indicates a general decrease in corrosion rates after 70 days exposure. The equilibrium corrosio

rates of the coupons were 0.20 to 0.38 mils/month or approximately one-half to one-third of the initial rates. Additional tests will be run to determine whether in-reactor rates will decrease after 60 to 70 days.

Titanium Corrosion

Samples of commercially pure titanium (A-55) were enclosed in capsules containing 40 and 70 weight percent nitric acid and held at 145C for a period of two months. The samples, following the exposure, showed no ignition sensitivity when checked by abrasion and impact. Corrosion rates observed were 0.0003 inches penetration per month in 70 weight percent HNO_3 and less than 0.00005 in 40 weight percent acid.

Commercially pure titanium was exposed to a concentrated solution of boiling UNH. No significant attack occurred nor has pyrophoricity been noted. The corrosion rate was less than 0.0001 inches penetration per month.

Tensile Properties of Zircaloy-2

Post irradiation examination was started on Zircaloy-2 tensile specimens exposed in the MTR. The estimated neutron exposure of the material was 1.4×10^{20} nvt (>1 Mev) and 7×10^{20} nvt (thermal). The data obtained are shown in the following table along with pre-irradiation control results.

Tensile Properties of Irradiated Zircaloy-2

History	0.2% Y.S. 1000 psi	Ult. Str. 1000 psi	Elongation % in 1 in.	Modulus 10^6 psi
Annealed	43.9	66.8	22	14.6
Control	44.3	70.0	24	15.0
Annealed and	-	77.8	15	-
irradiated	70.5	82.7	12	15
Percent change (avg)	+60.0	+17.5	-41	nil

The changes observed compare favorably with the maximum change determined for annealed zirconium irradiated at Hanford to an exposure of 2.4×10^{20} nvt (thermal).

Standard Uranium Fuel Elements

Failures. A report (HW-45211) demonstrating and discussing the excellent correlation between reactor failure rate and inspection reject rate was issued. This report presents strong evidence that bond and braze porosity due principally to gas evolution from the uranium core is a heavily contributing cause of in-reactor failure.

One of the standard fuel elements being corrosion tested in a 1706 KE in-pile tube ruptured. It was a core failure of the longitudinal split variety. This fuel element had attained an exposure of 479 MWD/T. There was no indication of excessive attack.

Examination of two split type failures from KW Reactor were completed. The failure occurring in tube 0986-KW had attained an exposure of 668 MWD/T and that in 0990-KW reached 753 MWD/T. Both failures resulted from an unusually large number of 2 to 8-mil

inclusions in the normal reactor grade uranium.

Cleaning. Laboratory tests were made to evaluate various etchants for the purpose of removing possible copper contamination from canning sleeves prior to use. The most attractive reagent was a mixture of chromic acid and sulfuric acid.

Welding. The Roto-Arc welding process, consisting of a cylindrical electrode located in a strong magnetic field, has demonstrated that it should be suitable to automatic welding applications because the part to be welded is heated uniformly and no crater weld is formed.

I and E Fuel Elements

Forty vacuum canned I & E slugs were evaluated to establish a standard canning procedure These slugs showed good quality with respect to (1) residual can wall (2) complete wetting and (3) absence of voids or inclusions. Several assemblies exhibited excessive can wall penetration and poor bonds. One hundred slugs will be examined in the near future.

The occurrence of small black surface inclusions in the weld beads of I & E slugs which were canned in a manner similar to the "F" process were partly responsible for an abnormally high weld rejection rate for these slugs.

Experimental tests to establish instability characteristics of an I & E fuel column were initiated on the full scale, low pressure electrical prototype mockup. The simulated active zone consisted of a 1.43" O.D. cupro-nickel rod with a 3/8" hole drilled along the axis. The heater rod was located inside an electrically insulated B-D-F type process tube. Flows were adjusted to give an initial annulus flow of 3 gpm and a hole flow of 18 gpm. At 750 kw tube power, 75F inlet water temperature and 50 gpm total flow, 69% of the total heat generated was found to be dissipated to the annulus. To determine pressure-flow characteristics for the entire tube, the total flow to the tube was reduced stepwise to a flow of 31 to 32 gpm. Flow and heat removal ratio remained at initial values of 1.83 and 2.2. Further reduction in flow caused both ratios to decrease. These results show that for 750 kw total heat generation and with 400 psig pump discharge pressure the system is stable to at least 18.9 gpm in spite of the fact that boiling was occurring in the annulus.

Using information gained from the in-pile irradiation of I & E fuel elements, a study was made of the relationship between the high temperature at the top of the annulus flow channel and the bulk temperature at the outlet of the process tube. Results show that the ratio of the two temperatures is as high as 1.6 in some cases and that the ratio increases slightly with time. The high temperatures are probably due to the eccentric position of the fuel element in the process tube.

Enriched Fuel Elements

Ten "E" slugs were irradiated in the in-pile loop at H Reactor for 47 days, using water with pH 5.4 at an average outlet temperature of 195C. Corrosion data obtained on these slugs at effective surface temperatures of 225C indicated aluminum corrosion rates of 3.0 mils/month.

Hot-Pressed Fuel Elements

Preliminary evaluation of a lot of vacuum-hot-pressed solid fuel elements from Sylvania has been completed. The SEP hot-pressing process appears to yield a better product than the HAPO hot-pressing process. However, the slugs from Sylvania are inferior in (1) closure quality (2) surface quality and (3) conformance with dimension specifications.

Insulated Fuel Elements

Examination was continued on an insulated cored uranium thermocouple slug which was irradiated in the MTR. The material exhibited some inclusions and blow-holes. This indicates that recrystallization had occurred after the gases causing the blow-holes had been driven to the grain boundaries.

Projection Fuel Elements

A test to aid in the corrosion evaluation of projection fuel elements has been completed. The fuel elements were exposed in process water at 125C for periods up to 94 days. A corrosion rate of 0.9 mils/month was observed. No localized attack was apparent. Film patterns downstream of the projections indicate the possibility of hot spots on the surfaces of the heat generating fuel elements. Such hot spots can be a source of excessive corrosion leading to jacket failures. Tests have also been made to determine the rupture characteristics of projection fuel elements. Two failures have been induced in the Flow Laboratory using defective fuel elements in 145C process water. Both failures resulted in corresponding failure of the process tube. The greatest swelling of the process tube occurred adjacent to the fuel element projections.

Tests made on AlSi canned fuel elements with ribbed supports attached by resistance spot welding showed that this method of attachment offers several advantages over other methods.

Uranium-Magnesium Fuel Elements

Three powder metallurgical U-Mg samples from KAPL have been returned from the MTR. Two samples were irradiated to 1000 MWD/T and the third to about 3000 MWD/T. Microporosity appears to have developed in the U-Mg material, possibly a sintering effect. The U-Mg material was stuck to the aluminum capsule. This could be due to interdiffusion of Al-U or Al-Mg to form a bond.

Experiments are being performed to determine whether U-Mg matrix fuel material can be fabricated by compacting U-shot with Mg.

PHYSICS AND INSTRUMENTATION

Lattice Testing Reactor

Operation of the Lattice Testing Reactor continued routinely during the month. There were three unscheduled shutdowns and several improvement items were completed.

Experiments were performed to test the validity of methods used for determining k_∞ in the Lattice Testing Reactor when large lattices are used. Lattice spacings of 11-1/4 inches, 10-1/2 inches and 9-1/2 inches were employed. Interpretations and further analysis of these experiments are in progress.

Thermal Test Reactor

Preliminary calibrations of the control rods in the Thermal Test Reactor showed a value of 60 cents each. The value of the last safety sheet to be removed is $1.66. These calibrations show maximum rates of addition of reactivity of $3.4 \times 10^{-5} \Delta k/sec$ for the individual control rods and $2.3 \times 10^{-4} \Delta k/sec$ for the final safety sheet. Safety rods are valued at 53.5 cents each. The reactivity drift caused by bubbles resulting from the fuel pieces and water reaction was determined to be one cent per hour. The addition of 100 ppm sodium dichromate reduced this to 0.08 cents per hour.

High Temperature Exponential Experiments

The high temperature exponential pile (approximately and eight-foot cube with 7-1/2-inch lattice) has been heated to 100C with a good temperature distribution throughout the pile. The temperature was constant to within 2C throughout the neutron flux measurement region. Buckling measurements at room temperature show that the six-inch thick magnesia block used on the pile surface for heat insulation purposes increase the extrapolation length by about 1.85 cm over the bare pile. Buckling is also being measured as a function of pile temperature up to 300C with the first measurement above room temperature being taken at 100C.

Enriched-Uranium Graphite Lattices

Additional measurements concerned with E-N loadings for tritium production have been made in 4 ft x 4 ft graphite exponential piles. Buckling is being determined for various ratios of N to E material to select the best ratio for possible loadings in the Hanford Reactors. The E slugs are uranium, enriched to 0.94 weight percent U-235, and are 1.34 inches in diameter and 6 inches long. The N material is aluminum-lithium alloy, 3.5 weight percent lithium, and is 1.34 inches in diameter and 0.909 inches long. The results of wet and dry measurements are shown below.

Lattice Spacing	N/E (Length ratio)	Pile Condition	Buckling (10^{-6} cm^{-2})
8-3/8"	0.151	wet	1.9
7-3/16"	0.151	wet	-19.5
	0.151	dry	3.6
7-3/16"	0.076	wet	153.2
	0.076	dry	159.0
7-3/16"	no N Material	wet	326.0
	no N Material	dry	321.5

Enriched-Uranium, Water-Moderated Lattices

Four buckling measurements were made with enriched hollow fuel elements in light water. These fuel elements were enriched to 1.007 weight percent U-235 and were 1.66 inches in outside diameter and 0.94 inches in inside diameter. These fuel elements were positioned in Type 2S aluminum tubes. An aluminum thimble was positioned within the inside diameter of each fuel rod. A fuel rod consisted of eleven 4-inch fuel elements in a tube. The results were as follows:

Lattice Spacing (hexagonal geometry)	Center Tube Condition	H_2O/U (by volume)	Reflector Savings (assumed)*	Buckling (10^{-6} cm^{-2})
2.45"	wet	2.33	6.94 cm.	2750
2.45"	dry	1.93	7.14	2530
2.70"	wet	3.09	6.68	1530
2.70"	dry	2.69	6.80	1620

*The reflector savings were assumed from Brookhaven data on water-moderated uranium lattices.

When these results are combined with previous data for 2.05-inch and 2.20-inch-lattices, it is possible to estimate the maximum obtainable buckling for this fuel element in light water. The maximum buckling with the center tube in the wet conditions occurs at a H_2O/U volume ratio of about 1.86 and is 3000 x 10^{-6} cm^{-2}. The maximum buckling with no water in the center tube occurs at a H_2O/U volume ratio of 1.70 and is about 2600 x 10^{-6} cm^{-2}. Under either condition the buckling is 2500 x 10^{-6} cm^{-2} when the H_2O/U ratio is 1.36, i.e., buckling curves plotted as a function of the H_2O/U ratio cross at this point.

Wrap Around Fuel Elements

A series of P_3 calculations have been completed to determine the thermal neutron flux distribution in 8-3/8-inch and 7-1/2-inch lattices with aluminum-oralloy wrap around fuel elements and an aluminum-lithium target. The compositions and dimensions of the fuel components are shown below.

Fuel Element (23 and 25 w/o U-235):

Fuel material thickness: 0.065"
Cladding thickness: 0.030"
(bonded to the inner and outer surface)
Fuel element I.D.: 1.190"
(cladding included)
Fuel element O.D.: 1.440"
(cladding included)

Li-Al Target (3.5 w/o Li):

Diameter: 1.010"
Cladding thickness: 0.030"

Inner Water Annulus

Annulus thickness: 0.060"
Annulus I.D.: 1.070"
Annulus O.D.: 1.190"

Outside Water Annulus:

Annulus thickness: 0.075"
Annulus I.D.: 1.440"
Annulus O.D.: 1.590"
O.D. of process tube: 1.744"

The calculations indicate that a reactor completely loaded with a fuel assembly of this kind will always lose reactivity upon the loss of water coolant. When the water is removed from the inner annulus, the target material is placed in a region of higher neutron flux which results in a lower utilization in the fuel element. Lattice parameters determined from the calculated flux distributions are given below.

Lattice Spacing (inches)	Enrichment (weight %)	$f_{\text{fuel element}}$	$f_{\text{Li-Al}}$	Buckling (10^{-6} cm^{-2})	k_{∞}	Conversion Ratio
8-3/8(dry)	23	0.4792	0.4368	-162	0.9144	0.91
8-3/8(wet)	23	0.4943	0.3929	16	1.0090	0.79
8-3/8(dry)	25	0.5055	0.4121	89	1.0514	0.81
8-3/8(wet)	25	0.5183	0.3714	105	1.0600	0.71
7-1/2(dry)	23	0.4886	0.4451	-4	0.9973	0.91
7-1/2(wet)	23	0.5050	0.4019	61	1.0308	0.79
7-1/2(dry)	25	0.5153	0.4198	102	1.0538	0.81
7-1/2(wet)	25	0.5294	0.3798	159	1.0826	0.71

$f_{\text{fuel element}}$ and $f_{\text{Li-Al}}$ are the thermal utilizations of the Al-U-235 fuel element and the Al-Li target material respectively. The conversion ratio is equal to the neutron absorption in Li/neutron absorption in U-235.

Fuel Element Disadvantage Factors

The disadvantage factors (ratio of the thermal neutron flux at the outside edge of the fuel element to the average over the interior) have been determined for a series of natural uranium fuel elements. The neutron flux was calculated by means of the P_3 approximation to the transport equation. The calculations were carried out on the 702 digital computer and results of these calculations are listed below.

Outside Diameter of Fuel Element (inches)	Inside Diameter of Fuel Element (inches)	Disadvantage Factor
0.926	0.00	1.146
1.175	0.00	1.222
1.360	0.00	1.276
1.448	0.00	1.315
1.660	0.00	1.391
1.660	0.81	1.217
1.660	1.10	1.120
1.360	0.50	1.203

Cross Section Measurements

The automatic neutron spectrometer has been used to examine the fission cross sections of Pu-240 and Pu-241. The work on Pu-240 was done using plutonium which had received a long exposure in the Materials Testing Reactor. The results agreed with data obtained from a plutonium sample enriched in Pu-240 by the electromagnetic separations process at Oak Ridge National Laboratory. Results confirmed the existence of a small fission cross section in the 1 ev resonance. Data is currently being taken on the fission cross section of Pu-241.

Critical Mass Calculations

The method for computing critical masses of bare metal reactors using model non-escape probabilities has been used to calculate the critical mass of a bare plutonium sphere. The results are within less than one percent of the value determined by the Los Alamos Scientific Laboratory. The method involves comparatively little computational effort and promises to be of value in nuclear safety and other types of calculations.

Sutton's Diffusion Equation

Analysis of the observations yielded a value of 1.6 for Sutton's stability parameter "n". This is somewhat smaller than the value of 2.0 assumed by Shorr and considerably greater than Sutton's upper theoretical limit of 1.0. This result also throws considerable doubt on Sutton's formulation of the virtual diffusion coefficient, C_z, since this quantity is imaginary for values of "n" greater than 1.0. This problem has been tentatively resolved by assuming that "n" is a function of the intensity of the turbulent motions and ranges from 0.0 to 2.0, the lower limit being associated with maximum turbulence and the upper limit with laminar flow.

Atmospheric Physics

Experimental data collected during periods of stable temperature stratification during the summer months was analyzed. Analyses of the vertical distribution of concentration downwind from the source showed that, while variance of this distribution could be specified with a satisfactorily small uncertainty, all valid statistical tests suggest the tracer concentration was not normally distributed in the vertical direction. A persistent anomaly observed in these experiments was an excessively high concentration

of tracer material at the centerline of the plume and at 1000 feet from the source. In the single observation of the vertical distribution of the tracer material at both 1000 and 2000 feet from the source this anomaly was observed at 2000 feet.

Instrument Research and Development

Preliminary work has demonstrated the feasibility of an instrument to measure intervals in the millimicrosecond range. Such an instrument is useful in measuring the velocity of neutrons generated by bombarding a suitable target with a pulse from the Van de Graaff Accelerator.

The study of plutonium x-ray counters for the body monitor was concentrated on finding and eliminating sources of background. Improved shielding and removal of materials found to be radioactive reduced the background of a counter to one-sixth its original value. A large share of the background had come from a beryllium window through which the x-rays entered the counter.

The questions involved in specifying the minimum detectable amount of a radioisotope for a body monitor or other counting facility were examined. The meaning chosen as suitable for body monitor work is: the MDA is the amount which can be expected to be detected 90% of the time when three successive counts equal to or greater than a critical count are said to establish the presence of the radioisotope; the critical count chosen so that 0.1% of uncontaminated subjects can be expected to be judged contaminated erroneously. The probability relations involved were worked out so that the MDA can be estimated from data on counter sensitivity and background. The present plutonium counter has an MDA of 0.09 microcurie for plutonium at the center of the chest.

A scattering chamber was fabricated for use in an experiment to measure W for protons. In this chamber a portion of the Van de Graaff accelerator beam will be deflected at right angles to the main beam by scattering in a thin gold foil to form a low intensity, monoenergetic beam for the experiment. A method was found for mounting thin nickel foils so that the scattered beam could pass from the accelerator into the measuring apparatus and yet the accelerator vacuum not be lost by leakage of air at the window.

A constant temperature bath was fabricated in preparation for calorimetric work at the electron Van de Graaff. Further improvements were made in the techniques of gamma ray calorimetry. More care in eliminating transient effects at the start of a measurement resulted in better reproducibility. Interchange of two recorders which were found to have different noise levels increased the sensitivity of the system.

The experimental beta-gamma Scintillation Dose Rate Meter was modified to provide an energy dependence curve flat from fifty key to two mev. This was accomplished by reducing the weight per square centimeter of the light shield and the crushed anthracene crystal to optimum values.

Standardized transistor circuits were developed for portable instrumentation utilizing photo engraved printed circuits. This is a step toward more reliable and more serviceable portable survey instruments.

[redacted]

Three coolant circulation systems have been considered (1) the annulus return (2) the central tube return and (3) the single pass. For the annulus return and the single pass systems, a cluster of nineteen rods on hexagonal spacing gave the most compact design. For the single pass system, a cluster of twenty-one rods arranged in two concentric circles was most compact. In most cases a UO_2 core density 90 percent of the theoretical was assumed. For the case of the most compact hexagonal cluster, calculations showed an increase to 95% of the theoretical density would lower the maximum temperature from 1680 to 1570C.

The uranium-bearing fuel elements consist of UO_2 in circular rod clusters zirconium clad or concentric cylinders zirconium clad. The plutonium enrichment elements will probably be made in rod form so that they will be interchangeable with UO_2 elements.

The disadvantage factor (ratio of surface to average flux) was calculated for two concentric ring UO_2 fuel element cases. Diffusion theory approximations were used. The results were:

	I.D.	O.D.	
Inner ring	.560	1.620	Case I
Outer ring	2.060	3.120	Case II
Central rod		.375	

Assuming 85% theoretical density of the UO_2, the disadvantage factor for Case I was 1.08 and for Case II was 1.10. This factor was calculated and plotted for concentric cylinder configurations of 85% density UO_2 with O. D.'s from 2.0" to 3.8" and I. D.'s from 0.0 inches to 3.5 inches.

Alternative fuel element configurations for the PRP Reactor were analyzed to determine the configurations which require the least zirconium in the jackets and process tubes per pound of uranium. The elements which appeared most attractive were a 19 rod cluster in a 3.25" I.D. process tube and a concentric cylinder element sized to fit a 3.25" I.D. process tube. The cost of fabricating the concentric cylinder elements will be approximately half the cost for cluster elements.

Support spiders, designed to hold the rods of a cluster fuel element in a fixed geometric pattern in a process tube, were fabricated by spot welding. When proper conditions are used, this process is quite satisfactory.

A Zircaloy capsule containing a sintered uranium dioxide core and having an argon filled annular gap between core and cladding varying from 0.001 inch to 0.011 inch has been irradiated in the MTR. Preliminary examination shows that the generally accepted small dimensional tolerances for uranium dioxide fuel cores can be relaxed and larger tolerances accomodated. The predicted maximum central core temperatures are 1400C, 2660C, and 2880C for annular gaps of 0.001, 0.006, and 0.011 inches respectively. These temperatures were predicted as the worst cases and represent central core melting at a point adjacent to a gap of 0.011 inch. There was no evidence that chemical reaction occurred between the Zircaloy cladding and overheated UO_2 which fell into contact.

The plutonium fuel elements present many uncertainties. The possible schemes for placing them in the reactor, for processing them with and without blending and for irradiation at varying burnup levels are endless. Studies are being made to determine the best approach to solution of this problem.

A preliminary estimate of the fuel cycle costs for a power producing plutonium recycle reactor has been prepared. Assuming a 200 MW heat output reactor producing 50 MW of exportable electric power, the fuel cycle costs were estimated to range from 10 to 12.5 mils/kwh. Of this total, chemical processing and plutonium fuel element fabrication were estimated at 8.6 to 9.7 mils/kwh. It is estimated that successful development efforts on inexpensive chemical processing and plutonium fuel element fabrication techniques could ultimately reduce cycle fuel cost to the range of 2-4 mils/kwh for a reactor of this size.

A report on the preliminary design scope of the Demonstration Reactor (HW-45929) was issued during the period.

Alternate Coolant for Hanford Reactors

The in-pile organic test loop, ORA-2, was started up in the KE Reactor on September 27. After 1.3 hours of operation, a sample of 75 percent MIPB-25 percent BP solution was drawn off and the radioactivity was determined. Additional loadings will be made.

Burnout Tests on Hanford Process Tubes

Calculations have been completed using the data of the electrical prototype burnout test runs on standard HAPO process tube geometries of July and August. The results were comparable to those obtained from a previous run. Steam qualities were determined for two different conditions of burnout (1) the first indication of a decrease of a heat transfer coefficient or rise in heater surface temperature and (2) by heat surface temperatures reaching 500C. Arbitrarily, 500C was the termination of the run in most cases and represented the conditions beyond which there would be risk of melting aluminum clad fuel elements.

Hanford Reactor Effluent Studies

The investigation to determine the source and mechanism for the production of radioisotopes in reactor effluent water was continued. Calculations indicated that the concentration of sodium in reactor cooling water was too low to account for the observed concentrations of Na^{24} in the reactor effluent water. Other possible sources for the production of Na^{24} include the reactions Mg^{24} (n,p) Na^{24} and Al^{27} (n,α) Na^{24}.

The concentration of Na^{24} in reactor effluent water was calculated to be 3 d/m/ml by using a cross section of 3.1×10^{-4} barns, an estimated corrosion rate of 0.001 mil per month for aluminum, and a minimum irradiation time of 30 days. This indicates that although the irradiation of aluminum probably does contribute Na^{24} to the reactor effluent water, the amount produced under the conditions described is small compared to the observed concentration of approximately 1100 d/m/ml.

The concentration of Na^{24} in reactor effluent water resulting from the irradiation of magnesium in reactor cooling water was calculated. A cross section of 6.8×10^{-3} barns, an average concentration of 40 ppm for magnesium in cooling water, and an

estimated holdup time of two hours were used for the calculation. The concentration of Na^{24} produced under such conditions would be about twice as high as the concentration of Na^{24} ordinarily observed in reactor effluent water. This indicates that magnesium is a possible source of most of the Na^{24} in reactor effluent water.

The concentration of Cu^{64} in reactor effluent water resulting from the irradiation of copper normally present in reactor cooling water was calculated. The concentration of copper in reactor cooling water was assumed to be 0.005 ppm, the average concentration of copper in Columbia River water. The holdup time for copper in the reactor was determined experimentally to be 8.6 minutes. Using these values for holdup time and concentration of copper in reactor cooling water, an average neutron flux, and the thermal neutron cross section for copper, the calculated concentration for Cu^{64} in reactor effluent was approximately 1800 d/m/ml. The observed average Cu^{64} concentration in reactor effluent water is about 2000 d/m/ml. The copper normally present in river water probably is sufficient to account for most of the Cu^{64} in reactor effluent water within the limits of the assumptions used for the calculations.

A study was completed and a recommendation made relating to disposal of reactor effluent during purges while operating the reactor. It was recommended that effluent during purges be discharged to the river, with certain limitations and controls defined By purging as frequently as permitted under the recommended controls, the maximum increase in dosage rate to humans is estimated at less than 5% over that resulting from discharge of normal effluents to the river.

Potential waste disposal and radiological safety problems arising from circulating dilute phosphoric acid in a pile experimental test loop were investigated. It was concluded that for the anticipated experiment only minor protective measures would be necessary. Estimates of final concentrations of P^{32} in the water were so low that disposal problems are not expected to be difficult.

Machine computation of reactor effluent data proceeded to the point of making available the functions necessary to determine statistical correlation between fission product concentrations. The result of this study may minimize the need for extensive radiochemical analysis for separate fission products if good correlation is found between isotopes.

Complete fractionation of trace amounts of yttrium and the four rare earths, neodymium, promethium, samarium and europium was accomplished with a 2.5 mm by 40 cm column of Dowex-50X8 cation exchange resin in the ammonium form. Elution was made with 0.474 M lactic acid and required 40 hours. This time could be reduced by further development, but the present technique will be satisfactory for preliminary investigations of the rare-earth radioisotopes in reactor effluent water.

Group separation studies of radioisotopes by a modified qualitative analysis scheme were started on reactor effluent water to determine the presence of trace radioactive constituents and to test the feasibility of gamma counting in conjunction with these group separations for rapid analysis of reactor effluent water. Trace (less than one percent) short half-lived isotopes emitting gamma rays of 0.3, 0.65, 0.7-0.8, and 2.0 Mev have not yet been identified.

Nalfilm 1 and 2 cationic and anionic exchange membranes (National Aluminate Corporation) were tested in a three compartment electrolysis cell. Complete separation of anionic and cationic radioisotopes in reactor effluent water made 0.3 N in nitric acid was made by applying a potential of 25 volts across the cell. The radioisotopes remaining on the membranes were removed by electrolyzing ammonium nitrate solution. This separation technique may prove useful in the study of the radioisotope composition of reactor effluent water.

Beta activity of the DR Reactor effluent increased 30% compared to the previous month. The largest increase was for the RE + Y fraction in the portion of the reactor which was using Separan treated water. Treatment of the DR Reactor cooling water with Separan 2610 was terminated for this treatment season on August 31.

CHEMISTRY AND SEPARATIONS PROCESSES

Hydrolysis of DBP in HNO_3

Further studies on the rate of hydrolysis of dibutyl phosphate in strong nitric acid (at 109C) showed that the hydrolysis constant for DBP increases essentially linearly with HNO_3 concentration in the range from two to eight molar.

Chemical Preparation of Uranium (IV) Fluorides

Eleven experiments were performed to test the feasibility of reducing uranyl nitrate with powdered iron in the absence of fluoride. The reduction of uranyl ion by iron is complicated by the competitive reactions of the reducing agent with nitrate and hydrogen ion. Despite efforts to control these side reactions by cooling the system, adding nitrate suppressor, maintaining low acidity and adding sulfate to stabilize the uranium (IV) ion, the yields of sodium uranic fluoride were only 50 to 75 percent. In contrast, the reduction of 0.3 molar uranyl sulfate gave yields of 99.9 percent in three experiments.

Leaching of Fission Product Activity from Irradiated Uranium by Boiling Isopropyl Diphenyl

An exploratory experiment is in progress to estimate the rate at which activity would be transferred to the coolant in the event of a slug rupture in a reactor cooled with isopropyl diphenyl. A 7-gram sample of uranium, irradiated to 849 MWD/T and cooled for approximately 90 days, was exposed to boiling isopropyl diphenyl. After 73 hours of exposure under reflux conditions, about 2.8×10^7 gamma c/m and 7.2×10^7 beta c/m had been transferred to the liquid phase. This corresponds to a loss of about 9×10^5 gamma c/m and 2.4×10^7 beta c/m per square centimeter of metal surface. This is greater by a factor of five than would have been predicted on the basis of reported corrosion rates for uranium in biphenyl (i.e., 3 $mg/cm^2/mo$).

Most of the activity found in the liquid phase was zirconium-niobium and ruthenium, and these appeared at essentially the same rate. A portion of the activity in the liquid phase was suspended particulate matter, but the proportion of this has not yet been established.

Purex

Semiworks. Operation of the semiworks in 200-E Area has been curtailed.

Mini Runs. Two additional Mini runs were made to test the ability of Versene to improve zirconium-niobium decontamination. In the first run a gamma decontamination factor of 1.3×10^5 was observed. In the second, the feed was exhausted before steady-state operation was reached. The gross gamma decontamination factor in this second run was 2×10^5 and the product gamma activity was still decreasing when the run was terminated. The ruthenium activity in the organic product was only about twice the gamma activity of aged natural uranium. However, the zirconium content exceeded uranium product specifications by a factor of about twenty.

Extraction Behavior of Zirconium. Additional evidence has been obtained in support of the hypothesis that the natural uranium fuel element contains an impurity capable of decreasing the extraction of Zr into either TBP or TTA. A previously reported experiment was repeated with a new batch of Purex plant dissolver solution. Results of both experiments show that when diluted dissolver solution is contacted with 30 percent TBP in Shell E-2342, the zirconium distribution ratios are 3 to 10 times lower than when (1) the resulting organic extracts are recontacted with cold aqueous solutions of the same gross compositions as the original solution or (2) solutions prepared from crystalline uranyl nitrate, nitric acid and purified zirconium tracer were employed. Thus, it appears that hydrophilic zirconium species were present in the same concentration in the two batches of plant dissolver solution tested.

In other experiments, samples of metal from different sources behaved differently. A hydrophilic zirconium species has been found in several experiments in which uranium metal supposedly similar to that in current use is dissolved in nitric acid and the resultant solution spiked with zirconium tracer. However, no such effect was observed with solutions prepared (1) by dissolution of a uranium-silicon alloy (2) by dissolution of "Derby" metal or (3) from crystalline uranyl nitrate hexahydrate.

Experiments were also performed in which solutions prepared by dissolving samples of the suspect uranium metal were subjected to exhaustive extractions with TbP and the bulk of the uranium removed prior to spiking with zirconium tracer. Under these conditions the extractability of the zirconium into either TBP or TTA was found to be significantly reduced over that found for synthetic solutions. Thus, it appears that uranium can be readily separated from the agent responsible for depressing the distribution coefficient of zirconium in these systems.

Experiments on successive scrubbing were performed with full process concentrations of uranium and with either fresh 30 percent TBP in Shell E-2342 or a sample of the Purex plant solvent inventory. The results show the deleterious effect of solvent degradation products. With the fresh solvent the zirconium distribution coefficient increased by a factor of about 2.6 through the four scrubs necessary to reduce the organic zirconium concentration by a factor of one hundred. By contrast, four scrubs of the used solvent sufficed to reduce the organic zirconium concentration by a factor of only about twenty, and the zirconium distribution ratio at this point was nine-fold greater than in the first scrub step.

Repetition of these experiments with the same solvents but with a much lower uranium concentration gave very similar results. When the ratio of the zirconium distribution coefficient at a given scrub step to that in the first scrub was plotted against the fraction of the initial organic activity remaining in the organic phase, identical curves were obtained for both high and low uranium concentrations.

Fission Product Chemistry. A series of multiple extraction-scrub studies have been performed on samples of plant dissolver solution in an effort to typify the ruthenium and zirconium species which limit decontamination in the Purex process. The results to date indicate that the behavior of ruthenium is much as expected i. e., the bulk of the ruthenium is present as an organophobic species with a small extraction coefficient. A small fraction, however, consists of one or more extractable organophillic species. The organophobic and organophillic species equilibrate with each other slowly, if at all. As would be expected, the extraction coefficients of both increase with decrease in percent saturation of solvent. The zirconium results permit several interpretations. As with ruthenium, there is indication of organophobic and organophillic species in inert equilibrium. Unlike ruthenium, a change in the extent of organic saturation did not effect the extraction coefficient, which had a lower value than expected (4×10^{-4} versus about 2×10^{-3}).

I O-Column. Work continued on the development of an improved cartridge for the Purex Plant IO column. Twenty-four "cold" IO column flooding runs were made in a 3-inch-diameter glass pulse column with a 21-ft.-high cartridge. Purex HW No. 3 Flowsheet with the influent streams at ambient temperature and heated to 50C. was used. Only organic phase continuous operation was investigated.

SUMMARY OF IO COLUMN STUDIES
Pulse Amplitude = 0.5 in. L/V = 0.33

Cartridge	Freq., Cyc./Min.	Volume Velocity Gal./(Hr.)(Sq.Ft.)	Temp., C.
10% free area	98 ± 6	635	25
SST nozzle plates(1)	110 ± 6	630	50
23% free area	92 ± 2	630	25
fluorothene	102 ± 2	630	50
sieve plates(2)	60	1650 ± 150	50
Fluorothene and SST	102 ± 2	610	25
sieve plates	115 ± 5	640	50
	60	1300 ± 45	50
Fluorothene	93 ± 3	630	25
and SST nozzle	103 ± 3	630	50
plates	60	1840 ± 20	50
23% free area	115 ± 5	640	25
SST nozzle	130 ± 5	620	50
plates	110 ± 5	1785	50

Notes: (1) 1/8-inch holes, 10 percent free area, 4-inch plate spacing, 0.04-inch-deep nozzles pointed downward, (2) 3/16-inch holes, 23 percent free area, 4-inch plate spacing.

Pulsed Spray Column. Studies utilizing a sparsely packed 12-ft.-high, 1-inch-diameter pulse column were continued. These runs utilized 30 volume percent TBP in Shell E-2342 as the organic phase and 2.5 weight percent sodium carbonate as the aqueous phase. Flooding characteristics were determined with (1) empty column (2) four fluorothene sieve plates with 3/16-in.-diameter holes and 23 percent free area located 1, 4, 7, and 10 feet above the organic phase inlet and (3) four stainless steel louver plates with 23 percent free area located as above.

If plates are used at a pulse amplitude of 0.5 in. and an L/V of 0.33, neither the plate material nor the choice of continuous phase had a strong influence on flooding frequency.

Cesium Recovery from Purex Waste. Work on the zinc cesium ferrocyanide process continued during the month. Major effort was expended on preparations for extending the full level demonstrations to feeds of higher specific activity (about 600 MWD/T instead of 200 MWD/T) and for determining the radiation stability of the product by use of the Van de Graaff generator. Scouting studies were also continued on means to overcome the deleterious effects of aluminum and mercury which would be introduced into the Purex IWW in event of the adoption of continuous mercury catalyzed dissolution procedures.

Strontium and Cerium Recovery from Purex Waste. The most satisfactory method for eliminating uranium interference in the oxalate precipitation step appears to be acid precipitation of uranium as the peroxide. This method avoids corrosion problems and recovers the uranium in a form convenient for recycle to process. Oxalate precipitation from the peroxide supernate precipitated the rare earths and left the strontium in solution. Iodate precipitation of cerium (IV) was found to be a promising way of separating cerium from the other rare earths. Further work has been done to optimize the iodate separation.

An alternative separation of cerium from the other rare earths by precipitation of ceric phosphate or pyrophosphate was further examined. No completely satisfactory set of conditions were established. Cerium losses were low with phosphate in 0.5 M nitric acid; however, strontium and the rare earths also carried.

Redox

Substitution of Calcium Nitrate for ANN. The potential economic advantage of using a solution of calcium nitrate in place of the aluminum nitrate salting agent in the Redox process was reviewed. Such factors as pH, decontamination, waste storage, and process control with calcium nitrate alone and in mixture with aluminum nitrate will be investigated before more detailed process and economic evaluation is undertaken.

Cesium Recovery from Redox Waste. Work on the removal of cesium from Redox HAW by zinc ferricyanide scavenging has been extended to cover a wider range of acidities. Possible interference by mercury has been investigated, as has the use of higher concentrations

of precipitant to compensate for the increased solubility of zinc ferricyanide at low aluminum concentrations. Removal of cesium from Redox HAW is independent of acidity from 1.78 M free acid to about 0.4 M-acid deficient, but declined in more basic solutions and became essentially negligible at 0.68 M acid deficient. With 0.001 M zinc ferricyanide, the cesium decontamiation factors range from 260 to 800 (without any apparent trend) and averaged about 500 from 1.78 M nitric acid to 0.4 M acid deficient and dropped to 1.5 at 0.68 M acid deficient.

Cesium decontamination factors of 277, 480, and 814 were obtained when 0.22 M acid deficient synthetic Redox HAW solutions containing 0.005, 0.01, and 0.05 M mercury (II) respectively were scavenged with 0.001 M zinc ferricyanide. Decontamination factors of 500, 77, and 299 were observed for solutions 0.6 M in free acid but otherwise identical to the acid deficient series. It is thus evident that use of mercury catalyzed dissolving in the Redox plant will not interfere with cesium recovery by zinc ferricyanide.

Since a large excess of zinc is required to obtain high cesium recovery with zinc ferricyanide, the resulting precipitate is of low specific activity. A promising method for extracting the cesium has just been discovered. Freshly precipitated zinc ferricyanide is metathesized with ammonium oxalate to dissolve the zinc ferricyanide and precipitate the zinc as the insoluble oxalate. Passage of the supernate through an anion exchange column removes the ferricyanide ion. The elutriate is then boiled down (to expell ammonia), acidified with hydrochloric acid, and evaporated to dryness to yield pure cesium chloride. Other reagents which form insoluble compounds with zinc may prove applicable in the metathesis operation.

Metal Recovery Process

UO_3 Studies. Studies were continued to establish relationships between physical and chemical properties, process variables and reaction characteristics of uranium oxides. As a result of an investigation of the surface areas of a large number of uranium oxide and uranium oxide hydrate samples, the following generalizations can be made (1) the surface area of Hanford "continuous" UO_3 is remarkably uniform, with an average value of $1.2 m^2/g$ (2) the surface areas of samples of UO_3 produced in "pot" calciners at different sites do not greatly differ with each other (3) the surface area of UO_2 produced by reduction with hydrogen is much larger when the reduction is done at a low temperature than at a high temperature (4) conversion of Hanford "continuous" UO_3 to the monohydrate resulted in a decrease of surface area to about 60 percent of that of the original UO_3 and (5) a study of Hanford "continuous" UO_3 spheroids showed no correlation between calcination temperature and the surface area.

Adsorption of Water by UO_3. A study of the rate of adsorption of water by UO_3 powders was made to see if this property can be correlated with the reactivity of the powders toward reduction and hydrofluorination. Various samples of UO_3 powders (sieved to narrow mesh ranges) were exposed to water-saturated air at 25C. Although some differences in the rate of water adsorption by various powders was observed, these differences could not be generally correlated with either the surface area or the reactivity ratio of the powders.

Removal of Co^{60} from Stored Uranium Recovery-Plant Wastes. In a previous report a procedure was described for scavenging stored wastes by reduction of the pH to 1.5 and precipitation of inert CoS as the pH is raised to about 9. Nickel ferrocyanide is then precipitated at pH 9. Residual Co^{60} was 4×10^{-5} μc/ml for several trials of the procedure of waste from tanks 102 C and 106 TY. Further study of the procedure on wastes samples from eight other East Area tanks has produced variable results; residual Co^{60} varied from as low as 3.5×10^{-5} μc/ml to as high as 1.6×10^{-3} μc/ml. The reason for these variable results has not yet been determined. Other conclusions reached from these studies are (1) that reduction of the pH to 1.5 before CoS precipitation does not improve Co^{60} removal and (2) that precipitation of NiS is just as effective for Co^{60} removal as precipitation of CoS.

Waste Disposal. Recommendations were made for tank storage or ground disposal on a specific retention basis of all TBP wastes scavenged during the month. These wastes contained complexed Co^{60} in excess of the recommended crib disposal limit of 4×10^{-5} μc/cc. To date 2.5 million gallons of high Co^{60} TBP scavenged wastes have been disposed of on a specific retention basis.

Plutonium Purification and Fabrication Process.

Nuclear safety checks were made on storage and handling capacities in the polishing and mating room of 234-5 Building. This study has led to increased allowable capacities.

Ion Exchange Processes

A study was made of the potentials for application of ion exchange techniques in the chemical processing plants. The most attractive potentials included (1) plutonium product concentration (2) plutonium recovery from Purex and Redox waste streams by anion exchange (3) final plutonium decontamination and concentration by anion exchange to obtain additional decontamination or to eliminate solvent extraction cycles in Purex and Redox and (4) plutonium removal from uranium streams.

Plutonium Anion Exchange Process

Work has continued on the recovery of plutonium from the Purex IWW stream. Since past experiments have disclosed relatively slow kinetics for plutonium sorption by anion exchangers under the conditions tested, a practical process requires the use of relatively long columns. However, in long columns the use of 50-100 mesh resin is not appealing because of the high head pressures needed to maintain process flow rates.

Elution studies are also being continued. About 70 percent of the plutonium was eluted from a ten centimeter column of loaded Dowex-1, X-8 (50 to 100 mesh), at a concentration of five grams per liter using 0.1 molar nitric acid at a flow of 0.25 ml/min. With mixed 0.4 molar ascorbic acid - 0.5 molar sulfamic acid, a 40 cm column was completely eluted (with no gas formation) to yield a product of 60 g/l. Unfortunately with this system, almost immediate precipitation was observed if the plutonium (III) reoxidized to plutonium (IV). Even if plutonium (III) was maintained, delayed precipitation occurred, usually after 12 to 24 hours. The use of

sulfite as an eluting agent was unsatisfactory due to apparent precipitation of plutonium (III) sulfate in the resin.

Isotope Separation - Chemical Exchange

Data from the uranium (IV) chlorides - uranium (IV) TTA complex exchange experiment at pH 1.3 are now complete. The four stage experiment resulted in a separation factor of 1.0003 per stage with the uranium-235 concentrating in the aqueous phase as expected. Results show that the separation factor of 1.0014 previously found for the system uranyl chloride-uranium (IV) chloride-uranium (IV) TTA complex at pH 1.35 is predominantly due to the uranyl-uranium (IV) exchange. If the combined separation factor is 1.0014 and that for the uranium (IV) system is 1.0003, the uranium (IV) chloride-uranyl chloride separation factor is calculated to be 1.0011, which agrees well with the value quoted in Y-184.

The uranium-238-uranium-235 partition function ratio for uranyl ion has been calculated to be 1.0011 relative to a completely free uranium (IV) ion. Using this reference value, a table of partition functions for the uranium-235-uranium-238 exchange may be set up as follows:

U (free)	1.0000
Uranyl	1.0011
$U(IV)Cl^-$	1.0022 (pH 1.3)
$U(TTA)_4$	1.0025

It does not seem possible to devise a counter-current system which can utilize the

Analytical Development

The feasibility of assaying plutonium metal to a precision (σ) of ± 0.2 percent by the coulometric titration method was established. An interim report, HW-45668 is being issued.

In-Line Analysis

Studies of anion exchange methods for separating plutonium from americium, curium, and fission products have been initiated with the objective of obtaining a pretreatment method for an alpha count in-line monitor on HAW streams.

A neutron count method for gross plutonium monitoring is being designed. To assist this project, a suitable preamplifier was designed and the electronics circuitry was set up and tested.

The main instrumental development phases of square-wave polarography have been completed, and an interim report has been issued as HW-43513.

The Purex process solvent develops a color with usage because of chemical and radiation induced degradation. A study of the magnitude and rate of build-up of the organic color under Purex operating conditions has just been completed by means of a spectrophotometric examination of plant samples over a period of several weeks. As a result of the study, the sensing unit cell dimensions and the best plant location for the color monitor have been established. The color monitor will be located on the 1CW stream.

Chemical Instrumentation

The calibration was completed on the Stack Effluent Monitor for the Redox Plant. Effluent samples are collected by a continuous strip filter sampler connected in series with a scrubber sampler. The data from these samplers are applied to a system that automatically computes and records the quantity of each of three isotopes in the effluents as a function of time. The system was put into operation for testing operating conditions and for final calibration adjustment.

An experimental High Level Alpha Air Monitor was developed and placed in operation for field tests in the Redox facility. The instrument is expected to alarm by the time that an exposed person can inhale approximately 0.2 of the maximum permissible amount of Pu-239.

The technical specifications for gamma scintillation monitors (HW-39821 - REV 1) were revised to incorporate the latest development improvements (1) a high gain, high impedance amplifier to measure the multiplier phototube output current (2) a molded fluorothene sample cell (3) substitution of E 180 F pentodes for the 404-A's in the differential analyzer of pulse measuring systems (4) exclusive use of RG11/U signal cable and (5) inclusion of a remote indicating flowmeter.

A pulse generator circuit to calibrate count rate instruments at low and high counting rates was conceived and initially tested. Such an instrument with a reliable

simple circuit should prove valuable in checking count rate meters used in fixed installations. When the count rate meter is used as part of a system to record emission from radioactive isotopes quantitatively, it is essential that its response be stable and reproducible. The circuit developed should provide a control on this stability.

Contact Alpha Counter. A prototype model of a counter designed to measure the alpha activity of a solution in situ (contact alpha counter) is being developed and tested. The sample cell and phosphor uses a zinc sulfide phosphor bonded to fluorothene or glass and covered with a one-quarter mil Teflon film. This film separates the phosphor from the liquid sample. Results with a solution containing 0.03 gm of plutonium per liter are tabulated below.

Observed Counting Rates - Teflon Protected Phosphor

Total Counts c/m	Background Counts c/m	Net Counts c/m	Remarks
20,000	6,000	14,000	Initial counts.
27,000	13,000	14,000	Solution in cell overnight.
34,000	20,000	14,000	Solution in cell four days.
33,000	19,000	14,000	Cycle solution through cell every two minutes for two days.
40,000	30,000	10,000	Cycle after third day.
34,000	20,000	14,000	After a single flush with 6.5 M HNO_3.

Development work is continuing to determine the effect of increasing concentration, difference in phosphors, and the stability and usefulness of various protective coatings and films.

Prototype Uranium Polarograph. An improved and more trouble-free means of removing dissolved oxygen from waste streams, prior to polarographic analysis, has been tested and found satisfactory. Helium for sparging is introduced into the air bleed line of the sampling system rather than through a sinter in the electrolysis cell. This results in a simplification of the system, and eliminates the possibility of process solution getting into the sparge line.

Plutonium Resin Column Controls. Laboratory tests show that a conductivity probe isolated from the resin in a resin dilute acid mixture is more sensitive than one not shielded. A probe shielded with fine wire mesh screen was installed in the 321 prototype resin column. This probe has performed well under simulated plant flow conditions.

Equipment and Materials

Gold Gaskets. Severe galvanic corrosion of the gasketed face occurred when a simulated flange of 304-L stainless steel with a gold gasket was exposed to boiling 65 weight percent nitric acid for 92 hours. Gold gaskets are not suitable in process

piping handling hot nitric acids or other oxidants.

Johnston P-19-7 Pump. Throttle bushing leakage from this pump was cut from 5 gpm to 350 ml./min. by using a Polypenco K-51 throttle bushing with a conical shaft deflector below it.

Operation with a set of Polypenco K-51 bearings and a 17-4 PH stainles steel shaft, using reduced diametral clearances, resulted in failure after 1/2 hour.

Titanium - Tube Heat Exchanger. The prototypical titanium-tube heat exchanger fabricated for use as a product concentrator in the Purex Plant, developed transverse cracks in the welds joining the titanium tubes to the titanium tube sheet facing. Gas analyses have not yet been made of the weld metal, but is thought that the cracking was due to gas embrittlement incurred during the welding operation. Although adequate inert gas shielding was provided on the front side during the fusion welding, air trapped between the tube sheet and the tube sheet facing may have been absorbed into the titanium, thereby reducing the ductility of the welded metal.

Chemical Compatibility. Polypenco K-51. The Polypenco K-51 test has continued. In a solution containing approximately 390 g/l. UNH and 330 g/l. HNO_3 for 25.6 hours at the boiling point, the K-51 decreased 14 percent in weight. After 24 hours in 100 percent UNH, the K-51 showed no change in hardness or physical dimensions but did decrease three percent in weight. After a thorough washing approximately 5000 counts per minute remained on the surface of the K-51.

Silicone. Silicone rubber with dacron reinforcement was tested by static immersion at room temperature in 60 volume percent TBP-Soltrol, and 15 volume percent TBP-carbon tetrachloride. The silicone rubber dissolved completely in the two solutions.

Soil Studies

The effect was investigated of a 1 ppm concentration of Separan 2610 in solution on the adsorption of Cs^{137}, Sr^{90}, and Pu^{239} by soil. All of the Cs^{137} and Pu^{239}, within the limits of the experimental measurements, was adsorbed. The adsorption of Sr^{90}, however, resulted in a distribution coefficient of approximately 50. An increase or decrease of pH from that normal for the Separan solution (8.6) resulted in a lesser adsorption. The experiments indicated that although Separan has an apparent beneficial effect on the infiltration rate of water, the use of this material probably is not advisable if the water contains appreciable amounts of Sr^{90}.

Additional work on the effect of various decontaminating agents on the adsorption of Cs^{137}, Sr^{90} and Pu^{239} by soil indicated that none of the 11 agents tested favored the adsorption of all three radioisotopes by soil. Equilibrium experiments indicated a favorable adsorption of Pu^{239} and Cs^{137} at certain pH values, but Sr^{90} was not adsorbed from these same solutions at any pH. The data indicated that no general conclusion can yet be made for disposal to the ground of solutions containing decontaminating agents. Each case must be considered on its own merits.

A preliminary investigation was begun on the possibility of disposal to the ground of radioactive wastes containing aluminum on the basis of complete immobilization of the liquid within an excavation. The initial results indicated that if the soil at the

perimeter of an excavation was treated with solid sodium bicarbonate, the addition of a solution of 1 M aluminum nitrate produced a "seal" at the soil-liquid interface. Upon standing, the solution then slowly formed a gel, presumably a highly hydrated aluminum hydroxide. Additional work will attempt to determine the effect of other salts on the formation of this gel as well as the stability of the gel itself.

Greater reliability in the prediction of the behavior of liquid radioactive wastes in the ground and particularly in the ground water can now be made as a result of the determination of the deformation of the Ringold formation sediments beneath the ground surface and parallel to the underlying basalt in the seven plant sites so far closely examined. Correlation of the results of geological and hydrological studies with field tests, laboratory studies, and monitoring data indicates that the present well network is minimal and that its 2 to 3-mile spacing is probably the maximum allowable for the solution of the geological problems posed by the Hanford site. Other means, including regional geological mapping, geophysical explorations, and intensive local field and laboratory studies will be necessary to supplement the standard geological criteria which to date have proven inadequately definitive with the present network.

The geological event, in which sediments of the lower "blue clay" Ringold formation were upwarped with the underlying basalt east of the 200 East Area and locally above the ground water table, explains the southeastward direction and high rate of flow of the ground waters observed beneath 200 East Area. Several anomalies in the ground water contour maps of the project, including the former elongate form of the B-Plant ground water mound and its north-south orientation are similarly explained by the stratigraphy and the lateral change in permeability. The need for relocation of the Purex swamps to provide better control on the movement of contaminated ground waters at the Purex site is accordingly better substantiated while the preferred location of future cribs at the Purex plant and other sites is subject to more precise definition.

BIOLOGY

Biological Monitoring

As one means for evaluating potential hazards of radioactive wastes disposed to the atmosphere, ground, and the Columbia River, terrestrial animals and aquatic animals and plants are regularly assayed for concentrations of radioactive substances in them.

Results are reported for specimens routinely collected from selected sites and show the average and maximum contamination levels noted for the month. Trend factors are an adaptation of the Regional Monitoring method of reporting. Those factors which show the n-fold increases (+) or decreases (-) from the previous month (where values of n less than 2 will not be noted) are routinely listed.

Atmospheric Contamination. The principal radioactive contaminant of stack from separation processes is usually I^{131}. This deposits on vegetation which is eaten by indigenous animals and is deposited in their thyroids. Concentrations of I^{131} in rabbits' thyroids are listed below.

Location	μc I^{131}/g thyroid Average	Maximum	Trend Factor
1 mile SE of Redox	1×10^{-3}	2×10^{-3}	-7
Prosser Barricade	1×10^{-3}	2×10^{-3}	-8
Meteorology Tower	7×10^{-4}	8×10^{-4}	-9
4 miles SW of Redox	7×10^{-4}	2×10^{-3}	-6
East of 200-E Area	2×10^{-3}	3×10^{-3}	-2
West of 200-W Area	8×10^{-4}	2×10^{-3}	-9
100-B Area	5×10^{-4}	2×10^{-3}	-4
R4S, M14	1×10^{-3}	2×10^{-3}	-10*
3 miles S of White Bluffs	8×10^{-4}	1×10^{-3}	- *
Wahluke Slope, E	1×10^{-3}	2×10^{-3}	-6 *
Wahluke Slope, NE	5×10^{-4}	5×10^{-4}	-4 *

* The last four trend factors compare values with July instead of August since corresponding collections are taken bimonthly.

Although trends are downward as compared to the previous month or two, the thyroid contamination levels are 2 to 3 times those observed one year ago.

Swamp Contamination. Of the several contaminated swamps on the project, only the 221-U swamp supports a population of waterfowl large enough to permit routine sampling. Concentrations of waste fission products in bone and soft tissues are listed below.

Specimen	μc FP's/g tissue Average	Maximum	Trend Factor
Coots			
bone	2×10^{-4}	4×10^{-4}	-5
soft tissue	2×10^{-4}	6×10^{-4}	-4
Diving Ducks			
bone	2×10^{-3}	6×10^{-3}	-20
soft tissue	2×10^{-4}	6×10^{-4}	-4
Puddle Ducks			
bone	5×10^{-4}	7×10^{-4}	-50
soft tissue	4×10^{-5}	6×10^{-4}	-5

The decrease in contamination of diving and puddle ducks is a direct reflection of a higher proportion of migrant birds among those sampled. The decrease in contamination of coots resulted from reduced disposal of wastes into the swamp.

Columbia River Contamination. Contamination levels in representative aquatic forms for September are shown in the following table. Listed are the location from which purely aquatic specimens were taken and the principal food of the amphibious specimens collected. All amphibious specimens were taken near Hanford. For each of these two specimen types, the location and principal food, respectively, appear to be most readily correlatable, at least qualitatively with the contamination levels.

Specimen	Location	μc Radioisotopes/g Tissue Average	Maximum	Trend Factor
Plankton	Hanford	3×10^{-2}	3×10^{-2}	+4
Caddis larvae	Hanford	2×10^{-2}	3×10^{-2}	+2
Minnows	Hanford	1×10^{-2}	2×10^{-2}	+2
	100-H	2×10^{-2}	5×10^{-2}	-2
Whitefish *	Hanford	4×10^{-4}	7×10^{-4}	+4
	Priest Rapids	1×10^{-5}	4×10^{-5}	+2
	McNary	8×10^{-5}	-	-

Specimen	Principal Food	μc Radioisotopes/g Tissue Average	Maximum	Trend Factor
Shorebirds *	Snails, insects	1×10^{-2}	2×10^{-2}	+3
Puddle ducks *	Insects, vegetation	1×10^{-3}	6×10^{-3}	-
Terns *	Small fish	4×10^{-3}	4×10^{-3}	+4
Gulls *	Large fish	1×10^{-3}	5×10^{-3}	-
Mergansers *	Large fish	1×10^{-3}	3×10^{-3}	-

* Values are for edible flesh. Levels of radioactive substances in bone of waterfowl were 1 to 3 times those of flesh, and in whitefish about ten times that of the flesh.

The contamination level of fish is roughly twice that of a year ago. That of waterfowl, however, is but one-half to one-fourth of those observed one year ago. The difference in trend factors is probably due to differences of sampling dates. The level of contamination is increasing very rapidly at this time of the year and samples taken late in the month will be appreciably more radioactive than those taken early in the month.

The positive trend factors are typical of this season, as river flow diminished and the average water temperature was at a maximum. The comparatively high contamination level noted late in summer immediately below 100-H Area diminished as the flow of river water decreased and effluent from this area no longer entered the river by the emergency overflow flume.

To determine whether radioactive substances can be detected as far downstream as the mouth of the Columbia River, about 1200 specimens were collected in that vicinity, from the ocean beaches immediately north of the river's mouth, and from the southern Oregon Coast. A few specimens were also obtained off Cape Cod on the Atlantic Coast for comparison. Results are not yet available.

Fish are routinely exposed to different concentrations of reactor effluent in troughs in order to observe directly possible toxic effects which could occur in the Columbia River. In the past, juvenile salmon and trout were used for this type of monitoring activity. This year juvenile whitefish were used and there is some indication that they may be more sensitive to reactor effluent than salmon or trout. The mortality of young whitefish exposed to 2 percent effluent for about three months is now twice

that of the controls. The controls were exposed to water pumped from the river at 100-F that contained about 1.2 percent effluent from reactors upstream. In the past, no effects on salmon were evident until the concentration of effluent reached 3 or 4 percent. Whether the increased sensitivity among whitefish is due to the effect of chromate, temperature, or radioactivity is not known.

Metabolism and Toxicology of Radioactive Materials

It appears that "Separan", a material now being used in treating reactor water, will have no toxic effects on fish. Young trout have not been affected by exposure to 0.07 ppm for over two months. This concentration is twice that specified for addition to the process water as an aid to filtration, and is many times the concentration which will occur in the River.

Reactor Effluent. There is a possibility that there may be present in reactor effluent radioactive substances which are not readily detectable by ordinary methods, but still may present a biological hazard if humans or animals are exposed to them in drinking water. To investigate this and to check the accuracy of the calculated hazard of drinking reactor effluent, rats were allowed to exist for about one year with reactor effluent concentrated 40-fold being their sole source of drinking water.

During the month it was noted that 85 percent of the beta activity in the muscle of these rats was due to P^{32} and the remaining 15 percent to K^{40}. There is a suggestion of the presence of a long-lived radioelement that has deposited in the animals. This will be checked in some of the animals after most of the P^{32} has decayed. No information was obtained to clarify the earlier result that indicated that the deposition of P^{32} in rats is significantly less than predicted by theory.

Plutonium. The absorption and deposition on bone of plutonium fed to adult rats and pigs have been carefully measured. For establishing a permissible limit for plutonium in drinking water appropriate for large non-occupational populations, it is necessary to know the absorption and deposition coefficient for the very young. Rats one-week-old and less were noted to absorb and deposit 10 to 100 times more plutonium than do adult rats. Distribution of plutonium in rats one-week-old was the same as in adult rats.

Ruthenium. Rats which were two weeks' or less old absorbed radioactive ruthenium from 5 to 10 times more than adult rats. Of the ruthenium absorbed, a higher proportion is deposited in the bone.

The long-term chronic ruthenium feeding experiment was completed with analyses of animals sacrificed at 500 days. Previous conclusions were confirmed; depending on methods of extrapolation of results from rat to man, kidney, bone or testes might equally qualify as critical organs. The previously suggested MPC of 4×10^{-3} µc/ml of drinking water seems to be the most reasonable value.

The extent to which this and the MPC for plutonium may be changed because of the increased hazard to very young animals is yet to be determined.

Iodine. To determine the quantity of radioiodine that may be permitted on local vegetation, groups of sheep have received daily feedings of I^{131} for about five years. For sheep, a limit for vegetation contamination has been fairly well established. Pig are now being used to extend results observed in the long-term sheep experiment. These pigs are supplied by Washington State College, and in return, the research on defining the toxicity of I^{131} to pigs is being extended. This includes a corollary experiment on the effect of high and low plane diet (sufficient and insufficient calories) on the uptake of I^{131} by pig thyroids. The high-plane pigs show a tendency to concentrate more I^{131} than do the low plane. The difference may be due to larger thyroids or to less available stable iodine in the high-plane pigs.

Prior thyroid damage in pregnant ewes appeared to increase the I^{131} uptake by the fetal thyroid. Among ewes fed 0.15 μc/day, the I^{131} concentration in the fetal thyroid was about equal to or exceeded that of the dam in advanced pregnancy. However when dams were fed 5 μc/day (since weaning), the I^{131} concentration in the fetal thyroids was 3 to 4 times that of the thyroid of the dam.

Radioactive Particles. Of all potentially hazardous radioactive materials, probably the least is known about the biological effects than may be caused by inhaled radioactive particles. One hundred and eighty days after mice were intratracheally injected with hydrosols of PuO_2 at 0.003 μc/lung and RuO_2 at 0.5 μc/lung, no more lung tumors developed than among mice injected with inert materials. It was also found that PuO_2 at 0.01 μc/mouse lung plus a chemical carcinogen did not increase the incidence of tumors beyond that caused by the carcinogen alone.

New techniques were developed for the preparation of RuO_2 particles to be used for aerosol exposures in the future. This included the preparation of alcoholic ruthenium oxide colloids to make dust for single exposures and the combustion of ruthenium acetate in a hot tube to make dilute radioruthenium oxide aerosols for repeated exposures.

Gastrointestinal Radiation Injury. For some poorly absorbed radioactive substances, calculations of MPC's are based on the quantity of the given radioactive substance present in the intestine which will cause the intestinal walls to be irradiated at the rate of 0.3 rem per week. Many assumptions, experimentally unsupported, are inherent in this type of calculation. Among the more important of these assumptions is that weakly penetrating radiations, such as alpha particles from plutonium, actually reach important portions of the intestinal wall. Another is that the intestinal wall is as radiosensitive as other internal organs, one of which might otherwise be considered the critical organ. In order to test the validity of some of the assumptions involved, rats were exposed to poorly absorbed Y^{91}. The LD_{50}^{30} for orally ingested Y^{91} was found to be 17 mc/kg. Of the amount fed approximately 0.03 percent was absorbed from the tract. The mortality data, when compared with X-irradiation results, are consistent with the assumption that the Y^{91} beta particles are as effective as X rays in causing intestinal damage.

Genetic Effects of Metabolized Radioisotopes. When radioactive substances are deposited in living tissues, toxicity may be exerted by the effects of the ionizing

radiations emitted by the decaying substance. If the metabolized radioactive substance is a part of an essential molecule, the energy of atomic recoil may be sufficient to disrupt the structure of the molecule. If the decay results in transmutation of an element to a markedly different element, the new element may be foreign to the molecule and change its biological activity.

If the metabolized isotope is present in germinal tissues, the toxic effects may be manifested through genetic changes. To determine the extent of possible changes, yeast is being used to test the genetic effects of S^{35}. For a constant amount of S^{35} (and hence constant energy delivered to the growing culture), a decrease in available non-radioactive sulfur should result in an increase in mutation rate of the yeast, if the transmutation and recoil effects are important. In performing these experiments, interesting corollary results were observed. It appears that yeast grown on media containing very small concentrations of sulfur are more radio-resistant than yeast grown on high concentrations. It also appears that the yeast cells mutate at a higher rate when grown on high sulfur media. The fundamental significance of these findings is obscure.

SUPPORTING ACTIVITIES

OPERATIONS RESEARCH AND SYNTHESIS

Economic Liaison

Self-education on "combined operations" was continued with special emphasis on the economics and principles of operation of the gaseous diffusion plants and their relationship to Hanford reactor operation. Several intensive discussions were held on the mathematical basis for cascade operation and different methods were examined for expressing burnout costs in terms of cascade parameters. It was noted that the penalty for burning slightly enriched uranium instead of normal uranium is relatively small.

Investigation of Problem Areas

Preliminary investigations were started in several new problem areas. These included (1) the possibility of developing a model of the factors influencing the cost of radiation work which would permit the systematic study of the effect of different control methods, reduced limits, or increased dose rates on future operations at HAPO (2) the creation of a symbolic model of the communication of objectives, rationale, and assignments, together with feedback information and its influence on other facets of communication (3) a study of the factors, such as the chemical, physical and radiological limitations on the Columbia River, which limit total reactor capacity at HAPO and (4) the possibility of keeping records by exception from normal occurrence.

Reactor Model

A report was begun on the mathematical derivation of those "variable discharge curves" which have the property of minimizing the expected occurrence of fuel element failures. Assistance is being given in determining a functional form which will explain and predict the frequency of fuel element failures under varying power and exposure conditions. This work is a prerequisite to the analytical determination of the appropriate balance between goal exposure and power in the different reactors.

RADIATION PROTECTION

The average daily emission of I-131 from chemical processing plants was 0.5 curie with a maximum of 1 curie per day from the Purex Plant. This is well within the HAPO standards. The average daily emission of beta-emitting particulates from the Purex Plant increased 14-fold to 0.15 curie with a maximum daily emission of 0.7 curie. The cause for the sudden increase in particulate emission was not determined.

A slug which caught fire on the rear face of C Reactor resulted in a stack emission of 1.4 curies of radioactive particulates. These particles were deposited primarily directly south of 100-B Area.

One significant case of plutonium deposition occurred. Hospitalization of the employee was required to complete decontamination. Zirconium citrate and calcium EDTA were administered as a precautionary measure. Initial estimates placed the body deposition of plutonium below 50 percent of the maximum permissible limits.

The method of totalling cases of plutonium deposition was modified to provide a more current total of known cases of deposition. There are 195 employees who are known to have plutonium deposition. No new cases of fission product deposition were detected with the routine bioassay program. No cases of whole body exposure exceeding 0.3 r per week occurred, as measured by the film badge program.

The use of impaction-type continuous alpha air monitors looked very favorable in permitting rapid evaluation of plutonium air contamination. Improved sampling rates permit evaluation of air contamination within five minutes as compared to the 24 - hour waiting period now required to distinguish between plutonium and naturally - occurring alpha emitters.

CONDENSED EXPOSURE RECORDS

Type	Number of Readings	Potential High Results	Confirmed High Results
Pocket Chambers-gamma	320,858	51	0
Pocket Chambers-slow neutron	1,998	1	0
Film Badge-beta gamma	63,231	26	0
Film Badges-neutron	746	0	0
Pu Bioassay	1216	31	30
F. P. Bioassay	1281	1	0
U Bioassay	557	17	17
Alpha Hand Counts	47,654	0	0
Beta Hand Counts	38,942	0	0
Thyroid Counts	0	0	0

[redacted]

REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density /uc/ml	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	9.0×10^{-9}	--
Richland, N. Richland, Benton City Wells	alpha	$(<0.5 \text{ to } 1.2) \times 10^{-8}$	--
100 Areas	beta	$(0.14 \text{ to } 3.6) \times 10^{-6}$	--
200 Areas	beta	$(0.1 \text{ to } 1.4) \times 10^{-6}$	+2
Pasco, Kennewick, McNary Dam	beta	$(<0.05 \text{ to } 1.7) \times 10^{-6}$	+2
Backwash Solids - Pasco Filter Plant	beta	2.1×10^{-2}	--
Backwash Liquids - Pasco Filter Plant	beta	1.8×10^{-6}	--
Anthracite, Sand Filter - Pasco Filter Plant	beta	1.0×10^{-4}	--
Other Waters and Related Materials			
300 Area Wells #1, #3, and #4	U	$(2.0 \text{ to } 2.4) \times 10^{-7}$	--
200 East Wells	beta	$<5 \times 10^{-8}$ to 3.4×10^{-1}	-2
200 West Wells	beta	$<5 \times 10^{-8}$ to 2.0×10^{-2}	--
Wells Near 200 Areas	beta	$(<5.0 \text{ to } 7.0) \times 10^{-8}$	--
107 and 108 Wells	beta	$(<0.0005 \text{ to } 4.7) \times 10^{-4}$	--
Outlying Wells	beta	$(<5.0 \text{ to } 7.0) \times 10^{-8}$	-3
Columbia River - Hanford Ferry	beta	1.8×10^{-5}	--
Columbia River - Below Reactors	beta	1.5×10^{-5}	+2
Columbia River - Patterson to McNary	beta	3.5×10^{-7}	--
Columbia River - Shore Mud	beta	$(1.5 \text{ to } 7.4) \times 10^{-5}$	-4
Raw Water - Operating Areas	beta	$(<0.005 \text{ to } 1.2) \times 10^{-5}$	+2
Reactor Effluent Retention Basins to River	beta	6,700 to 25,500 /uc/sec/reactor	--
		$(2.6 \text{ to } 8.7) \times 10^{-3}$	--
Reactor Effluent Retention Basins to River	alpha	<0.04 /uc/sec/reactor	--
		$<5 \times 10^{-9}$	--

* The trend factor shows the n-fold increase (+) or decrease (-) from last month, where values of n less than 2 will not be noted.

Sample Type and Location	Activity Type	Average Activity Density /uc/ml	Trend* Factor
Other Waters and Related Materials (contd)			
I-131 in Farm Wastes to River		21 /uc/day	+2
	I-131	3.2×10^{-7}	+2
I-131 in Columbia River - Hanford	I-131	1.1×10^{-7}	--
300 Area Pond Inlet	alpha	2.8×10^{-5}	+28
Atmospheric Pollution			
Gross Alpha Emitters	alpha	$(< 4 \text{ to } 6) \times 10^{-15}$	-4
Gross Dose Rate - Separations Areas	beta-gamma	1.4 to 6.7 mrad/day	+2
Gross Dose Rate - Residential Areas	beta-gamma	0.7 to 11.1 mrad/day	+2
Active Particles - Separations Areas	beta	$(0.9 \text{ to } 1.3) \times 10^{-12}$	+2
I-131 Separations Areas	I-131	$(2.9 \text{ to } 8.2) \times 10^{-13}$	+6
I-131 Separations Stacks	I-131	0.47 curie/day	+5
Ruthenium - Separations Stacks	Ru-103-106	< 0.02 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.04 to 0.21 ptle/m^3	-2
Active Particles - Project	--	0.03 to 0.25 ptle/m^3	--
Vegetation			
Environs of Separations Areas	iodine	$(< 0.3 \text{ to } 1.3) \times 10^{-5}$ /uc/gm	--

[redacted]

LABORATORY AUXILIARIES

Principal engineering activity was devoted to accumulating project and equipment status and cost information to be used in planning of this work to match FY-1957 budget allocations.

Preliminary plans have been made for conducting an engineering study of 300 Area. Negotiations are being made with Fuels Preparation Department to obtain their cooperation and assistance in planning for future development regarding traffic flow, area expansion and building utilization.

A program is being planned for the annual testing of power boilers. X-ray and ultrasonic thickness measurements will be made to detect pipe that needs to be replaced.

X-ray examination of zirconium process tubes was completed. It is anticipated that a large scale examination program employing a number of tests will develop in about six months.

Radiographic testing of welds in construction materials for Project CG-558 continued on a routine basis. The piping for DR Reactor was nearly completed. Some difficulty was experienced with cracks in the weld joints.

Preliminary testing of high tension electrical connectors is being carried out in anticipation of field work on the HAPO electrical distribution system.

Steps were taken during the month to abolish the HAPO Non-Technical Document Review Board and reassign its duties to the Supervisor, Classification - Declassification. This proposed change is awaiting concurrence from the AEC.

The HOO Classification Committee has released the Hanford Classification Guide for transmittal to Washington for final approval. The Guide was sent to Washington September 26.

Transfer of Kadlec Hospital Library books and periodicals to the new Kadlec Methodist Hospital was completed. Some of the books and subscriptions are being retained by HAPO in the Industrial Medical Library. The Plant Library will continue to maintain records on these.

The secretaries manual for the preparation and handling of classified documents, "Confidentially Yours" has been revised.

HANFORD LABORATORIES OPERATION
PLANT AND EQUIPMENT PROJECT

PROJECT NUMBER	TITLE	USING COMPONENT	PRESENT EST. TOTAL PROJECT	AUTHORIZED FUNDS	DETAILED DESIGN	CONSTR.	REMARKS
PLANT AND EQUIP PROJECTS - FY 1956							
AEC 2-23X-6009F							
CG-682	High Level Exam. & Cut-Off Cell-327	Reactor & Fuels	$225,000	$ 16,500 (Design only)	44%	Not Started	Revised project scope indicates higher project cost.
AEC-23X-56-L-2 Gen. Plant Proj.							
CG-635	Redox Stack Particulate Sampler	Radiation Protection	42,000	40,000	100%	54%	Work slowed by manpower demands of higher priority projects.
CG-660	Modifications and additions to the Metallographic cell 327 Building	Reactor & Fuels	135,000	135,000	12.5%	Not Started	Procurement started. Further design progress dependent upon dimensions of Metallograph. Invitations to bid have been distributed for this equipment.
CG-664	350° Flow Loop 306 Building	Reactor & Fuels	120,000	120,000	100%	Not Started	9/24/56 Design submitted to Estimating for detailed estimate to use with Purchase Requisitions and to AEC for appr. AEC to obtain contractor in Oct. to install Detonizer.
CG-671	Improved Calibrations Facility - 3745 Bldg.	Radiation Protection	22,500	22,500	100%	98%	Construction 98% complete. Calibrating wells not yet completed or accepted.
CG-672	Monochromatic neutron beam Facility (Bldg. 105-KE)	Physics & Instruments	112,000	112,000	80%	Not Started	Design will be completed 11/1/56; 2 major requisitions issued; bids will be returned by 11/1/56.
IR-204	Office Addition to 141 M Bldg.	Biology	15,000	15,000	Comp.	86%	

PROJECT NUMBER	TITLE	USING COMPONENT	PRESENT EST. TOTAL PROJECT	AUTHORIZED FUNDS	DETAILED DESIGN	CONSTR.	REMARKS
AEC 9950 Equip. Not Included in Constr. Proj.							
CG-620	Melt Plant Modif. 306 Building	Reactor & Fuels	$143,000	143,000	32%	Not Started	Original bids for equipment rejected. Requisition rewritten & reissued on 9/18/56. Bids expected 10/8/56.
CG-661	Additional Heat Generation Facility-189 D Bldg.	Reactor & Fuels	Not Determined	22,400 (Design only)	100%	Not Started	On 9/20/56 preliminary design study sent to AEC for approval. Construction project proposal to be prepared. Total estimate $300,000 to $500,000.
CG-681	Hanford Equip. in the ETR	Reactor & Fuels	Not Determined	80,000 (Design only)	5%	Not Started	Design scheduled for completion in February, 1957.
PLANT & EQUIP. PROJ.-FY 1957							
AEC-2-23-57 N-2 Gen. Plant Proj.							
CG-658	Shielded Personnel Monitoring Station	Radiation Protection	150,000	Not Authorized	--	--	Project proposal awaiting AEC approval.
CG-680	Corrosion Testing Facilities - 314 Building	Reactor & Fuels	171,000	29,500 (Design & Procurement)	Not Started	Not Started	Authorized 9/24/56 for Design & Procurement only.
CG-685	Alterations to 325 and 326 Buildings	Reactor & Fuels	23,000	23,000	Started 9/20/56	Not Started	Specifications for bid assembly on 325 Bldg. Elevator door completed.
CA-693	Alteration & Expansion of 2704-C Bldg. Lunch Room and Office Facility	Chemical Research	32,000		--	--	Project proposal being withdrawn. Future submission dependent upon Hot Semi-Works operating program.
CA-700	Geological & Hydrological Wells	Chemical Research	137,000		--	--	Project proposal forwarded to AEC-Washington by AEC-HOO.

PROJECT NUMBER	TITLE	USING COMPONENT	PRESENT EST. TOTAL PROJECT	AUTHORIZED FUNDS	DETAILED DESIGN	CONSTR.	REMARKS
(ER 3170)	High Level Exposure Facility Addition 141-M Bldg.	Biology	26,000		--	--	Project proposal approved by CEO. Currently being reviewed by HLO for approval
B-5776	Effluent Technology Lab.	Chemical Research	$ 95,000	--	--	--	Preliminary information & cost estimates compiled for project proposal preparation.
A-00617	Ventilation Improvements - 222-U Bldg.	Chemical Research	73,000	--	--	--	Project proposal completed by CEO. Currently being routed for HLO approval.
AEC-2900	Equip. Not Incl. in Constr. Proj.						
CA-695	Radio Telemetering Network	Physics & Instruments	95,000		--	--	Approval as Equipment not included in Construction Projects awaiting submission of financial plan by General Electric.
New Constr. - FY 1957 for Which Funds not Determined							
ER-3175	Plutonium Metallurgy Facility Expansion	Reactor & Fuels	Not Determined	None	--	--	Plant & Equip. analyses report and project proposal being prepared. Local source of funds needed. Scope of project being re-evaluated.
NEW CONSTRUCTION FY 1958							
B-57129 ER-3174	Critical Mass Laboratory	Physics & Instruments	2,000,000	None	--	--	Hazards study completed 9/24/56. Preliminary design & site selection to be started. Completion of project proposal requires completion of former.

EMPLOYEE RELATIONS

At the end of September, the staff of the Hanford Laboratories Operation totaled 1141 employees, including 463 exempt and 678 non-exempt personnel. There were 417 employees with college degrees, including 394 technical degrees as follows:

BS	MS	PhD
209	101	84

Plans for presenting PBM-1 to HLO personnel have been formulated and will be implemented upon approval of the HAPO-wide plans by the AEC. Studies pertaining to personnel development were initiated during the month. These include (1) manpower inventories, (2) proposed non-exempt personnel development program and (3) training activities.

At the close of the month 23 technical graduates and 9 technician trainees were assigned to Hanford Laboratories Operation from training programs conducted by Relations and Utilities.

Final preparations were completed for the Hanford Laboratories Operation's portion of a dry-run of a proposed HAPO tour by press, radio and TV personnel.

All personnel of the Hanford Laboratories Operation were placed in the new salary structure of the Operation during the month. The semi-annual salary administration report for the period ending September 30, 1956 was compiled for HLO and forwarded to Personnel Accounting for transmittal to Employee Compensation Services.

The employment activities of HLO have been integrated into a HAPO-wide program to insure that non-exempt employees throughout the plant are accorded transfer and other privileges on a consistent basis.

At present, secretarial and stenographic vacancies represent the only critical openings. There are 54 such openings at HAPO of which 10 are for HLO.

EMPLOYMENT - NON-EXEMPT

Requisitions open at end of month	34
Requisitions filled	20
Requisitions cancelled	2
Requisitions received	15
Applications considered	14
Active transfer cases at end of month	26
New requests	8
Transfer effected	0

TRANSFER CASES - EXEMPT

(Includes only cases handled by Employee Relations representatives)

Total cases handled since 9-1-56	31*
Initiated by employee	25
Initiated by management**	6

Active cases at end of month	28
New cases during month	8
Initiated by employee	5
Initiated by management**	3
Cases closed during month	3
Transfers effected within HLO	1
Transfers effected to other GE	1
Terminations	1

*Includes cases initiated prior to 9-1-56
**Includes ROF's, transfer proposed by employee's management and requests from other GE departments.

A suggestion board consisting of coordinators representing each of the level 3 components except Operations Research has been established. Fifteen suggestions were submitted during the month by HLO employees representing 2.2 suggestions per 100 eligible employees. Six suggestions are pending board action and one is pending AEC approval.

HLO participation in the Employee Benefit Plans as of the end of September is as follows:

	Number Participating	Present Participation
Pension Plan	988	96%
Insurance Plan		
Personal Coverage	1,123	98%
Dependant Coverage	689	--
U. S. Savings Bonds		
Stock Bonus Plan	648	57%
Savings Plan	93	8%
Good Neighbor Fund	677	59%

HLO currently has 209 employees subject to military service of which 87 are reservists and National Guards members. Of the 122 subject to selective service, 15 are classified I-A and deferments have been granted or are being processed for 43.

Recruiting efforts were at a minimum during the month with a major portion of the activity being directed toward planning for the coming recruiting season.

TECHNICAL RECRUITING ACTIVITIES

PhD

	Visits to Richland			Offers			On the Roll
	Invitations Extended	Visited	To Visit	Extended	Accepted	Open	
Elect. Engr.				1		1	
Metallurgy		1*					
Physics							1

*No HLO interest.

Experienced BS/MS

	Visits to Richland			Offers			On the Roll
	Invitations Extended	Visited	To Visit	Extended	Accepted	Open	
Chemistry	1						
Math.	1	1					
Met. Engr.	1						
Physics	2	1					
Other	1	1					

During the month of September, grievances were received and processed as follows:

Step I

	Number Discussed	Answered Satisfactorily	Withdrawn	Answered unsatisfactorily - Pending Step II	Discussed at Step II
Unit	8	2	1	1	4
Non-Unit	0	0	0	0	0

Step II

Number Discussed	Step II Answers Given	Pending Step II Answers
4	1	3

In addition, there were two Step II grievances carried over from the former organizatio HAMTC was not in agreement with the Step II answers but has not yet taken further action. One is considered as closed during the month due to the expiration of the three-month time limit.

HLO personnel worked a total of 166,684 employee hours during the month with no disabling injuries. There were 43 medical treatment cases for the frequency of 2.58. There were no serious incidents during the month. Two incidents resulted in minor injuries and there was one fire which caused no injury or property loss.

A 300 Area accident Prevention Committee has been formed with equal representation between HLO and the Fuels Preparation Department.

Approval for use of Separan 2610 for drinking water cannot be given by Health and Safety because approval has not been received from the U. S. Public Health Service.

FINANCIAL

Basic accounting records for HLO were established as of September 1, 1956, reflecting balances transferred from HAPO General Books coincident with decentralization. Supporting details were also transferred and appropriate accounting procedures have been established and are operating.

Cost accounting ledgers were established for operating costs, research and development and other end functions, and equipment and construction work in progress. Procedures were established for accumulating costs and liquidating costs to research and development studies and customers.

The following control budgets were established for Hanford Laboratories:

Attendance at Meeting of Professional and Trade Societies	$18,000
Charges Against the Fee	$ 7,600
Overtime	1.5% of available man-hours

Control budgets have been or will be established for Level 3 components.

The gross payroll paid during the month was $570,299.85, of which $321,842.25 was paid to exempt employees and $248,457.60 to non-exempt employees. Payments to the non-exempt employees represents four weeks.

Salary rates for all non-exempt employees, except Technical and Business Graduates, were changed to reflect an increase of 3% on base pay rates in accordance with the Company's Better Living Program. The revised rates were effective October 1, 1956, and were reflected in weekly salary checks on October 12, 1956.

A cash fund was established in the 3702 Building for the convenience of HLO people desiring travel advances.

The HLO Forms Review Program was established in an OPG issued early in October. A revised forms numbering system was established, which will result in easier reference to forms and more efficient handling.

Data for measurements systems for Hanford Laboratories and its components were prepared for Laboratories managers. On September 11 the Specialist - Measurements attended a meeting in Schenectady of measurement specialists of Company laboratories and components to exchange thinking and progress on measurements applicable to laboratories.

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. J. Davis D. G. Watson H. A. Sweany	9/3-9/15	Astoria and Coos Bay, Oregon	Collect biological samples.	-	-
W. B. Weihermiller	9/4-5-6	Dow Chemical Company Rocky Flats, Colo.	Witness inspection.	E. Walko	Yes
E. A. Evans R. J. Anicetti	9/5-8/56	GE - San Jose, Calif.	Discuss design criteria for UO_2 fuel elements.	W. K. Woods	No
J. J. Fuquay	9/5/56	U.S. Air Force, Kirkland Field, Albuquerque, N. Mex.	Atmospheric Fall-Out Conference.	Lt. D. A. Baker	Yes
J. L. Jaech	9/6-9/7	Phillips Petroleum Co. Idaho Falls, Ida.	Consultation on Project Bluenose.	F. P. Vance	Yes
B. Mastel	9/9-13	Univ. of Wisconsin Madison, Wis.	Present paper at Electron Microscope Society of America	-	No
C. Groot	9/9-12	American Institute of Chemical Engineers Pittsburgh, Pa.	To present a paper.	-	No
J. A. Berberet E. D. Clayton	9/10/56	LASL - Los Alamos, N. Mex.	Discuss Critical Mass Experiments.	H. C. Paxton	Yes
	9/11/56	Dow Chemical Co., Denver, Colo.	Discuss Critical Mass Experiments.	C. L. Schuske	Yes
	9/12-9/13	ORNL, Oak Ridge, Tenn.	Discuss Critical Mass Experiments.		Yes
R. E. Burns	9/10-9/14	Columbus, Ohio	Corrosion School	-	-
	9/17-9/18	Atlantic City, N. J.	Attended Council Meeting as Alternate Councilor at American Chemical Society.	-	-

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
M. T. Walling	9/10/56	G. E. - GEL Schenectady, N. Y.	Deliver talk to the Chem. Professors' Conf.	H. R. Schmidt	No
D. E. Baker	9/10/56	Schaevitz Engineering Co. Camden, N. J.	Calibrate and test before shipping equipment order on PR G-299120.	E. E. Williams	No
W. J. Ozeroff	9/11-9/13	USAEC, Wash., D. C. Div. of Civilian Application	Discuss reactor safeguard problems.	C. K. Beck	Yes
Z. E. Carey	9/11-13	General Electric Co. Schenectady (KAPL, G.E. Lab. Research Services)	Attend meeting and to gain additionalinformation in the field of measurements.	D. Kerr C.A. Gillespie L. E. Simpson F. J. Maguire	Yes
	9/14/56	General Electric Co. Cincinnati, Ohio (ANP, AGT)	Gain information in the field of measurements.	J. McCarthy R. K. Dibble W. Eagon	Yes
O. J. Wick I. D. Thomas	9/12-14	UCRL, Livermore, Calif.	Discuss Hanford Assistance Program.	W. M. Ramsey	Yes
M. D. Freshley	9/12-14	UCRL, Livermore, Calif. Los Angeles Engelberry Co. Los Angeles True-Trace Co. Los Angeles, Calif.	Discuss plating problems. Equipment evaluation	W. M. Ramsey B. Dunn	Yes No
C. A. Rohrmann	9/12-9/15	Chemistry & Chemical Engineering Professors' Conference, Lake George, N.Y.	Present talk entitled "Process Eng. Problems in the Hanford Separations Plants"	J. W. Hall D. H. Ahmann	No Yes
	9/17/56	KAPL, Schenectady, N.Y.	Consultations on separations & waste processing and related data.	H. W. Alter J. K. Davison	
	9/17/56	Research Laboratory Schenectady, N. Y.	Review types of work which may be done for HAPO.	C. G. Fick	No
	9/18/56	GEL, Schenectady, N. Y.	Same as above.	H. R. Schmidt	No
	9/19/56	ORNL, Oak Ridge, Tenn.	Consultations on separations & waste processing & related data.	F. L. Culler	Yes
	9/20/56	ANL, Lemont, Ill.	Consultations on separations & waste processing & related data.	S. Lawroski Rodger	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. L. Burger	9/13-9/14	Oak Ridge Nat'l Lab. Oak Ridge, Tennessee	Discuss research on organo phosphorus compounds.	E. H. Taylor	Yes
	9/17-9/21	Atlantic City, N. J.	Attending Nat'l ACS Meeting	--	No
G. W. Stuart	9/13-9/14	ANL, Lemont, Ill.	Discuss reactor calculations.	B. I. Spinrad	Yes
	9/17-9/18	E. I. duPont de Nemours Savannah River Plant Augusta, Ga.	Discuss reactor calculations.	D. S. St. John	Yes
C. G. Stevenson	9/13/56	Seattle, Wash.	Attend meeting of Washington State Library Commission	--	No
A. R. Keene	9/13-9/14	Boise, Idaho	Presented a paper on "Radiation Hazards" before the Governor's Annual Safety Conference.	W. L. Robison	--
H. G. Rieck	9/16-9/21	11th Annual Instrumentation & Automation Exhibit and the Data Handling Workshop in New York City	Attend Conference.	--	No
T. F. Evans	9/17-9/18	National Lead Pilot Plant, Grand Junction, Colo.	Observation of processing equipment of interest to HAPO.	C. MacArthur	Yes
L. G. Merker	9/18-19	Axelson Co. Los Angeles Engelbery Co. " True-Trace Co. "	Equipment evaluation	B. Dunn J. D. Kreager G. F. Fry	No No No
W. S. Kelly	9/18-20	North American Aviation Atomics International Canoga Park, Calif.	Technical discussions and consultations on hot laboratories operation.	J. M. Davis	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. P. Bupp	9/18/56	National Carbon Co. Cleveland, Ohio	To attend dedication of research labs.	A. S. Johnson	No
	9/19-20	Argonne National Laboratory, Chicago, Ill.	Reactor Handbook discussions.	S. McLain	Yes
G. B. Barton	9/19-9/24	G. E. - San Jose, Calif.	Employment Interview	F. W. Shell	No
O. F. Hill	9/20-9/21	AEC Division Reactor Development Washington, D. C.	Attend meeting on processing of industrial reactor fuel elements.	S. B. White S. G. English W. N. Munster	Yes
W. A. Burns	9/20-9/21	G. E. Co. Schenectady	Pers. Dev. & Training Methods Consultation	T. W. Zebley T. K. Koerner W. S. Hill Dr. Giddings B. B. DeLack	No
	9/23-10/5	G. E. Co. - New York	Communications Course II	C. V. Dover	No
O. J. Wick	9/20-21	AECL, Chalk River, Can.	Attend U.S.-Canadian reactor conference.	W. B. Lewis	Yes
R. M. Fryar	9/20-21	Atomic Energy of Canada, Ltd.	Technical discussions on heavy water reactors.	W. B. Lewis	Yes
	9/24-25	Canadian General Electric Co.	Same as above.	I. S. McRae	Yes
P. M. Thompson	9/21-9/22	G. E., New York	Interview on potential assignment.	B. B. Field	No
C. A. Bennett	9/22/56	American Society for Quality Control in Salt Lake City, Utah	Invited speaker.	W. A. Hoaglund	No
J. R. Triplett M. V. Davis	9/23-24	Brookhaven National Lab. Upton, N. Y.	Discussions on resonance capture of neutrons.	J. Chernick	Yes
J. F. Fletcher	9/24-29	Materials Testing Reactor Phillips Petroleum Co. Idaho Falls, Idaho	Installation of experiment in MTR.	H. T. Watanabe	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
H. Neumann	9/24-26	BNL, Upton, N. Y.	Attend Resonance Absorption Meeting.	J. Chernick	Yes
			Discuss Water Moderated Lattices.	H. Kouts	Yes
G. W. Anthony	9/24-25	BNL, Upton, N. Y.	Attend Resonance Absorption Meeting.	J. Chernick	Yes
R. C. Thompson	9/25-30	Idaho Falls, Idaho	Present a paper at Industrial Physicians Meeting.	C. V. Beard	Yes
H. A. Kornberg	9/25-30	Idaho Falls, Idaho	Attend Bio-Medical Directors Meeting.	C. V. Beard	Yes
L. K. Bustad	9/25-9/28	Salt Lake City, Utah	Testify at Utah Sheep Trial	--	--
R. J. Brouns	9/25-9/27	AEC - Washington, D. C.	Attend Steering Committee Meeting.	D. R. Miller	No
A. E. Smith	9/25-9/26	Chicago, Ill.	1956 Trade Fair of the Atomic Industry.	--	--
	9/27/56	Allis Chalmers Norwood Works, Cincinnati, Ohio	Consultations with canned motor pump manufacturers.	--	--
	9/28/56	Coors Porcelain Plant Golden, Colo.	Discuss ceramic fabrication.	--	--
J. W. Healy	9/25/56	Chicago, Ill.	Presented a paper before Atomic Industrial Forum on "The Biological Effects of Radiation."	--	No
	9/26-9/28	National Reactor Testing Station, Idaho Falls	Biomedical Directors Meeting.	--	Yes
T. C. Mehas	9/26-9/27	Small Business Management Procurement Fair Seattle, Wash.	Protective clothing display booth.	--	--
D. P. Granquist	9/26-27	Atomics International Canoga Park, Calif.	Consultation on organic materials.	E. L. Colichman C. A. Trilling	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. J. Anicetti E. A. Evans W. E. Roake	9/27-28	Westinghouse Atomic Power Div., Pittsburgh	Discussion and conference meeting on oxides.	J. Belle	Yes
H. Neumann	9/27/56	Westinghouse Electric Co. Pittsburgh, Pa.	Discuss Water Moderated Lattices.	S. Stain	Yes
J. H. Kelly	9/28/56	Electric Steel Foundry Co. Seattle, Wash.	To attend demonstration on the fabrication of Polyvinyl Chloride.	--	No
J. H. Kleinpeter	9/28/56	Seattle, Wash.	Attend ESCO PVC fabrication training sessions.	--	--

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
G. H. Whipple	9/4-9/5	Univ. of Rochester AEC Project, Rochester	Visit Facilities.	HA Kornberg LK Bustad	No	100-F: 108-F 141-M:146-FR
	9/4-5/56		Discuss radiation protection procedures.	AR Keene and Staff	No	300 700
L. R. Martin	9/4-9/5	Detroit-Edison Co. Detroit, Mich.	Visit facilities and discuss autoradiographic methods.	HA Kornberg DE Warner	No	100-F: 108-F 141-M:146-FR
	9/4-5/56		Discuss radiation protection procedures.	AR Keene and Staff	No	300 Area 700 Area
R. E. Shanks E. Crebsch	9/5/56	Univ. of Tennessee AEC Project, Oak Ridge	Visit facilities and discuss ecological studies.	HA Kornberg RF Foster DE Warner	No	100-F:108-F, 146-FR
C. V. Theis R. C. Newcomb * G. E. Harbeck ** R. E. Glover **	9/5-9/7	US Geological Survey Albuquerque, N. Mex. & Consultant, AEC, Washington, D. C. * U.S. Geological Survey Portland, Oreg. ** U.S. Geological Survey	To discuss the geologic and hydrologic research being conducted at Hanford.	DW Rhodes RE Ewing DW Pearce RE Brown DJ Brown PP Rowe WH Bierschenk	Yes	200-W: 222-U. 300: 329

Name	Dates of Visit	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
C. V. Theis R. C. Newcomb * G. E. Harbeck ** R. E. Glover **	9/7/56	US Geological Survey Albuquerque, N. Mex. & Consultant, AEC, Washington, D. C. * U.S. Geological Survey Portland, Oreg. ** U.S. Geological Survey Denver, Colo.	Visit facilities and discuss Columbia River channeling and dispersion of effluent.	RF Foster LK Bustad	No	100-F: 108, 141-M, 146-FR
C. V. Theis	9/7/56		To discuss the geologic and hydrologic research being conducted at Hanford.	VR Cooper DW Pearce	No	300: 328
H. N. Townsend V. J. Nolan	9/10/56	National Carbon Co. Cleveland, Ohio	Technical discussions on graphite development.	M Lewis WA Snyder	Yes	300
R. Rowe	9/11/56	General Machinery Co. Spokane, Wash.	Equipment Observations	AE Smith	Yes	300: 321
	9/18/56	" "	" "	AE Smith	Yes	300: 321
H. Gustafson	9/11/56	General Machinery Co. Spokane, Wash.	" "	AE Smith	Yes	300: 321
W. P. Armstrong	9/11-13	Professor of Chemical Engineering, Washington Univ. at St. Louis and consultant for Mallinckrodt Chemical Works, St. Louis, Mo.	Tour Separations plants and obtain information on absorption of nitrogen oxides, nitric acid concentration, nitric acid corrosion and heat transfer.	CA Rohrmann ET Merrill	Yes	300: 326
	9/12/56		Inspect recirculation test loop	LP Bupp	Yes	100-K: 105-KE
A. T. Storrer	9/11-13	Chemical Engineer in Engineering Dept. of Mallinckrodt	Accompanied W. P. Armstrong			
Atomic Power Associates	9/14/56	Various Industries	Guests of AEC - touring facilities	RF Foster LK Bustad	--	100-F: 141-M, 146-FR

Name	Dates of Visit	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
T.J.E. Glasson	9/17/56	KAPL - Schenectady	Discuss organic coolant technology.	JM Atwood	Yes	100-K: 105-KE 100-D, 300
E. W. Connor	9/17/56	Miller Electric Co. Portland, Oregon	Consultation on Miller welding equipment.	L. C. Lemon	No	300: 306
F. L. Brown	9/17-9/21	ANL, Lemont, Ill.	Discuss ANL research.	JJ Cadwell	No	300: 326
J. B. Newkirk	9/17/56	G. E. - Schenectady	Discuss X-ray diffraction and metallography.	JJ Cadwell	No	300: 326
C. N. Spalaris	9/19-9/20	G. E. - San Jose, Calif.	Consultation on welding in an inert atmosphere.	D. C. Kaulitz	No	300: 326
F. Brown, H. Paine, Jr.	9/19-9/20	Argonne National Laboratory, Chicago, Ill.	To discuss effects of irradiation to materials.	L. D. Turner	Yes	300
EL Van Nostrand, Jr.	9/20/56	Industrial Physician KAPL, Schenectady, N.Y.	Toured facilities and discussed research problems.	HA Kornberg	-	100-F, 108-F, 141-M, 146-FR
			Discuss radiation protection procedures.	AJ Stevens	No	300: 313

Name	Dates of Visit	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
T. Fisher	9/24/56	KAPL - Schenectady	To discuss metallography of irradiated materials.	LD Turner	Yes	300
J. C. Biery, F. J. Linck, Jr.	9/24/56	Dow Chemical Co. Rocky Flats, Colo.	Discussion of Metal Reduction Technology.	EJ Wheelwright, EE Voiland, WR DeHollander	Yes	300: 324, 200-W: 234-5
	9/26/56		Solvent Extraction	RG Geier	Yes	300: 326
L. P. Ferris H. C. Anderson	9/24/56	Dow Chemical Co. Rocky Flats, Colo.	Discussions of analytical problems of mutual interest.	FM Smith RJ Brouns	Yes	200-W Area. 300: 325
M. J. Fortenbery, G. R. Jasny, J. Kurtz, F. S. Patton.	9/24/56	Union Carbide & Carbon Oak Ridge, Tenn.	Reviewing departmental & operational data and obtaining design criteria for uranium oxide continuous calciner.	RG Geier RE Burns	Yes	300: 326, 303 Bldgs. 200-E: 202-A, 200-N: 271-U, Redox, 100-K, 105-KW.
A. Lagani	9/26/56	KAPL - Schenectady, NY	Discussion covering analytical work in connection with KAPL-120.	HJ Anderson, FE Holt, R Ko, DM Robertson.	No	300: 325
B. L. Bailey	9/27/56	Great Lakes Carbon Co. Niagara Falls, N. Y.	Technical discussions on graphite development.	M Lewis WA Snyder	Yes	300
R. C. Thorburn	9/27-28	General Electric San Jose, Calif.	Discuss radiation protection procedures.	AR Keene and Staff	No	300: 313
C. Wraith, C. O. Herrala	9/28/56	UCRL - Livermore, Calif.	Discuss Plating Operation.	OJ Wick	Yes	200-W: 231

INVENTION REPORT

All Hanford Laboratories Operation personnel engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during September 1956 except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR(S)	TITLE
H. R. Gardner	Heat treatment of Uranium
W. J. Bailey	HW-45015 - Diffusion Welding of Aluminum with the Double Acting, Hot Work Punch, September 7, 1956
W. J. Bailey	HW-45016 - Diffusion Welding of Aluminum with the Single Stroke, Hot Work Punch, September 7, 1956
H. W. Lefevre & J. T. Russell	Time Measurement in the Millimicrosecond Region

H. M. PARKER
MANAGER, HANFORD LABORATORY