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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
OCTOBER 1956

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November 21, 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
OCTOBER 1956

	FORCE REPORT						PERSONNEL STATUS CHANGES					
	At Close of Month			At Beginning of Month			Additions		Separations		Sep. Rate	
	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Exempt	Non-Exempt	M	F
HLO General	1	1	2	1	1	2					0	0
Biology	31	42	73	29	42	71	2				0	0
Chemical Research and Development	126	94	220	130	92	222		3	4	2	2.80	2.58
Laboratory Auxiliaries	34	196	230	34	197	231	1	8	1	6	3.07	3.03
Operations Research and Synthesis	12	3	15	12	3	15					0	0
Physics and Intrument Research and Devel.	60	20	80	59	20	79	1				0	0
* Radiation Protection	41	209	250	40	196	238	1	17		8	2.30	2.50
Reactor and Fuel Research and Devel.	135	83	218	130	84	214	5	3	2	2	1.61	1.30
Employee Relations	13	11	24	13	11	24					0	0
Financial	15	30	45	15	30	45		1		1	0	4.76
Total	468	689	1157	463	678	1141	10	32	7	19	2.25	2.23

Composite Separations Rate - - 2.24

For purposes of comparison with other HAPO departments the HLO Separations Rate is 0.86. This is based on removals from payroll not including transfers within HAPO.

*Radiation Protection turnover rates includes Monitors rotating on a 60-day basis.

Technical Degree Separation rate - 1.66.

HANFORD LABORATORIES OPERATION

PROMOTIONS AND TRANSFERS (8)

OCTOBER 1956

DURING MONTH

	Promotions			Exempt Transfers(2)				Non-Exempt Transfers	
	Exempt	Non-Exempt to Exempt	Non-Exempt(1)	To HLO From Other HAPO	To HLO From Other GE	From HLO To Other HAPO	From HLO To Other GE	To HLO	From HLO
HLO General									
Biology			2						
Chemical Research and Development	7		2				2	1	1
Laboratory Auxiliaries			7	1		1		2(6)	3
Operations Research and Synthesis									
Physics and Instrument Research and Development	1				1				
Radiation Protection			2(4)					10(7)	5
Reactor and Fuel Research and Development	2	3	7(5)	2				1	
Employee Relations			1						
Financial			4					1	
Total	10	3	25	3	1	1	2	15	9

(1) Changes involving pay increase only
(2) Transfers within HLO not included
(3) Within HAPO unless other wise indicated
(4) One effective 5/28/56
(5) One effective 9/10/56
(6) All effective 9/3/56
(7) Four effective 9/3/56
(8) Best available data thru 11/5/56

TECHNICAL ACTIVITIES

METALLURGY AND REACTOR FUELS

Uranium Metallurgy

Metallography of Fractured Uranium Surfaces. The metallographic study of fractured non-irradiated uranium surfaces is continuing in order to establish a basis for the interpretation of fractured irradiated uranium. Replicas of the interface of uranium fractured at room temperature by impact have been examined in the optical and electron microscope. The surface of this type of fracture consists of tongues and dimples which are associated with the more ductile and fibrous type of fractures. The abundance of inclusions occurring at the fracture interface indicates that the fibrous fracture path may be attracted by these impurities. The surface of one micro-tensile non-irradiated uranium specimen, fractured by slow tension at 370 C in an evacuated chamber, has also been studied. This particular specimen was tested to determine the mode of deformation and fracture applicable under the testing conditions used. Time lapse 16 mm motion picture photography was used to record changes in the material and will be analyzed shortly. High magnification studies of this specimen show extensive cracking in the "necked down" region of the specimen. In general, these cracks are perpendicular to the direction of stress and are estimated to be 0.2 microns deep. No evidence of crystalline cleavage facets, or twins, was observed in the highly deformed fracture interface. Presumably the extensive distortion which occurs at or near the fracture region must be attributed to complex slip.

Cellulose acetate ribbon has been used extensively for replication of cathodically vacuum etched surfaces for optical and electron microscopy. If such aluminumized replicas of uranium are examined under crossed nicols, these replicas exhibit optical anisotrophy. This anisotrophy is independent of the amount and angle of aluminum or gold evaporated on the cellulose acetate. If the primary cellulose acetate replica is replicated with polyvinyl alcohol and this secondary replica coated with aluminum, it also exhibits optical anisotrophy. Since these tests indicate that this anisotrophy is independent of the replica material and the shadowing metal, the anisotrophy therefore can only arise as a consequence of a change in polarization by reflection. The polarization effects can be explained on the basis that the structure within a grain presented by the replica consists of an assemblage of minute facets, the normals to which make relatively large angles with the incident light beam. Isotropic materials will, therefore, appear anisotropic, so the replica is a faithful reproduction of the metal surface in all respects.

Uranium Grain Size. In July, 1955, a grain size chart for uranium was prepared at HAPO so that grain sizes of uranium could be compared and estimated readily. The condition of heat treatment of the uranium was not considered a major factor at the time since it was hoped that a reasonable estimation of grain size could be made regardless of the appearance of the microstructure caused by heat treatment. Therefore, the chart was prepared from uranium which had been treated completely in the alpha phase or had been given a high alpha phase anneal as its final treatment. Copies of the chart were sent to all members of the Committee on Metallography of the Metal Quality Working Committee for their use and criticism. The use of this chart during

the trial period showed that it was acceptable for the estimation of uranium grain sizes in all conditions of heat treatment except beta transformed uranium. Consequently it was recommended by the members of the Committee on Metallography that the chart be used, with the one exception, and concurrence of the Metal Quality Working Committee followed.

In the time since preparation of the original chart certain changes and improvements have been made incorporating suggestions from members of the Committee at other sites. These changes will be presented to the Committee on Metallography for concurrence and adoption at the next official meeting scheduled at Bridgeport, Connecticut, in November.

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 four couples that were analyzed this month 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)	Uranium into AlSi (mils)	AlSi into Uranium (mils)
255	30	2.5	1.6
255	30	2.8	1.6
255	30	2.3	1.7
300	15	6.6	3.8

These couples were analyzed by the method described in the June 1956 Metallurgy Research Quarterly. Three U/AlSi couples have been annealed 45 days at 255 C, three have been annealed 30 days at 300 C and three are now being annealed 45 days at 300 C. The laboratory investigation of U/AlSi diffusion will undoubtedly be completed this quarter. No new results from the U/Zr diffusion studies are available.

Some difficulty has been experienced in applying the techniques used for the study of diffusion of the inert gases in silver to similar studies with uranium. Difficulty arises in that uranium does not cold-weld readily. Consequently, a new direct technique has been developed which uses a steady-state approach rather than the non-steady state approach. The apparatus is under construction and will permit the gas to be introduced by means of electrical discharge into one side of a uranium foil at a constant rate at elevated temperatures.

Outgassing. Installation of the Stokes model 435-502 vacuum furnace has been completed and the service and experimental work has begun. The unit is capable of holding an indicated vacuum of less than 0.1 micron at a maximum temperature of 800 C. The retort is ten inches in diameter and twelve inches deep, and can accommodate twenty standard uranium slugs. The majority of the work to date has been the low pressure outgassing of uranium slugs in the high alpha temperature region. Metallographic and X-ray examination has shown that the outgassing operation does not produce an undesired grain size nor a preferred grain orientation, but will, in general give a refined grain size and maintain random orientation. Some work has also been done in the vacuum annealing of zirconium and zirconium alloys.

Thermal Stresses. A method of calculating the thermal stresses in cylindrical fuel elements has been developed which can account for stress relaxation. This method can be used with a model of mechanical behavior which has a stress, strain, and temperature dependent strain rate. An incremental method of solution is utilized in which the stress relaxation is calculated with a viscoelastic model which has a time and radial dependent coefficient of viscosity. A coefficient of viscosity is evaluated at the start of each increment with the model of mechanical behavior of the material.

Uranium Tensile Specimen. The metallographic examination of sections cut from a uranium tensile specimen irradiated in the MTR according to GEH-3-20 was completed. Some small regions of gas porosity were observed, indicating that portions of the sample had operated at the calculated 800 C center temperature.

Plutonium Metallurgy

Fabrication Development. Development of coating methods for plutonium-aluminum alloy monitor pins and foils is proceeding. Barrel plating methods are showing promise. However, difficulties in maintaining a continuous electrical contact with the small tumbling parts being plated will require some modification of the barrel plater contact screen.

Assistance to Physics Research. Eighteen of the simulated 1000 MWD/T fuel elements prepared for tests in the PCTR were leak checked in the bubble tester. Eight of the eighteen were tight and the remainder of the slugs have small pin hole leaks in the braze closure. A heli-arc welding machine is being set up to make a fusion weld closure.

During discussions with PCTR personnel, it was brought out that the tests will be conducted in a vacuum at temperatures up to 300 C. The calculated allowable internal gas pressure within the standard aluminum can, with reference to yield strength, is

65 psi at 315 C at which time the can will expand and burst. To prevent the pressure from attaining this value, the slugs will have to be canned in a vacuum. Methods of performing this operation are being investigated.

Hanford Process Development. Two of the eight Pit 65 demonstration plugs shipped to Dow Chemical Company, Rocky Flats Plant last month corroded during shipment. The two replacements have been fabricated, inspected, and canned ready for shipment. To prevent a re-occurence of the corrosion problem, electroformed cans were made for these two plugs.

The ventilation controls and equipment for the tensile-compression hood were turned over to the Minor Construction forces for fabrication. The design of this particular system was given careful consideration as several new features were desirable on this particular installation. The results of this assembly may determine the future treatment of several hoods of a similar nature.

Zirconium Metallurgy

Recrystallization and Recovery of Zirconium Alloys. In connection with studies on recrystallization and recovery of zirconium alloys, electrical resistivity measurements were made on Zircaloy-2 and Zircaloy-3 sheet reduced 10 per cent and 50 per cent, then annealed for 10, 100 and 1000 minutes at 300, 400, and 500 C. Measurements were accomplished at the temperature of boiling nitrogen (-195 C). Maximum experimental error in an individual specimen is ± 1.5 per cent. Electrical resistivity for different specimens in the same condition varies ± 1.5 per cent. A general trend of recovery is evident. However, a number of anomalies persist which cannot be attributed to accepted recovery theory. Since the experiment utilizes a separate specimen for each experimental condition, a non-uniformity of rolling texture could account for inhomogeneous specimens evidenced in the observed anomalies in resistivity. A control experiment is contemplated wherein the same specimen will be annealed and measured repeatedly.

The kinetics of recrystallization and recovery in Zircaloy-2 and Zircaloy-3 are being determined to establish optimum conditions of heat treatment during fabrication

operations. Per cent cold work, temperature, time, and heat treatment atmosphere were selected as variables. Hardness data were obtained for 50 per cent cold worked material annealed in air and helium at temperatures from 300 to 800 C for 10 to 1000 minutes. These data indicate the recrystallization temperature range for this cold work. Minimum hardness was reached in the 600-700 C range for both Zircaloy-2 and Zircaloy-3. The hardness of both alloys increased after 800 C anneals due to atmosphere contamination or to second phase distribution. Examination of the microstructure of these samples has started. Approximately 80 samples were prepared from the heat-treated specimen for 680 F water corrosion testing.

Zirconium Creep-Testing Program. The processing of Zircaloy-2 sheet to be used by Battelle Memorial Institute for creep testing was completed and the material was shipped during the month. Battelle was furnished with the fabrication history, annealing treatment, and hardness data for these samples. Information will be available shortly on the grain size and chemical composition of the material supplied for this year's program and also the material used during last year's program. This information will be useful in comparing forthcoming test results with results obtained previous1 It is expected that the Zircaloy-3 shipment will arrive from the Bureau of Mines in time to process and ship creep-test sheets to Battelle during the next month. Battelle was furnished with a list of testing conditions and the chronological order in which these tests are to be conducted.

Zirconium-Hydrogen Reactions. Local hydrogen embrittlement of a zirconium tube in the 0961-H Recirculation Loop Facility has been reported as the primary cause for the failure of the tube when a fuel element ruptured in the H Loop on October 31, 1956. Throughout the month additional data concerning the sorption of hydrogen by zirconium and the resultant effects on its mechanical properties have been collected from HAPO experimenters and offsite authors. As a result of this survey, it appears that additional experimental work is needed to establish minimum concentrations of sorbed hydrogen which would result in failure at specific temperatures and stresses, and to define what exposure conditions must be maintained to restrict the hydrogen content to the established minimums. The initial draft of a summary of the collected data and a suggested experimental program have been completed.

B-D-F Size Process Tubes. The Superior Tube Company has decided to do the engineering and procurement for lengthening the tube reducing machine to be used on this contract, rather than subcontracting this modification. The earliest completion date for this modification is estimated to be January, 1957, which is approximately six weeks earlier than if the work had been sub-contracted.

Subsequent to the failure of a Zircaloy-2 tube at the crest of the ribs during the second stage of double tube reducing, the tube reducing mandrels were thoroughly checked by Superior Tube Company for dimensional tolerances. It was found that errors had been made in the machining of the mandrels for both first and second stages of the tube reducing. The error in the first stage mandrel was such that the rib was in axial compression with respect to the tube wall and no failure occurred during this step of the operation. The machining error in the mandrel for the second stage of the tube reducing operation was such that the rib was in axial tension with respect to the tube wall and cracks were formed in the ribs during this stage. These errors in mandrel

fabrication will be corrected and several short lengths of Zircaloy-3 tubing are scheduled to be processed through the first step of the tube reducing operation during the week of November 5 or 12th.

Allegheny Ludlum reports that the extrusion tooling has been completed and the first trial extrusion will be made before the end of October. A special titanium alloy billet will be used as a stand-in for zirconium for this trial of the tooling. Tools for piercing billets prior to extrusion are being fabricated and the first attempt to pierce a zirconium billet will be made during the first or second week of November.

Mechanical and Physical Properties of Aluminum Alloys

A study is being made of several variables that affect the tensile properties of an aluminum-1 w/o nickel alloy, M-388, in preparation for tests to determine the extent of radiation damage in this material. Material was cold rolled to 10, 25, and 50 per cent reduction in area. Coupons were annealed for several time intervals at 400, 500, and 600 C. The resulting grain size is being determined to establish working and annealing conditions for specimen preparation. Samples cold worked 10, 25, and 50 per cent have been prepared to investigate recovery and possible aging effect through electrical resistivity and tensile property determination.

Aluminum Corrosion Studies

Effect of Water Composition on Corrosion Rates of M-329 Aluminum Alloy. The study to determine the effect of various ions upon the aqueous corrosion of aluminum has been continued. The corrosion inhibiting effect of phosphate has been ascertained over the range of concentrations from 100 ppm to 0.01 ppm in distilled water and 300 Area process water. The effects of acetate, citrate, oxalate, and arsenate at a concentration of 100 ppm in distilled water and at different pH's have also been determined. These data are given in the following table.

EFFECT OF VARIOUS ANIONS ON ALUMINUM CORROSION
Samples of M-329 Aluminum Exposed at 92 C at Low Flow

Water	Added Anion	pH	Average Penetration mils/month
300 Area Process	(none added)	8.1	0.19
	1 ppm $PO_4^{\equiv}$	7.8	0.18
	10 ppm $PO_4^{\equiv}$	8.2	0.12
	100 ppm $PO_4^{\equiv}$	8.1	0.033
Distilled Water	(none added)	7.2	0.035
	0.01 ppm $PO_4^{\equiv}$	6.6	0.012
	0.1 ppm $PO_4^{\equiv}$	6.5	0.024
	1 ppm $PO_4^{\equiv}$	6.8	0.010
Distilled Water	100 ppm acetate	7.2	0.05
	100 ppm acetate	4.5	0.033
Distilled Water	100 ppm oxalate	7.4	0.075
	100 ppm oxalate	4.1	1.3
Distilled Water	100 ppm citrate	7.9	0.45
	100 ppm citrate	4.4	1.1
Distilled Water	100 ppm arsenate	7.9	0.26

The data indicate that adding 100 ppm $PO_4^{=}$ to 300 Area process water at pH 8 reduces the corrosion rate of M-329 aluminum at 92 C approximately six-fold.

A concentration of 1.0 ppm $PO_4^{=}$ in distilled water reduced the corrosion rate nearly four-fold. Under the conditions tested, acetate, oxalate, citrate, and arsenate were ineffective as corrosion inhibitors. They actually accelerated the rate of corrosion.

Intergranular Corrosion of M-329. Previous experiments have shown that M-329 aluminum alloy (can stock) corrodes intergranularly and disintegrates within a few days at temperatures above 230 C in deionized water. It is more pertinent to know the minimum temperature at which this runaway attack will take place in the reactor. Consequently, long term corrosion tests of M-329 were started about three months ago. After 70 days' exposure at 200 C in deionized water, some evidence of accelerated corrosion attack was noted. The slope of the corrosion rate curve changed radically, and at this time, the M-329 is corroding approximately five times as fast as the M-388. Furthermore, it appears that this corrosion rate is continuing to increase with time. Although these observations are subject to further corroboration and to interpretation in terms of reactor operating conditions, it is tentatively concluded that M-329 may be unsuitable for use for any extended periods (greater than two months) when the temperature of the corroding surface reaches 200 C or above.

Corrosion Rate of M-388 Aluminum Alloy in High Purity Water. The corrosion rate of M-388 is being determined for samples exposed in static autoclaves and for those exposed in refreshed systems. The corrosion rates in all cases are lower in the static systems. This difference becomes more marked as the temperature is increased. Thus, the rate for M-388, in static 363 C water is only 1.5 mils per year, while the rate at 350 C in a system at low flow is 3.5 mils per year.

Pitting Corrosion of M-388. M-388 alloy is an aluminum alloy designed specifically for operation in water (or steam) systems at high temperatures. The resistance to intergranular attack at these high temperatures (200 to 368 C) is provided by additions of 1.0 per cent Ni and 0.5 per cent Fe to give a precipitated second phase material in a dilute alloy of aluminum. This type of material does have [illegible] anodes and cathodes. Consequently, it should be subject to pitting corrosion under proper conditions. These conditions are low temperatures, high conductivity water (or water containing a suitable corrosive ion such as chloride), and lack of a suitable inhibitor. However, all three conditions must be present. Therefore, if M-388 is to be used as a fuel-element jacket material, the above combination of conditions which result in pitting corrosion should be avoided in the design of the reactor, the coolant system, and the operating conditions. Fortunately, the operating conditions for most reactors avoid the combination of conditions that leads to pitting of M-388. In the reactors now operating at low temperatures (less than 150 C) with high conductivity water, dichromate is used as an inhibitor and will minimize pitting. In power reactors using recirculating deionized water, chloride is purposely excluded from the system, the water is of low conductivity, and the minimum temperature is above 150 C.

Evidence of pitting corrosion of M-388 has, in fact, been observed during the past month in 300 Area autoclave tests. Samples of M-388 were exposed in deionized water for four months at 120 C, 135 C, 155 C, and 170 C. The samples tested at 120 and 135 C showed pitting, while samples at 155 and 170 C did not.

The attack resembled chloride ion pitting, and it was suspected that some of the hydrochloric acid used to regenerate the resins of the deionizer might have contaminated the deionized water, though none was ever detected by conductivity measurements. Samples of M-388 and M-329 were tested at 100 C for 24 hours in deionized water to which 100 ppm chloride ion was added as sodium chloride. The M-388 was pitted and the M-329 was not. The observations are being checked by setting up new samples at 120 C, and by submitting water samples for analysis.

Corrosion in Phosphate Systems. Spectrographic analysis of ELMO-6 samples exposed at 250 C in water containing phosphoric acid at pH 5 has shown strong phosphorus lines. Standards containing known percentages of phosphate have been prepared to calibrate the phosphorus spectral line intensities. A quick quantitative analysis of phosphate in corrosion product films will be helpful in study of the inhibition by phosphate ion of aluminum corrosion at high temperatures.

Bonding of Aluminum Oxide Films. Two aluminum coupons were corroded in deionized water at 300 C for 30 days. During the exposure the faces were in close contact. When the samples were removed it was noted that the faces were bonded together so tightly that they could not be pulled apart by hand. The samples were sent to the Metallographic Laboratory to be mounted and sectioned. During the preparation of the samples for mounting, the two coupons fell apart. It was not possible to tell anything about the nature or strength of the bond. It appears likely that the oxide formed during the corrosion of the aluminum formed a mechanical bond between the two faces. So far as is known, this is the first time that this has been observed for the high temperature films.

During reactor operation such variables as heat transfer, cycling, and thermal expansion and contraction would tend to prevent the formation of such a bond. Additional experiments have been started to learn more about the strength and nature of these bonds. In all the experiments to date there has been no indication of bonding of aluminum to zirconium, stainless steel or other materials nor has there been any indication of bonding of zirconium to zirconium by oxide films.

Irradiation Effects on Plastics and Elastomers

Work is continuing on the effect of dose rate on the change in properties of various plastics and elastomers. Samples have been submitted to the MTR under GEH-502- for irradiation over the range from 10^4 r/hr to 10^7 r/hr.

Initial results from the irradiation of styrene-butadiene rubber PR408-70 indicated a post irradiation change in mechanical properties. However, this effect has not been observed in the irradiation and testing of additional samples. In the event that the combination of stress and radiation may have caused the observed results, a group of samples is being irradiated while held at a known elongation and stress.

Two runs have been completed in which about 30 materials have been irradiated at 125 C. When this series is completed it will be possible to determine the combined effect of elevated temperature and radiation.

Graphite Studies

High Temperature Graphite Irradiations. Downward temperature drift problems were experienced in GEH-9-3 similar to those in GEH-9-2. While the exact cause is still unknown, several reasons for such behavior were investigated. Previously it was thought that creep of certain 304 stainless steel parts was the cause, but this explanation is believed voided after similar failure of GEH-9-3 which used molybdenum in place of stainless steel. A thermocouple retrieved from GEH-9-1 was tested and was found to agree closely with a platinum standard laboratory couple and also with the mean of four unirradiated couples. Unless thermocouple discrepancy is occurring only during irradiation, this indicates the thermocouples are functioning satisfactorily.

Thermal Annealing of Irradiated Graphite. Six isothermal annealing runs up to 200 C have been completed on the cooled test hole series. Both length and C_o annealing began during the 20 hour heat treatment at 120 C as would be expected from the Vand annealing theory. A small increase in the A_o crystal parameter resulted from anneals up to 200 C and shows that the apparent carbon-carbon bond distance is increasing slightly. The samples, which are all cut transverse to the extrusion axis, decreased in physical length upon annealing with one exception. The highest exposure sample (5720 MD/CT) expanded during the first four anneals (up to 153 C) and then began to contract. No samples have shown any changes in crystallite size.

A second annealing series was started in an effort to learn more about high temperature radiation damage. Anneals to 750 C have been completed on several samples irradiated at about 425 C. Changes in physical length, C_o, A_o, L_C, and L_A are being measured as a function of activation energy. Some annealing of C_o damage was accomplished during the first anneal at 300 C.

Graphite Physical Properties. X-ray parameter measurements were made on 59 graphite samples. Included were a series of reactor-grade graphites being prepared for long term irradiation, and irradiated samples from the hot test hole at C Reactor and the GEH-9 facility at the MTR.

Thermal conductivity measurements were also made on the samples being prepared for long term irradiation and experimental graphite samples produced at Battelle Memorial Institute which were irradiated in the hot test hole.

Diffusion Bond Tensile Specimens

Four assemblies containing nickel and nickel-iron diffusion bonded tensile specimens were received after irradiation to 1500 MWD/T at 50 C according to Production Test 105-537. Both bonds on each tensile sample were observed to be broken when the assemblies were opened. The examination results show that the nickel-iron bonds have not suffered as much irradiation damage as the bonds formed with nickel. In addition, a larger failure rate occurred in the nickel bonded samples. The irradiation temperature appears to influence the bond failure rate as seven failures occurred in the group irradiated at 50 C while only four occurred in the 200 C irradiation.

High Temperature Thermal Conductivity

Chromel alumel thermocouples, under thermal cycling tests up to 400 C, gave reproducible readings within 0.5 to 1.0 degree C. While this precision is adequate for

most plant purposes, it is not sufficient for the requirements of laboratory thermal conductivity measurements now in progress. As a result, the thermocouples in the high temperature thermal conductivity apparatus are being replaced with platinum-13 per cent rhodium vs. platinum thermocouples. Although this type of couple produces a lower electromotive force for a given temperature, it is believed its stability will yield more reproducible results for the present laboratory measurements.

Rockite Process for Tube Reducing

A theoretical study of the Rockite Process of tube reducing has begun. The initial study will be made by breaking down the forming process into stages which can be handled by existing methods of analysis. Such a study will give insight into the physical phenomena of plastic flow encountered in this process and may suggest ways of eliminating tube failures during rolling. The initial study of a roller and mandrel having equal velocities has been completed. This analysis predicts tensile stresses in the rolled material. The next example which will be studied is that of a wedged-shaped material being rolled on a moving mandrel which is tilted with respect to its velocity of travel. The kinetic conditions existing in the Rockite Process are similar to the above conditions.

Machine Computation of Fuel Element Data

Preparation of an expanded and generalized input was started for the IBM study of fuel element variables. The program will facilitate corroboration of previous computer results and will permit extension of the areas covered. Equations to determine the temperature distribution in inverted cluster fuel elements have been programmed for solution by the IBM 650 computer.

Standard Uranium Fuel Elements

K Reactor Split-Type Failures. Examination of one of three recent failures from the KE Reactor has been started. This slug failed in tube 4573-KE after an exposure of 500 MWD/T. It was split longitudinally over its entire length and a short second crack was observed at an angle of about 30° to the major split at the cap end. The aluminum jacket was split open the entire length of the slug on one side, but was intact on the opposite side. A hot spot was observed on the jacket which was bisected by the jacket split and located about three inches from the base end. The slug was warped an estimated 50 to 100 mils, and the plane of this warp was such that it appeared to be responsible for the formation of the hot spot. Failure of the aluminum in the region of the hot spot appeared to be brittle with no evidence of plastic deformation, indicating that intergranular corrosion of the jacket may have occurred. Sectioning of a wafer from the hot spot zone revealed that a small section of aluminum on both sides of the crack may have melted, however, confirmation of this and also the presence of intergranular attack will be objectives of a scheduled metallographic examination.

100-H Hot Spot Rupture. An eight-inch uranium slug canned in a standard M-329 aluminum alloy can by the normal "F" fabrication process failed on September 6, 1956, in the tube 1587-H, after an exposure of 376 MWD/T. The slug was part of a production test to evaluate aluminum cans which had been manufactured by a new vendor.

SECRET

The slug was received in Radiometallurgy for examination to determine whether any unusual characteristics of the aluminum jacket might have contributed to the rupture.

Visual examination disclosed a hot-spot side rupture approximately two inches in length. The rupture, which was near the cap end, was on the side opposite the rib marks. The rupture had jammed against the top of the tube, as shown by the deep longitudinal scratches caused by the ribs while discharging the slug. The slug was dimensionally similar to unirradiated pieces, and was unwarped, indicating that dimensional instability of the uranium was not a cause of failure.

The only visible flaw in the can, other than mechanical handling damage, is what appears to be a longitudinal seam extending along the slug from the vicinity of the rupture. A section has been cut from the slug and is being examined to confirm the presence of the longitudinal seam.

Closures. It is desirable to make end closures on certain fuel elements in a high vacuum. Work with standard welding equipment and procedures proved to be unsatisfactory for this application. A welding process has been devised and equipment is now under construction which will utilize a concentrated focused beam of electrons to furnish the heat required to heat and melt locally a small area on the end of the fuel element. By rotating the fuel element beneath the beam of electrons a complete end closure may result.

Thermal Conductivity of AlSi Bonds. Equipment was tested for experimentally measuring the thermal conductivity of the bond zone (or unbonded zone) between the meat and the can of a fuel element. This equipment tests full size fuel elements under simulated power conditions so that important effects of temperature of operation, cycling and conditions of surfaces before canning can be evaluated. The apparatus consists of a short unribbed process tube containing the test element. The can wall of the element is extended beyond the ends of the slug to smooth out the water flow through the annulus between the process tube and slug. Power is supplied to the slug by a resistance heating element that passes axially through a hole in the slug. An eight-inch AlSi bonded slug was tested at power levels up to three KW/ft. The upper limit of power for the equipment is about 10 KW/ft. Temperature data from the first test was inaccurate because of thermocouple insulation failure. A second test using a four-inch unbonded aluminum canned slug was started. Stainless steel sheathed magnesium oxide insulated thermocouples are to be used in this second test in an effort to avoid thermocouple failure.

I and E Fuel Elements

To develop a uniform and a void-free AlSi braze, experiments in vacuum canning of I and E fuel elements were made and subjected to welding tests and non-destructive tests (Sonobond). High reject rates were observed. The difficulties encountered with welding of these fuel elements have been overcome by more stringent cleaning of cans and caps prior to the fuel assembly operation. However, metallographic examination of the Sonobond rejects failed to reveal any void or unbonded areas which this instrument usually detects. Hence, it appears that this instrument measures slight differences in accoustical properties of the bond of vacuum canned fuel elements in the same manner as it measures void areas in the braze of the conventional AlSi dipped canned

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fuel elements. Work is now under way, to reconcile the Sonobond measured differences between these two types of fuel elements. Also, the frost test and other nondestructive tests are being developed which will determine more accurately the functional adequacy of the new fuel elements.

Several selected I and E weld beads from weld reject slugs were examined to help identify the sources of I and E weld bead inclusions. Lead was identified as the contaminating substance in three of the female-end weld beads. Presumably this lead is included in the AlSi braze layer during canning.

Cored Fuel Elements

The first of three enriched four-inch cored slugs irradiated under PT 105-607-A-57MT was examined to determine the degree of beta-phase transformation from operation at high specific power. These slugs were broken in two with the C Basin slug breaker. Examination of the fracture surfaces at the C Basin revealed a band surrounding the core which had a structure indicating beta-phase operation.

The first slug examined was discharged from tube 2163-C after an exposure of 703 MWD/T. A wafer was sectioned from near the center of the slug for metallographic examination. This examination confirmed the presence of a zone surrounding the 5/8-inch diameter core which had operated in the beta phase. The average width of this band (measured at four points 90° apart) was 120 mils.

Self Supporting Fuel Elements

To eliminate slug cocking and column bowing of fuel elements, both of which result in hot spots and fuel element failures, considerable effort has been expended for the development of a self-centering or a self-supporting fuel element. Results of autoclave tests on fuel elements with solid supports such as studs and rails reveal that such elements are too rigid and burst the process tubes when the failures are permitted to take place intentionally. The implication of these results is that a similar occurrence can take place in a reactor if a defective self-supporting fuel element is not discharged immediately after failure occurs. To overcome these difficiencies, several designs of flexible supports have been conceived, fuel elements have been fabricated and autoclave and flow laboratory tests are under way to determine the functional adequacy of these new concepts.

The corrosion characteristics of eight-inch solid canned slugs having six 1/8" x 1-1/8" 1100 aluminum ribs "ultrasonically welded" on the exterior of the can are under investigation. Two of these slugs have been exposed to 125 C, pH 7.0 process water at 1706-KE. They were exposed for 60 days at a flow of 25 to 30 gpm. Post-exposure examination of these slugs showed the projections were still firmly attached even though a minor amount of corrosion had occurred under one of the twelve projections. Little evidence of localized corrosion was found.

Three of the same type of self-supporting slugs were exposed to flowing 300 Area water at 100 C. One of these three slugs was removed and examined after 38 days exposure. It showed a localized corrosion of the can wall immediately adjacent to the upstream end of each of the projections. This localized corrosion could probably be greatly reduced by modifying the end-shape of the projection.

Wafer Fuel Elements

Since the wafers for wafer fuel elements are stamped from hot rolled and cold rolled uranium sheet, there has been some question as to the degree of crystallographic randomization in these wafers. It has been assumed that a beta heat treatment after stamping will erase any preferred orientation which may have been present. One way of measuring orientation is by X-rays. However, since each fuel element contains 43 wafers, X-ray measurements, except on a spot check of random samples, is not practical. Hence, a rapid technique for accomplishing such measurements would be very desirable. It was decided to apply other force fields to this problem and preliminary experiments employing electrical resistance measurements did not yield any reproducible results. Experiments are now under way which employ the thermal force field as a measurement of preferred orientation.

The irradiation of an eight-inch internally and externally cooled wafer fuel element in the HAPO fuel element testing facility in the MTR contined. The irradiation began September 28 and is scheduled to continue through December 17. The exposure at present is approximately 180 MWD/T. Thermocouples in the cooling water immediately above and below the specimen indicate a temperature rise of 9.5 C which, at the indicated flow of 19.8 gpm, corresponds to a specific power of 74 kw/ft.

Rod Cluster Fuel Elements

A four rod cluster fuel element has been completed for irradiation in the Fuel Element Testing Facility at the MTR. Each rod is stainless steel clad with 0.001-inch cold air gap on the fuel radius. Power generation is estimated at 20 KW/ft and the operating temperature should be about 500 C maximum uranium temperature. The fuel element and basket assembly will be shipped to the MTR before the end of the month. Final assembly of 40 KER cluster fuel elements is underway. All weld closures have been made. These first 40 fuel elements will have internal support rings and eight runners per element for spacing in a ribless tube. Ribbed tube operation will also be possible with this geometry.

Thermocouple-Insulated Slugs

Examination was continued on a thermocouple-insulated cored slug irradiated in the MTR according to Production Test GEH-4-11. The examination consisted of a metallographic study of selected samples which were annealed, either during irradiation or after irradiation, at temperatures ranging from the high alpha phase region through the beta phase temperature range to the gamma phase temperature region. The results

indicate that gas blow holes, such as were observed in the transverse section from the cored slug, occur only when the material is in the gamma phase temperature range. This leads to the belief that the transverse temperatures near the midsection of the slug, except for a narrow ring at the outer edge, were in the gamma phase temperature region instead of the beta phase as was previously believed.

Thermocouple Uninsulated Slugs

Examination has been started on two cored uninsulated slugs, one of which contained a thermocouple, and had been irradiated in the MTR in accordance with GEH-4-12. Evidence of U-Zr diffusion bonding was observed when the end caps were removed from the slugs. A film of oxide also was observed on both sides of a zirconium spacer from the large grained uranium slug. The end of the uranium exhibited the appearance of a water stain. After the can was pushed off, a "hot" spot was observed near the cap end. More than normal porosity was visible in the "hot" spot. The cores of both slugs were open and the large grained uranium slug had a warped core while the thermocouple slug core appeared straight. Visual examination of the thermocouple slug disclosed nothing unusual. However, the can wall could not be pulled off. Localized bonding of the can and fuel element had occurred about one-inch from the cap end. Diameter measurements showed the thermocouple slug had increased 5 to 10 mils in diameter. The average diameter of the large grained uranium slug had increased 70 mils. Examination of the large grained uranium slug, however, disclosed a depressed area near the middle about 2-1/4 inches long.

Thorium-Uranium Alloy Fuel Material

The two samples of thorium-2 wt. % U-235 alloy previously reported as received from the MTR are being examined in the Radiometallurgy facility. The ends of the Zr II capsules were cut off to permit the removal of the cores. The cores could not be removed from the jackets even at liquid nitrogen temperatures. The Zr II jackets on these two samples were therefore removed by dissolution in HF. Visual examination of the cores indicates good dimensional stability. Slight extrusion defects in the surface of the samples appear to have been exaggerated, but whether this was caused by irradiation or the HF solution used in dejacketing is not known.

U-Mg Matrix Fuel Elements

A preliminary test has been made to determine the feasibility of fabricating dispersion type fuel material or fuel elements by swaging. A heavy walled aluminum can filled with iron shot has been reduced from one-inch diameter to 0.43-inch diameter by swaging. The swaging operation forced aluminum from the heavy wall into the interstices of the iron shot to form a nearly continuous matrix around the iron. The swaging was done cold and without any annealing between reductions. Similar tests are to be made with iron shot and magnesium to simulate the fabrication of U-Mg matrix fuel. Hot swaging will be done in the case of the magnesium matrix material.

A third powder-metallurgy U-Mg capsule was received after having been irradiated at the MTR according to GEH-3-18. The canned sample was little changed, dimensionally, by irradiation. The can wall is being dissolved in sodium hydroxide to free the sample.

PHYSICS AND INSTRUMENTATION

Physical Constants Testing Reactor

Operation of the PCTR continued routinely during the month. There were three unscheduled shutdowns and several improvement items were completed. A new remote control panel was designed to consolidate all the power level and pile period instruments on one panel.

The PCTR oven has been modified to permit addition of direct cooling water to the oven cover. This modification provides sufficient cooling for the cover "O" ring vacuum seal and the teflon electrical insulation so that a more rapid cooling rate of the oven core can be utilized. The more rapid cooling rate will greatly reduce the time required for the temperature coefficient experiments.

Measurements of k_∞ for lattice spacings larger than 7 1/2 inches were continued. In these measurements, the value of k_∞ -1 has been examined as a function of the number of buffer rods surrounding the central rod in a 3 x 3 array of the lattice.

For the 8 3/8, 9 1/2, and 11 1/4-inch dry lattices with 1.36-inch slugs, the value of k_∞ -1 has been observed to decrease as buffer rods were added until a minimum value was obtained, beyond which k_∞ -1 increased in value with the further addition of buffer rods

Methods for determining the unique value of k_∞ -1 for a given lattice are being studied by means of cadmium ratio and total flux measurements from foil activation.

Thermal Test Reactor

Calibration experiments were continued. The reactivity change was measured as the level of the water in the annulus around the fuel tubes was varied. Similarly, the reactivity change was measured as the level of the water in the fuel tubes was varied. In each case, a maximum reactivity was observed when the water level was slightly below the full mark.

High Temperature Exponential Experiment

Buckling measurements were taken in a graphite-uranium, exponential pile at temperatures ranging from 24 C to 460 C. The pile (approximately an eight-foot cube with 7 1/2-inch lattice) was loaded with 1.36-inch diameter, natural uranium fuel elements. Neutron detection was accomplished by means of Au foils, In foils, a 1/2-inch diameter water-cooled BF_3 counter, and a smaller BF_3 counter designed for high temperature operation. The buckling was measured at nine different temperatures with the water-cooled BF_3 counter. In addition to this, the buckling was measured with In foils at 100 C and with Au foils at room temperature, 300 C, and 400 C. Measurements were also taken with the high temperature BF_3 counter up to 250 C.

The results of these measurements show the temperature coefficient of the buckling to be negative and of value -0.098×10^{-6} cm^{-2} per degree C, or $\frac{1}{B_o}\frac{\Delta B}{\Delta t} = 0.93 \times 10^{-3}$ per degree C, where B_o is the value of the buckling at room temperature. The buckling varied linearly with the temperature over the entire range (24 C to 460 C) although some scatter occurred in the data at the higher temperatures. The

temperature distribution along the vertical axis of the pile was held constant to within ± 1 C. Horizontal temperature distributions across the pile were measured as follows:

Center Line	9" From Center Line	18" From Center Line	27" From Center Line	36" From Center Line	45" From Center Line
100 C	100 C	100 C	100 C	100 C	100 C
200	200	200	200	200	199
300	300	299	299	299	298
400	400	400	399	399	396
460	459	459	457	454	452

Buckling measurements are being taken at several temperatures as the pile cools off. A measurement has been taken at 300 C which is in agreement with the value obtained when the pile was being heated and at that same temperature. Bucklings measured after the pile has been heated and then allowed to cool are expected to be slightly different, since small voids will be left in the pile as the result of expansion and subsequent contraction.

Exponential Experiments in Small Piles

Measurements of bucklings were continued in small (~ 4' x 4') graphite, exponential piles. The series of measurements with E slugs (0.94 weight per cent U-235) and N slugs (aluminum-3.5 weight per cent lithium alloy) has been completed. Data was obtained with 4-inch N slugs positioned in different patterns in the pile. Preliminary examination of this data indicates that in such a non-homogeneous mixture, the measured bucklings are sensitive to the positioning pattern used in the pile. Further examination of this data is required before conclusions can be given.

Results of measurements taken in the 8 3/8-inch lattice pile are given below:

Slug Diameter	Type of Uranium	Al/U	C/U	Process Tube Condition	H_2O/U	Buckling
0.925"	1.007 wt. % U-235	0.97	183.5	Dry	--	249×10^{-6} cm^{-2} *
0.925"	Natural uranium	0.69	186.8	Dry	--	63×10^{-6} cm^{-2}
		0.69	186.8	Wet	0.174	39×10^{-6} cm^{-2}

The ratios listed are the atom ratios for the cell.

* A buckling for this lattice was reported in June. The value given here is the result of a re-measurement which was taken because of inconsistency in the data in the previous measurement.

Measurement of Lattice Parameters

From an exposure in the PCTR, and subsequent analysis of the data, the following lattice parameters are given for a 1.68-inch solid slug in a 7 1/2-inch lattice under the following conditions (1) no coolant (2) water and (3) MIBP. The volume of coolant per cm length of process tube in case (2) and (3) was 4.63 cm^3.

Case	E	f	p	Conversion Efficiency
(1)	1.0426	0.942	0.764	1.075
(2)	1.0426	0.905	0.808	0.971
(3)	1.0426	0.915	0.796	0.999

These measurements are of interest for the IPR program.

Neutron Cross-Section Measurements

Plutonium fission foils with an isotopic composition considerably different from previous samples have been successfully used on the neutron spectrometer. The small component of fission previously detected in the 1 ev resonance of Pu-240 was again seen with these foils, more firmly establishing the assignment of this resonance to the Pu-240 isotope. The isotopic content of these foils also permits derivation of the fission cross section of Pu-241 below about 1 ev to a much better precision than the cross sections reported by others because of the relatively small background of Pu-239 fissions The energy region from 0.03 ev to 0.5 ev has been obtained in one run to a precision of about one per cent. Final analysis of these data must await the results of mass spectrometric analyses of the plutonium samples from which the fission foils were prepared. These isotopic determinations will be performed by KAPL.

Neutron Time of Flight Instrumentation

The circulating loop millimicrosecond timer was rebuilt in final design. The coincidence between the loops were detected by an auxiliary circuit. With this circuit, the stability of detecting a coincidence appears better than 0.1 millimicrosecond. This indicates that the channel position stability of a multichannel time spectrum is about 0.1 of one millimicrosecond. The temperature coefficient of the circulation time was measured, giving a very negligible value of about 60 parts per million per degree C.

Reactor Calculations

Methods were investigated for calculating the fast effect in close-packed lattices.

A Fermi-type calculation of the age of neutrons in pure protons was completed. The results agree with those reported by Zweifel and Hurwitz, namely, oxygen is worth about 17 cm^2 in the age of water.

Calculations are being made to determine collision probabilities for slabs. This will be useful for foil calibrations.

The problem of setting up a program for processing the exponential pile data on the IBM-650 was pursued.

Solid State Physics

A modification of the Bohr theory of energy loss of particles in matter is being developed.

Quantitative calculations commend on the cross section for the production of lattice vibrations in crystalline materials by neutrons. These are usually termed phonon-neutron interactions.

Radiological Physics

The study of plutonium X-ray counters was concentrated on finding and eliminating sources of background. Part of this study revealed that the background counts with a bare photomultiplier can be reduced but not entirely eliminated by cooling the tube and by soldering the resistors of the voltage divider to the pins of the photomultiplier.

The measurements were completed on the strength of the cobalt-60 source with the calorimeter. The yield was 1.890 ± 0.012 curies corrected to January 1, 1957, for the decay of the source.

A study was completed on the response of the modified CP instrument and the film badge when exposed to beta radiation from an extended uranium source. An extrapolation chamber was employed as the standard. When the film badge is calibrated on the surface of uranium it reads a dose 80 per cent too high at 44 cm from the surface while the CP reads 70 per cent of the true dose at the same position.

Investigations were continued on the flux and dose sensitivity of the double-moderator version of the moderated BF_3 dosimeter with accelerator neutrons and with neutrons from SbBe, PoBe, PoB and RaBe neutron sources.

Atmospheric Physics

Systematic and detailed analyses of experimental data were continued for a major study of atmospheric diffusion of stack gases in stable atmospheres. One field experiment for this study was completed on October 3, prior to the onset of persistently unfavorable meteorological conditions.

The use of fluorescent pigment as a tracer material was improved further by the accurate determination of the size-frequency distribution of the tracer particles both before and after emission from our generators. It was found that these spectra were identical, indicating that the generation method used at HAPO does not agglomerate or disassociate the tracer particles. It was also found that there was no significant variation among the size-frequency spectra at 50, 100, and 200 m from the source, indicating no preferential dispersion or deposition of the various sizes of particles present.

With the above information it is possible to proceed with a precise particle-per-gram of pigment count and plans for this final step were completed. This tracer technique can be put on a completely quantitative basis and will permit quantitative interpretation of individual air samples taken downwind from a source of tracer material.

Collection of wind observations from the wind station network and reduction of these data for processing on the IBM computers continued on a routine basis.

Weather Forecasting

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	80.2
24-Hour General	62	80.2
Special	61	75.4

Temperatures during October averaged 52.1, which was 1.1° below normal. Precipitati totaled 1.03 inches, which was 0.37 inch above normal. The most unusual weather during the month was the occurrence of a thunder storm on October 24.

Radiation Protection Instrument Development

Field tests continued on the Alpha-Beta-Gamma Hand and Shoe Counter. The instrumen was checked daily for proper operation and was found to require approximately two hours of maintenance during one month.

Equipment was ordered to demonstrate the digital techniques with the radioisotope analyzer. This will be a general purpose instrument designed to analyze a sample containing a mixture of radioisotopes and to indicate the quantity of each isotope. The Redox Stack Effluent Monitor is an example of a radioisotope analyzer employing analog techniques. This instrument has been on operating test for approximately six weeks and it was found that a filter sampler modification is required to provide greater filter tape capacity. It was also found that the scrubber sampler requires periodic flushing. Power supply metering circuits were designed and installed in the equipment.

Standard printed circuit boards for experimental portable survey instruments were developed by a photo engraving process. Several experimental instruments and extra plug-in printed circuits will be fabricated to demonstrate the use and maintenance of the instruments using plug-in components.

The battery charger voltage regulator for the radiotelemetering data station was improved to provide greater reliability. The modified circuit follows more closely the lead-acid battery temperature characteristic.

The sensitivity of the erioglaucine dosimeter was increased by deoxygenation of the solution prior to use so that an absorbed dose of as little as 10 rads can be detected colorimetrically in a 1 cm light path. Sensitization by adding ethanol increases the sensitivity to 7 rads. The sensitivity of the chemical dosimeters are now approaching the levels necessary for personnel monitoring application. Work at other sites indicates that a sensitivity of 0.5 rads may soon be possible.

Instrument Development

Development started on an underwater borescope to be used for inspecting the inner surfaces of irradiated I & E slugs. It will consist of two parts (1) one small diameter unit to be inserted in the slug and (2) a standard type underwater periscope to relay

the image to the observer's eye. The small diameter unit must be water-tight, carry its own electric lamp and have lenses that do not darken in the radiation field of the slug. Two of the non-darkening lenses for this unit have been designed.

Instrument Evaluation

Acceptance tests were completed on 21 CP-TP-type exposure-rate meters made in the HAPO shops. Evaluation tests were completed on an experimental model transistor GM meter with loudspeaker, voltage, regulator tubes, and neon tubes for the flyback power supplies. Evaluation tests were continued on the experimental transistorized battery scintillation poppy.

Analogue Computer

The reactor coolant loss problem is now ready to be set up on the analog computer. System and computer diagrams, based on the equations and functional relationships, have been completed in work sheet form and provide a basis for preliminary studies.

Machine Computation of Physics Data

A formulation of equations for an IBM 650 code to provide case cards for the 8 region diffusion theory physics code has been completed.

REACTOR TECHNOLOGY

Fuel Element Test Reactor

A preliminary functional description of a HAPO Fuel Element Test Reactor concept has been prepared. The success of a test reactor is highly dependent upon the appropriate selection of test space at various neutron energy spectrums and intensities thereof. Furthermore, it is desirable to be able to achieve accelerated fuel testing without employing special enrichments in the test material. The fuel element test reactor is conceived to provide extensive test space at thermal neutron fluxes in the uranium of 120-200 per cent greater than current maximum HAPO values and successive less space to a minmum of 10 lineal feet at 8-10 times the current HAPO flux. This maximum thermal flux region would merge with a region of fast flux approaching 10^{15} neutrons/cm^2 sec thereby providing an excellent materials testing facility.

A functional criteria for such a facility is shown below.

1. Negligible flux variations along a one-foot sample size.
2. Provides for process tubes to 4" I. D.
3. a. Provide several hundred lineal feet of test section at flux levels from 120-200 per cent current HAPO maximum values tapering off to peak flux levels of 800-1000 per cent current HAPO maximum values.
   b. Provides for minimum lot sizes of 10 lineal feet even at peak flux levels of 800-1000 per cent of current HAPO maximum value.
4. Provide horizontal and vertical fuel element test holes (charge-discharge on nearly all sides).
5. Provide a central zone for fuel and materials testing at fast fluxes approaching 10^{15} neutrons/cm^2 sec.
6. Provide for various test coolants and test coolant temperatures.
7. Provide for sound integrated and instantaneous neutron flux measurements throughout testing zones as well as safety and heat balance instrumentation.

As currently visualized this flexibility would be achieved by employing a totally unflattened reactor (average flux = . 35 the maximum) with an active zone at least 10 feet in length but not necessarily cubic. The fast flux region would be achieved by employing a water moderated section in the center. The majority of the reactor would employ low average density graphite and/or D_2O moderation to provide a loose lattice to permit many test holes (horizontally and vertically) and to minimize the flux variation/foot of fuel element length. By virtue of the active zone size and flux, this reactor would produce approximately 300 MW of heat. Approximately 100 MW would be generated in test specimens and 200 MW in drive fuel elements. While this facility does provide for routine testing at fluxes just above current HAPO values, the higher fluxes provide for accelerated fuels testing from which scaling factors to lower fluxes could be employed with a substantial reduction in testing time. The scaling notion is a sound one especially if no non-linear factors are encountered, such as cycling through uranium metal phase changes (660 C and 790 C and melting at 1133 C) or the melting at 2750 C of UO_2. Almost all fuel element configurations, except the massive solid cylindrical types currently employed at HAPO, could be tested in this facility without

encountering phase changes. Positions would be available wherein the characteristics of fuel element exposure through phase changes could be evaluated.

At an average exposure of 1000 MWD/T and 80 per cent operating efficiency, the fuel element test reactor would process 29 tons of test fuels per year. If this were in the form of 8" HAPO fuel elements it would total 6970 slugs. This represents an average development production of 27 eight-inch long fuel elements/day which is a substantial development effort.

Plutonium Recycle Program - Reactor Design and Engineering Studies

Schedule. No major changes were made in the PRPR schedule during the past month. The Site Study is scheduled for completion November 15, 1956.

Site Study. A site study for the location of the Plutonium Recycle Program Reactor was initiated. The objective of this study is to find a site which is optimum with respect to (1) construction costs (2) availability of utilities and service (3) safety from disaster such as Columbia River floods and (4) convenient location. Higher construction costs for utilities and higher area operating costs eliminated consideration of a new isolated research reactor area. None of the existing manufacturing areas, 100, 200, and 300, have sufficient excess river water capacity to supply the PRP Reactor At 100-F Area the construction costs for the river water supply would be lowest because no river pump house construction would be required. Although construction costs may be slightly higher for a 300 Area site, the latter site would have several advantages over a 100-F Area location. The 300 Area site offers greater safety from Columbia River floods and is more conveniently located with respect to the laboratories.

Building Structure and Arrangement. As presently scoped, the main structure will consist of a shielding and containment vessel comprised of two reinforced concrete cylinders. The upper section, approximately 80 feet O. D., will be the reactor hall. The lower section, approximately 130 feet O. D., will be divided into eight compartments four of which each house a process pump and heat exchanger system and one compartment each for (1) moderator systems (2) clean-up system (3) pile instrumentation and (4) in-pile experiment equipment.

The storage basin, central room, offices, shop, lunch room, toilet facilities, electrical switchgear room, viewing room, supply fans, and crane control booth, will be attached to the hut outside the containment vessel.

The exhaust fans, filters and stack will be separate structures located adjacent to the reactor building.

Shielding. Permissible levels of radiation around the reactor and shield have been specified tentatively. One scheme for shielding the reactor has been worked out which appears to be adequate and economical. The side shields will consist of high density concrete. The side thermal shield will be made of water with barite aggregate. The top and bottom shields will be removable in order to replace the reactor core. Ferrophosphorous aggregate could be used in the top and bottom shield with water as shield moderator and coolant.

Primary Coolant System. The primary coolant system as presently scoped consists of four 6000 gpm, 275 foot pumps, with heat excnanger(s) and surge tank. One of the pumps will be on standby. A cost and flexibility study is being made to establish the number of heat exchangers required. Three methods of wasting the heat from the reactor are under consideration (1) liquid-liquid heat exchange to river water (2) steam generation at low pressure and (3) steam generation at high pressure.

Reactor Coolant Piping. The connector piping pattern for the individually piped process tubes has been established. Connector size has been tentatively set at 1 1/2 inches outside diameter. A tapered-bottom process tube (tapered near the inside of the bottom shield) has been selected to simplify tube installation and removal and to reduce the initial cost of the Zircaloy-2 process tubing.

The process tube assembly contains a nozzle and metal to metal gas seal at the top of the process tube. The process tube tapers at the bottom to provide a central, cooling water, inlet connection which provides for ease of complete draining of the process tube and for ease of process tube replacement. A bellows gas seal is provided at the bottom of the process tube.

Moderator. In the reprocessing of the heavy water moderator for a plutonium recycle reactor, the light water contamination which occurs necessitates major and potentially costly retreatment either on-site or by shipment to off-site faccilities. A study was begun on the problem of routine removal of light water from the heavy water stream. The process and probable economics of several techniques were being reviewed (1) distillation (2) low temperature (freezing) (3) electrolytic (4) chemical techniques, and (5) combinations of these in order to select the most favorable methods for more intensive study.

Control Systems. In the moderator level control system currently under consideration, the level of the moderator will be maintained by applying a differential gas pressure above and below the moderator. An annular siphon trap at the bottom of the calandria will prevent bubbling of gas through the D_2O. Moderator level will be adjusted by varying the differential pressure.

Control of the moderator temperature will be used as an assist to the controlled-level mode of reactor control. In addition, mechanical shim controls are under consideration. These will provide for flux pattern adjustment and for damping of flux transients. As currently envisioned, these will consist of a number of flexible cables or braided tapes running through channels in the calandria. Each tape will be relatively weak in poisoning strength, but with the strength varied along the length of the tape.

The quadrant regulation of moderator temperature has been eliminated in favor of a more flexible mechanical shim control. The mechanical shim control, possibly in the form of metal tapes passing through the moderator tank, will permit more rapid control with greater local and over-all strength than the quadrant control method.

Shutdown of the reactor will be accomplished by "dumping" the moderator Pressures within the calandria will be equalized, whereupon the moderator will drain through the siphon trap into an annular chamber at the base of the calandria and subsequently to storage tanks. A fast-acting system is being developed which will insure shutdown of the reactor within one second of receipt of a scram trip.

Heat Transfer. Equations were derived for the predicting of the maximum core temperatures in cylindrical UO_2 fuel elements. The design proposed is based on a central rod surrounded by two concentric rings, all centered in a 3.25-inch I. D. process tube. The exact dimensions are to be determined.

Calculations were also made of core temperatures in the proposed Pu-Al elements. These calculations showed the maximum core temperature of these elements, and their stability relative to melting, to be highly dependent on the core-jacket gap resistance. For example, at the proposed conditions a 0.003-inch helium gas gap between jacket and core can cause a 290 C temperature rise at that point and result in a maximum core temperature as high as 640 C. However, it is anticipated that the 0.003-inch gas gap can be essentially eliminated or more temperature resistant materials may be used.

Charge-Discharge and Material Handling. It is presently planned to discharge the irradiated fuel elements into a vertical lead lined cask (weighing about 12 tons) on the top face of the reactor The cask will rest on floor rails and will be positioned over the tube to be discharged. The fuel element will be discharged from the cask into a water pit at the edge of the reactor hall.

It was proposed that a ruptured fuel element be removed in its process tube to prevent the spread of contamination. The process tube would be separated from the fuel elemer after the fuel element-process tube combination reached the storage basin. The process tube would then be replaced in the reactor and a new fuel element charged

Test Facilities. Test facilities in the PRPR that merit consideration are (1) the use of process tube channels for high pressure loop experiments (2) vertical holes located at the extremities of the active zone (3) a special facility for failing fuel elements and (4) side beam holes through the reflector and shield.

The scoping of a basic test facility to furnish heated pressurized water to PRPR mock-up tests has been started. This facility will contain a recirculating pump, a heater section, a heat exchanger, a pressurizer, a make-up pump, a flow control valve, and suitable instrumentation for control of the test facility. Normal operating conditions will be: flow - 50 to 100 gpm, pressure, 2000 psi, and temperature - 315 C. The facility will be constructed on a single frame with the various PRPR mock-ups flanged to the inlet and outlet connections of the facility.

A vertical test section of the PRPR process tubing size for out-of reactor corrosion testing has been designed and components ordered. Installation of the test section in the ELMO-7 test loop should begin about January 1.

Preliminary plans have been made for the testing of proposed process tube-nozzle connections. Cold hydrostatic testing will be carried out in the 314 Building, while long term tests at proposed operating conditions will be carried out in one of the ELMO Loops.

Plutonium Recycle Program - Reactor Physics

Material Balance Study. Isotope concentration equations for the material balance study on the PRPR have been set up and solved by Laplace transform methods. These will be converted to Fourier series and related to the two requirements (1) that the reactor be critical throughout a fuel cycle and (2) that the plutonium obtained from the previous cycle be sufficient for the subsequent fuel cycle. An attempt has been made to make the equations as all-inclusive as possible.

Reflector Shielding Study The flux distribution in the PRP reactor was calculated using the two group method. Assuming a central thermal flux of 10^{14}, a core radius of 119.38 cm, a graphite reflector thickness of 60 cm, the flux values were:

	At shielding-reflector interface	At core-reflector interface (tank wall)
Thermal	2.78×10^{10}	5.75×10^{13}
Fast	4.52×10^{11}	9.30×10^{13}

In this calculation, pile flattening was not considered. If flattening were included, the peak flux values in the reflector would be greater by a factor not exceeding about 1.2. The flux in the central region would be less by a similar factor.

Control Study. A rough draft report, "PRPR Control Requirements, Part 1" was completed. It describes the types of control needed (semi-permanent poison shim, flux balancing shim, regulating, primary and secondary scram) and discusses performance of: (1) rod controls (2) fluid controls (3) spline controls (4) uniform controls (5) moderator and reflector controls and (6) coefficient controls.

It was concluded that the rod, spline, moderator and uniform controls were of chief interest in reactors of the PRPR type, but that the rod controls are not well adapted to the experimental objectives of the PRPR because of their interference with reasonably accurate measurements of flux and exposure.

Subsequent reports will deal with more detailed aspects of the control problem, including analog computations.

Kinetics Study. The transient behavior of the PRPR has been analyzed and the results presented to the data processing unit for numerical evaluation. A report is being written discussing the problems and the methods of solution.

Some experiments have been suggested to obtain information about the physics of uranium oxide fuel elements. The test pieces currently being fabricated are to be irradiated in the HTP.

Plutonium Recycle Program - Fuel Element Studies

Ceramic Fuel Studies. UO_2 containing 10 per cent water, 1 per cent "Methocel" and 0.1 per cent "Sterotex" was extruded through a 0.75-inch diameter "Scotchcast" die nozzle. A pressure of 15,000 pounds was required when the mixture was loaded in the extrusion cylinder as a loose charge. When the charge was precompacted at a

pressure of 7600 pounds per square inch, 30,000 pounds pressure was required for extrusion. The extruded material exhibited 1 per cent shrinkage upon air drying. The green density was 6.09 g/cc, which is 56 per cent of the maximum theoretical density. The green strength was sufficient to allow repeated handling and even simple machining, i.e., sampling with cut-off saw and facing of ends. Sintered density of the extruded rod will be determined as soon as sintering has been accomplished. A die was designed to extrude UO_2 tubes for testing in the Materials Testing Reactor.

The hydrostatic pressing of refractory powders or pre-formed bodies in molds or dies offers an excellent method for the fabrication of large tubular fuel elements having high green strength, low firing shrinkage, and high sintered density. This technique is currently being compared with other fabrication procedures. Efforts were made to purchase or fabricate on site high pressure pressing equipment to be used for hydrostati pressing. Meanwhile, a hydraulic jack capable of producing working pressures of 11,000 psi was used to press a tubular UO_2 fuel element approximately five inches in length, one inch in outside diameter and containing a hole 0.5 inch in diameter. The tube possessed sufficient green strength to be handled without breaking.

UO_2 pellets, 0.5 inch in outside diameter, 0.5 inch in length, and approximately 90 per cent of theoretical density, were examined by x-ray diffraction and metallographi techniques. No change in the crystal structure of UO_2 occurred on sintering the green pellets, although the presence of silicides, nitrides, or carbides of uranium was observed. The samples contained few pores, had a hardness comparable to tool steel with a Rockwell C of 60, and tended to crack transgranularly.

Slip casting of UO_2 fuel elements is being investigated as a method of producing a wide variety of shapes with uniform densities and with a low initial capital outlay. A UO_2 slip with good casting properties has been developed by the addition of 0.2 w/o Daxad 23 to a UO_2 (MCW) mixture containing 10 w/o H_2. Daxad 23 is an excellent deflocculant for the UO_2. A rod 9.94 inches long and 0.623 inches in diameter cast with this slip had a green density of 6.41 gms/cc, or 58.5 per cent of theoretical density. This rod was easily handled in the green state and was cut with a grinding wheel without fracturing. Other tests conducted revealed that (1) the addition of polyvinyl alcohol as a deflocculant and binder markedly increases the viscosity of the slip without appreciably altering the green strength of the cast ware (2) lowering the water content of the slip below 10 per cent by weight rapidly increases the viscosity, making the slip considerably more difficult to cast, while slightly increasing the density of the cast ware prior to sintering (a rod cast from a slip containing 8.5 per cent by weight H_2 had a green density of 6.7 gm/cc) (3) a UO_2 slip leached with HCl casts a body with excellent green strength but with densities less than Daxad deflocculated slips (densities obtained were 5.88 gms/cc prior to sintering and 9.44 gms/cc after sintering). This investigation has indicated that UO_2 slips can be satisfactorily cast. A density of approximately 10.45 gms/cc, or 95 per cent of the theoretical density determined on one piece of slip cast ware after sintering, indicates the possibility of obtaining high densities.

A report, HW-45631, "Compaction of UO_2 by Swaging" was issued. This report discusses the results of preliminary tests on the use of the rotary swaging machine to simultaneously compact and clad UO_2 for rod-type fuel components.

Dimensions and physical characteristics have been established for 19 rod cluster fuel elements. Information will be available during November on interest in bidding and approximate cost of a sufficient number of these elements for necessary testing and development and for reactor startup.

Calculations are almost complete that will permit selection of proper dimensions of the nested tubular fuel element.

Plutonium Fuel Elements. The possible use of graphite as a matrix for the plutonium in the fuel elements for plutonium recycling systems is being investigated. Types of graphite and methods of impregnating with plutonium have been suggested and are being tested.

Planning has begun on methods of preparing the PRP plutonium-bearing fuel elements needed for the PCTR tests. As soon as the induction vacuum melting furnace is repaired, casting of the Pu-Al alloy will begin. It is planned to cast the alloy in graphite molds and machine to size. Attempts will also be made to cast directly to size and to extrude 0.504-inch alloy rods in the tensile machine.

Centrifugal vacuum casting equipment has been designed for the purpose of producing 20-30 per cent plutonium-uranium alloy fuel plates, or possibly straight alpha plutonium plates. Preliminary tests of the equipment, not in vacuo and using lead as a substitute for plutonium, have shown that this technique is quite feasible.

Reactor Process Specifications and Control

I & E Thermal Hydraulic Tests. Experimental tests to establish instability characteristics of an I & E slug column continued on the full scale, low pressure mock-up until October 8 when motor generator sets failed to maintain the required power levels for an adequate period. A program was untertaken to determine the cause and to rectify the limiting component.

The reference condition of an annulus-to-hole flow ratio of 1.83 at a total flow of approximately 50 gpm and 750 KW was established. The pressure flow characteristics were determined for a simulated partial hole plugging to give initial annulus-to-hole flow ratios of 2.0, 2.25, and 3.0 and for a simulated annulus plugging to give an annulus-to-hole flow ratio of 1.63.

Upon reduction in total flow by simulation of cone screen plugging, local boiling was initiated in the annulus at total flows of 34, 33, 32, and 31 gpm, respectively for the initial flow ratio cases of 1.63, 1.83, 2.0 and 2.25. In each case, further total flow reduction resulted in gradually decreasing flow ratios. At annular flows of 11 to 13 gpm bulk boiling began in the annulus. This caused a decrease in the flow ratio and the hole flow increased. Bulk boiling was initiated at a total flow of approximately 20 gpm.

Experimental tests at 1000 KW indicated the same trend but at higher flows for the same conditions. Local boiling in the annulus started at 38 to 41 gpm total flow. Bulk boiling began at approximately 25 gpm total flow.

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At 750 KW tube power and a flow ratio of 3.0, decreasing the total flow to 28 gpm caused local boiling in the hole. With a reduction to 21 gpm the local boiling apparently shifted to the annulus. Bulk boiling was initiated at 19 gpm.

Analysis of test results wherein hole stream plugging was simulated at 750 KW indicates a significant (about 20 per cent) shift of heat from hole stream to annulus stream when hole stream temperatures get near the boiling point This tends to reduce the hole flow corresponding to incipient bulk boiling in the hole. Inability to make accurate predictions as to the magnitude of this effect resulted in past limit calculations being made with the assumption that no heat shift occurred. These limits were therefore conservative but to an unknown extent. Taking into account the heat shift shown in the experiment will enhance ultimate relaxation of I & E slug instability limits A major weakness of I & E slug flow monitoring protection pertains to lack of Panellit gauge sensitivity to selective plugging of the hole flow stream.

Reactor Process Assistance

Flow Orifice Calibrations. A re-run of the orifice calibrations for B Reactor under CG-558 conditions revealed that critical flow would exist in the No. 2 orifice zone for rear header pressure less than 30 psig. This data was determined experimentally using a fully loaded new tube with a front header pressure of 545 psig. It was found that rounding the leading edge of the orifice with a 1/16-inch radius suppressed the critical flow conditions from flow corresponding to a full load to flow corresponding to a loading of about 14 slugs in a clean tube. This would indicate that critical flow would not occur in fully loaded pile tubes which are corroded to a residual wall thickness of as little as 25 to 30 mils.

A re-run of the present CG-558 third zone orifice for B Reactor indicated that critical flow would not occur until the loading was reduced to 18 slugs with a front header pressur of 545 psig and a rear header pressure of 30 psig.

Experimental studies were initiated to obtain data which will be used in properly sizing the orifice combinations for reactors with Project CG-558 flows with respect to critical flow. This data may be useful for future orifice sizing problems. Three basic orifice shapes (i.e., sharp edges, one rounded edge, both rounded edges), were investigated.

Laboratory data was taken on a normally loaded K-process tube to obtain the pressure flow characteristics of the outlet assembly at various outlet temperatures using a modified rear pigtail outlet adapter. Two blank outlet adapters were drilled to inside diameters of 0.467 inch and 0.549 inch, respectively, instead of the standard 7/8 inch. This orificing effect causes pressurization of the process tube and may allow higher outlet temperatures to be utilized consistently in the 1706-KE single pass, high power tube.

Heat Transfer Studies

Calculations were made to find the maximum core and skin temperatures in slugs in C and K Reactors at various tube powers and water flow rates. Solid, cored, and I & E slugs were considered. The results indicate that at constant tube power and water flow the maximum slug core temperature elevations above zero degrees

centigrade are in a ratio of 1 to 0.84 to 0.38 for solid, cored, and I & E slugs, respectively, for all cases examined in both reactors.

A literature search was made to find the latest and best correlations relating the conditions to be found at burnout under forced circulation, bulk boiling heat transfer conditions.

Shielding Studies

Neutron Dosimeter Measurements. Neutron dose measurements were taken at DR Reactor. A traverse of the front face was made from the elevator three feet from the front face. Measurements were taken horizontally on row number 24 and vertically on column number 73. Tube number 3573, containing shielding pieces but no water, gave a dose rate of 5.1 m rem/hr. The rest of the front face gave a dose rate of less than 2 m rem/hr. A work area traverse showed a dose rate of less than 0.5 m rem/hr. Dose rate measurements were taken at the test well on top of the reactor. Just inside the chain and three feet from the surface a dose rate of 24 m rem/hr was measured, near the balcony stairs 6.7 m rem/hr and near the freight elevator 2 m rem/hr. These measurements generally are one half the dose rate as measured by R. M. U. However, these are the first measurements with this dosimeter and should be regarded as preliminary in nature.

Shield Attenuation Tests. The counting of the foils from the last test of Magnetite-Limonite is almost complete. Measurements on the present loading of Magnetite include thermocouple measurements at each layer, and ion chamber and neutron dosimeter measurements in a cave on top of the test well. This is the first use of the neutron dosimeter for this purpose, and should make the conversion from flux (measured by foils at each layer) to dose much more realistic than at present. The present method requires a guess at the spectrum and conversion to dose, while the dosimeter allows a direct measurement at the edge of the shield and a possible extrapolation part of the way is guided by the foil measurement.

The loading for the next test was prepared and put in on October 25. This is a loading of bare gold and cadmium covered gold foils in masonite strips to be placed in each layer. The bare gold and cadmium covered gold foils from the first test were removed.

An investigation is under way to identify the contaminent in the CuS foils. Gamma ray scans show a 0.6 mev gamma ray with a 25 day half-life. Twenty-six days after removal a CuS foil from zero level had a gamma counting rate of 26,000 D/M at 0.6 mev. There are also two lesser photopeaks above 1 mev. Tests are in progress to determine how much this gamma activity affects the beta counting rate and if there is any beta activity associated with the gamma. A review of beta counting in connection with the attenuation tests was made. Specific recommendations will be submitted as to increasing counting accuracy, reducing maintenance costs and increasing the number of counts per man hour. Reductions in repair and maintenance could be as high as several hundred dollars per month.

Bore Diameter Gauge

Construction of the servogenerator mounting for the graphite bore and process tube diameter measuring system has been completed. The recorder, amplifiers and linear variable differential transformers have been received from Schaevitz Engineering. Assembly of the various components is in progress. The transformer retainers in both measuring probes have been redesigned to increase the sensitivity of the system and to prevent binding when the probe passes through a region of abrupt dimension change.

Fuel Element Performance

Thermocouple probes in the exit of six I & E charges now in C Reactor were replaced to verify whether observed high temperatures at the top of the annulus were due to instrument error. The new probes indicate top of annulus temperatures markedly lower than the old ones. This tends to indicate past observed high top of annulus temperatures were in error. If this is true, it makes the data easier to understand because the short charges in C Reactor in normal as-corroded tubes are almost concentric.

Reactor Thermocouple Studies

The experimental graphite thermocouple stringer in D Reactor has operated for six months at temperatures up to 520 C in channel 2182-D. Analysis of the recorder traces shows that the stainless steel sheathed thermocouples are reading the graphite temperatures to within 10 degrees of the values being read from the asbestos-covered thermocouples in the same locations. Both chromel-alumel and iron-constantan couples are being tested. No evidence of unsatisfactory behavior to date has been observed in any of the thermocouples.

Process Water Corrosion Tests

In-Reactor Tests. Corrosion rates of standard aluminum jacketed fuel elements are being determined in the 1706-KE in-reactor tubes, operating at pH 6.5 and 6.0. Metal from five tubes was discharged for examination during the month. Plugging of an inlet strainer on one in-reactor tube resulted in a reactor scram. The difficulty was corrected and reactor recovery was made.

Eight weighed charges of slugs were removed from 105-F under PT 105-554-E for examination. Corrosometer probes were installed in the near and far effluent riser water sample lines in 105-F reactor on October 17, 1956. Initial measurements of carbon steel corrosion during equilibrium reactor operation indicate that steel corrosion in pH 7.0 process water is approximately 1.4 times as great as in pH 7.3 process water.

1706-KE Mock-up Tubes. The test of 2S aluminum and M-388 aluminum under heat transfer conditions has operated for 80 days at 175 C in pH 6.0 process water. There has been no indication of failure due to intergranular corrosion.

Specimens of 2S aluminum in pH 5.5 process water at 115 and 135 C were discharged after 15 days exposure. The data showed that the weight losses were insignificant and in most cases the dummy slugs showed a weight increase after cleaning.

Specimens of 2S aluminum in pH 6.5 process water at 135 C were discharged after 44 and 62 days exposure. The corrosion rates were 0.015 and 0.019 mils per month respectively.

189-D Mock-up Rupture Test. Two canned uranium, AlSi bonded projection slugs have been ruptured in the 50 tube mock-up. Both pieces had one-inch long rails welded at the quarter points and ruptured after approximately the same time. The pieces had been drilled down to the uranium core and were exposed in pH 7.0 process water at 145 C. The process tube failed approximately ten hours after the first sign of swelling was noted on the slug.

Pressurized Water Cooling Technology

KER Program. The failure of the original process engineering design of the KER screwed tube-nozzle connection during 200 to 600 F thermal cycling on ELMO-7 has resulted in setting back the KER pile tie-in outage from four to six weeks. The silver-plated hollow "O" rings that have been tested have proven unsatisfactory. A test using gold-plated hollow "O" rings is now being run. Another test section using a solid nickel "double-sealing" gasket with a revised compression fitting nozzle-tube connection will be tested upon completion of the present test.

The out-of-reactor evaluation of the mechanical and hydraulic characteristics of candidate KER fuel elements has been completed and the results reported in document HW-44916. This evaluation consisted of mechanical strength and pressure drop tests for Elephant and Bull slugs and four rod clusters as well as for standard slugs which will be used during KER start-up.

Preliminary determination of the flow lines around KER fuel element shapes has been started using the polariscope. A formal test program will begin as soon as the precision rotameter has been repaired.

In-Reactor Tests. Run number 18 in H Loop was completed and the slugs were discharged. Average operating conditions for the loop were as follows:

Tube outlet temperature	195 C
Flow	13 gpm
pH	4.5 (with H_3PO_4)

Results of the H_3PO_4 addition indicate a marked reduction in the corrosion rate of the M-388 aluminum slug jackets. At an effective surface temperature of 235 C the corrosion rate was 0.75 mils/month. This is about 1/10 the corrosion rate in high purity water and 1/5 the corrosion rate in pH 5.3 water with HNO_3 addition. Extrapolation of pH 5.3 data indicate a corrosion rate of 1.5 mils/month at pH 4.5 with HNO_3. This means that the $PO_4^{\equiv}$ ion itself is beneficial when used in conjunction with low pH.

Out-of-Reactor Tests. The pH 4.5 (with H_3PO_4) test in ELMO-2 was terminated with the discharge of the last coupons. Data indicate the corrosion rates of the aluminum alloys tested were still quite low. Stainless steel coupons exposed to the water were in excellent condition and sensitization had not caused perferential attack by the low pH water.

The 250 C, pH 4.5 (with H_3PO_4) test in ELMO-6 was completed. The corrosion rate for the period following the first week of exposure was remarkably low, about 0.02 mil/month. Stainless steel coupons exposed to the water in the loop exhibited no untoward effects.

The ELMO-9 loop has been running at pH 6 and 250 C for several weeks. The water is treated with $Al_2(SO_4)_3$ to provide 0.1 ppm Al^{+++} ion. No data are available as yet. The previous run at 0.01 ppm Al^{+++} ion was inconclusive as Cl^- ion was found to be present in the water causing pitting to occur.

Organic Coolant Development

Heat Transfer and Fluid Flow. Fabrication of the heat transfer test assembly was essentially completed. The test section will be used for the study of heat transfer characteristics of organics proposed for irradiation facilities. A new test section, capable of producing heat fluxes of 350,000 to 400,000 Btu/hr/sq ft was added.

The test assembly is designed to provide velocities up to 20 fps and bulk organic fluid temperature of 360 F at lower velocities. Temperatures up to 450 F may be achieved. Maximum heat transfer interface temperatures up to 700 F are expected.

In-Reactor Tests. The activity data from the in-pile loop ORA-2 have been further analyzed. The approximate concentrations of impurities in the organic are:

Cl	3 ppm
Na	.07 ppm
Mn	.003 ppm
Br	detected, but very low

Assuming the system cycle is short compared to the activity half-life, the activity originating from these impurities would cause radioactivity levels of about the following magnitude:

Volume, In-Reactor Total Loop Volume	1' From Large Tank	1' From Small Pipe
0.1	70 mr/hr	30 mr/hr
0.01	7 mr/hr	3 mr/hr
0.001	0.7 mr/hr	0.3 mr/hr

ORA-2 was shut down after the short period of operation in which the above data were obtained. Start-up was attempted six days later, but the loop was plugged in the in-reactor section. An attempt to free the flow passage by raising the test hole water temperature to above 75 C and applying 30 psi gas pressure failed.

The loop failed to clear indicating that the plug was not composed of biphenyl but most likely of tars resulting from the decomposition of the organic that was not drained completely from the loop after shutdown. The test section was removed from the reactor and is awaiting examination pending sufficient radioactivity decay. A new test section is being fabricated.

Five stainless steel capsules and five quartz ampoules have been filled with organic materials for the first irradiation of candidate organic reactor coolants. The materials to be exposed include pure biphenyl, pure monoisopropylbiphenyl (MIBP), a mixture of 50 per cent biphenyl and 50 per cent MIBP, a mixture of 25 per cent biphenyl and 75 per cent MIBP, and the last mixture plus about 0.5 gram of water. The 25 cc containers were charged with approximately 15 cc of the test liquid, following which air was evacuated and replaced with helium at atmospheric pressure before sealing. If the quartz ampoules prove satisfactory for the initial irradiation, they will be used exclusively for future exposures in order to decrease the radioactivity levels associated with handling the containers after irradiation. Although the exposure temperature will not be controlled, the temperature of each stainless steel capsule and of the quartz ampoules as a group will be continuously monitored and recorded. All samples will be charged into the 2A test hole at KW Reactor during the outage scheduled for November 14. The duration of irradiation will be one month or less.

Out-of-Reactor Tests. The corrosion and fouling test loop, ORA-1 was essentially completed, and initial shakedown operation at 400 F was initiated. Minor mechanical difficulties observed during the shakedown run are being corrected.

Testing of KER valves in component test loop ORA-3 continued. Performance of KER valves in 75-25 MIBP-biphenyl appears to be satisfactory in the range 200 to 600 F. A report was issued describing the performance of several types of valves, joints, and gasketing materials in hot organic fluid.

The use of an alternate organic fluid, Aroclor 1248, for use in out-of-reactor test facilities is being investigated. This compound has a higher flash point, has a fire point above operating conditions, and is less expensive than MIBP. Manufacturers feel that this compound is more leak-seeking and harder to contain than MIBP. However, the toxicity limit of Aroclor 1248 is only 2 milligrams per cubic meter of air.

Static Autoclave Testing of Organic Coolants. A series of tests is underway in which potential organic reactor coolants are sealed in small stainless steel autoclaves and kept at elevated temperatures. The pyrolytic decomposition of the organic materials is followed by noting the pressure changes within the autoclaves. Metal samples are placed in the autoclaves along with the organic materials for the purpose of measuring static corrosion rates. The effect of the presence of water in the organic coolants will also be ascertained. Weight changes for three tests are shown in the following table.

WEIGHT CHANGES OF METAL SAMPLES

Organic Coolant	Temp. o C	Exposure Hours	Weight Change of Metal Samples mg/cm^2 Fe	Cu	Al	Mg	Zr
25% biphenyl 75% MIBP	350	168	-0.04	-0.07	-0.04	-0.04	
MIBP	425	80.5	-0.01	+0.02	0	+0.05	+0.7
MIBP	450	6	-0.4	+0.02	+0.03	-0.1	+0.3

In the first test performed, three autoclaves containing a mixture of 75 per cent monoisopropylbiphenyl (MIBP) and 25 per cent biphenyl, were maintained at 350 C for seven days. The organic material in one autoclave was water saturated at room temperature. Samples of mild steel, copper, magnesium, and aluminum were placed in another of the autoclaves. At the end of seven days there appeared to be very little pyrolytic decomposition of the organic coolant as indicated by the absence of tars or marked discoloration. The test was discontinued when it was realized that biphenyl had distilled from the mixture and had condensed in the lines leading to the pressure gauges. These lines were firmly plugged with biphenyl.

In the second test of the series, three autoclaves containing only MIBP were maintained at 450 C for six hours. One autoclave contained water-saturated MIBP and another contained samples of mild steel, copper, aluminum, magnesium, and zirconium. The pressure within the autoclaves increased with an ever increasing rate because of pyrolytic decomposition of the organic coolant. The autoclave containing the metal samples showed the lowest rate of pressure increase. A leak developed in the system containing water-saturated MIBP, and this portion of the test was not completed.

The third test was run at 425 C for 80.5 hours in exactly the same manner as the second test. The pressure increased at a linear rate in the autoclaves containing the MIBP alone and the water-saturated MIBP. The rate corresponded to the release of 0.0024 mole of hydrogen per mole of MIBP per hour. The autoclave containing the metal samples showed a much lower rate of pressure increase which gradually decreased with time. The organic material at the end of the test was black, tarry, and very foamy.

At the end of the test, the samples appeared very clean with no apparent film. The weight changes were determined by weighing samples before and after exposure. No correction was made for the film as it was assumed the film weight was negligible. The weight gains or losses are very low. Many are in the same order of magnitude as the experimental error (±0.01 mg/cm^2). Consequently, it is of doubtful value to convert these weight changes to penetrations. The weight increases for zirconium may be related to the formation of zirconium hydride, and such a mechanism would also explain the lower rate of gas pressure increase in the autoclaves which contained zirconium coupons. The zirconium samples are being analyzed for hydrogen content and change in hardness. At present, there is no explanation for the high value for iron at 450 C. These experiments are being duplicated.

Reactor Effluent Studies

The study to define the source of various radioisotopes in reactor effluent water was continued Purified magnesium was irradiated in the reactor and the approximate cross section for the reaction Mg^{24} (n, p) Na^{24} was calculated to be 8 millibarns. In view of the relatively large concentration of magnesium in cooling water (40 ppm), this cross section was considered to be significant. Results from irradiations in the experimental channel indicated the necessity of having the control and the experimental channels charged with uranium metal at the same time in order to make a valid measurement of the change in concentration of the radioactive components of the effluent water.

In the study of the influence of reactor variables on radioisotopes appearing in reactor effluent, it was decided to proceed with 702 machine computation of fucntions from which correlations may be derived. Dependent variables will be concentrations of six predominant isotopes and the independent variables will be outlet temperature, inlet temperature, flow rate, river turbidity, river sulfate ion concentration, and concentration of lime in cooling water. Grouping will be accomplished to permit effects of other possible variables to be identified. The identification of the influence of operating conditions on the quantity of radioisotopes in reactor effluent should prove useful in predicting effects of future reactor operations on river contamination.

An experiment was recently concluded in which uranium slugs were irradiated for 20 days with recirculation of coolant containing dilute phosphoric acid. It was determine that the P^{32} accummulated in the coolant was 0.08 curie, which compared favorably with the predicted quantity. It was recommended that the coolant be disposed to the river over a period of one hour. This would no more than double the hourly quantity of P^{32} disposed to the river during normal reactor operation.

The rare-earth radioisotopes from two samples of reactor effluent water were fractionated on an ion exchange column to determine the composition of this group of radioisotopes. Eight fractions, La, Ce, Pr, Nd, Pm, Sm, Eu and Y, were obtained and are now being analyzed by gamma and beta radiation decay measurements to estimate the amount of each isotope within the group.

Gamma ray spectrometry and beta ray absorption techniques for reactor effluent water samples were applied to three-gallon river water samples taken at the Pasco Water Plant inlet. The preliminary results indicate that the technique will be satisfactory for routine application to river water samples.

CHEMISTRY AND SEPARATIONS PROCESSES

200 Area Gamma Irradiation Facility

A study of an inexpensive irradiation facility to utilize the gamma radiation associated with the process waste from the separations plants is underway in conjunction with the Chemical Processing Department. Additional waste storage tanks (probably in the form of horizontal cylinders 25 feet in diameter by 200 feet long) will be required in the near future. Two possible schemes of utilizing the gamma radiation from the waste tanks have been considered (1) an irradiation region provided between two parallel waste storage tanks and (2) a tube (or tubes) through a waste storage tank. The first scheme would most easily adapt itself to bulk irradiation but would have a lower field intensity than the second scheme.

Gamma emission for the first type of facility was estimated to be 9,800 r/hour and for the second, 15,000 r/hour. These estimates were made on the basis of a single gamma energy of 0.75 Mev, a "semi-infinite" body of solution of specific gravity 1.8 containing 400 gamma curies/gallon and shielding of 1/2 inch of steel. Buildup is not included in the estimate. Because of activity concentration in the sludge that is formed in the waste, the above emission rates would easily be increased by a factor of five.

A third scheme considered was use of a "filter stick" to accumulate activity from the process waste. This idea is based on the fact that the waste solutions contain about 5 per cent by volume of sludge which in turn contains approximately 85 per cent of the activity. The sludge would be removed by a cylindrical filter element contained in a tube. The process waste would be pumped into the annular space and filtrate would be removed from the center of the filter element. This system would permit the production of inexpensive linear sources of relatively concentrated gross fission products.

Hydrogen Production in Waste Tanks

Further consideration has been given to the radiolytic production of hydrogen in waste storage tanks. Calculations based on recent yield data published in ORNL-1940 indicate a hydrogen production rate of about 2×10^{-7} liters of hydrogen per liter of solution per second and an oxygen generation rate some fifteen times this in a Purex Flowsheet tank. Dilution by steam would be sufficient to prevent accumulation of an explosive mixture inside a tank in which boiling is occurring. However, hydrogen concentrations in the range three to five per cent would be possible downstream from the condenser with present air flows through the recirculators. A tank that had cooled to below the boiling point and had been sealed to prevent air circulation would also be expected to contain hydrogen concentrations in this range. Arrangements have been made to obtain gas samples to check these calculations.

Half-Life DBP in HNO_3

It was reported previously that the half-life of DBP in 8 M HNO_3 - 0.05 M $Na_2Cr_2O_7$ (at 11° C) was 0.48 hour as compared to 2.2 hours without the $Na_2Cr_2O_7$. Further studies show the DBP half-life to be dependent on the $Na_2Cr_2O_7$ concentration; values of 1.7, 1.31, and 1.05 hours were obtained for 0.005, 0.01, and 0.02 M $Na_2Cr_2O_7$, respectively. Similarly, when starting with TBP (2 volume per cent) in 8M HNO_3, the

presence of 0.02 M $Na_2Cr_2O_7$ reduced the reflux time required for builup and decay of DBP to about four ppm by a factor of six over that required without dichromate.

Chemical Preparation of Uranium(IV) Fluorides

Although it has not proven possible to satisfactorily reduce uranyl nitrate with metallic iron, the reduction of uranyl sulfate by this method is essentially quantitative.

A series of five experiments were performed to establish the hydrofluoric acid excess needed for "complete" uranium recovery. The results show that the chemical cost of producing $NaUF_5$ would be $315 per ton of uranium based on $0.24 per lb of hydrofluoric acid, $0.085 per lb of iron, and a 15 per cent excess of hydrofluoric acid. This estimate assumes no value for recovered sodium fluoride and does not include recycling the supernate which should be possible.

Hydrated uranium tetrafluoride was prepared in two precipitation experiments at 90 C using 15 per cent excess hydrofluoric acid. Uranium losses were 4.9 and 1.5 per cent, respectively. The ammonium double salt was also made at room temperature. The uranium loss was 0.52 per cent. The concentration of iron contaminant was about 100 ppm.

Leaching of Radioactivity from Irradiated Uranium by Boiling Monoisopropylbiphenyl

This experiment, in which irradiated uranium was exposed to MIBP at its boiling point, was terminated after 133 hours since the activity levels in the liquid phase had remained essentially constant from about 90 hours on. Final activity levels (after the samples were allowed to settle) were as follows: 1.3×10^6 c/m, ml gamma, 1.5×10^7 c/m, ml beta, 1.5×10^7 gamma/m, ml Zr-Nb, and 7.5×10^6 gamma/m, ml Ru-Rh.

Samples taken near the end of the experiment contained some 5 to 10 volume per cent of particulate matter, presumably pyrolysis products.

The rate of corrosion is estimated from the activity present in the liquid after 100 hours exposure, and is about 2 mg/cm^2 per month, or about equal to corrosion rates reported for uranium in biphenyl. However, the rate of accumulation of activity in the liquid was not linear with respect to time.

Purex

Hot Semiworks Waste Self Concentrator. Observations on the Waste Self Concentrator are nearing the end of the present phase of the study, prior to concentrating the waste further to higher solids content. The concentrator currently contains approximately 15 ft of neutralized concentrated IWW, corresponding roughly to 35 per cent of the volume originally charged to the tank. This liquid level has been held at 15 ft since June 20, 1956 by batch reflux of the condensate (125-150 liter batches) back to the concentrator. Because of failure of the vapor header heaters, condensate flow has occurred only during pressure surge ("bump") periods.

Mini Runs. Two runs were made to test the feasibility of obtaining adequate fission-product decontamination in a single cycle of solvent extraction by (1) operating a dual extraction-scrub unit at 60 C on a "low-acid" flowsheet and employing scrub streams containing complexing agents for zirconium-niobium to improve decontamination from these fission products and (2) employing a supplementary scrub section operated at 60 C and on a "high-acid" flowsheet to accomplish decontamination from ruthenium.

Gamma decontamination performance was quite similar in the two runs. For the run employing phosphate in the scrubs, gross gamma decontamination factors were 7.7 x 10 through the extraction and scrubbing operations, and 5 x 10^5 through the batch stripping operation. For the run employing Versene in the scrub, gamma decontamination factors were 8.0 x 10^4 through the extraction - scrub operation and 6 x 10^5 through the batch stripping operation. The final product from the run employing phosphoric acid exhibited a specific gamma activity approximately six-fold higher than that of aged natural uranium. The product of the run employing Versene showed a specific gamma activity only twice that of aged natural uranium. However, the feed in this case had been diluted by a factor of 2.5 with cold uranium prior to the run.

Thus, Versene in very low concentrations is seen to be as effective as substantial concentrations of phosphoric acid in preventing the extraction of zirconium-niobium, and has the additional important advantage of apparently having little, if any, effect on plutonium loss. The plutonium loss to the aqueous waste in the run employing Versene was 0.03 per cent. The plutonium loss was not measured in the run employing phosphate but may safely be presumed to have been substantial.

Extraction Behavior of Zirconium. Studies employing the profile pulse column have recently been concerned with the effects of solvent uranium saturation on the decontamination behavior of tracer zirconium.

It has been found that, at least under certain conditions, altering the flowsheet in such a fashion as to increase the uranium concentration in the solvent will result in improved decontamination in the extraction section but will decrease scrub section decontamination. A definite, and fairly reproducible, decline in scrub section decontamination factor results from a decrease in the solvent to feed ratio and the corresponding increase in uranium concentration in the organic product.

The zirconium concentrations in organic samples withdrawn from the scrub section during the runs at the higher saturations were about ten time higher than the equilibrium values obtained when these organic samples were equilibrated with the appropriate aqueous samples. By contrast, the zirconium concentrations in the organic samples withdrawn from the scrub section during the runs at the lowest saturation proved to be only twice as great as the equilibrium values.

The extraction section and the scrub section respond in opposite fashion to changes in the solvent to feed ratio, with the result that little net change in decontamination occurs through the compound column when this ratio is changed.

Experiments have also been performed to evaluate the effect of fluoride ion on extraction of zirconium by both TTA and TBP. A mole ratio of about 4 x 10^{-4} moles of fluoride per mole of uranium (corresponding to about 32 ppm fluoride in uranium metal)

was required to duplicate the effect of the unknown impurity in extractions into solutions of TTA in o-dichlorobenzene. However, substantially greater concentrations of fluoride, corresponding to a mole ratio of the order of 2×10^{-3} moles of fluoride per mole of uranium, were required to duplicate the effect of the unknown impurity on the extraction of zirconium by 30 per cent TBP solution. Thus, it is tentatively concluded, that fluoride ion is not the impurity responsible for the observed effects.

2D Extraction Section Cartridge. The cartridge for organic phase continuous operation in the extraction section of the Purex Plant 2D Column consists of stainless steel nozzle plates with 3/16-inch-diameter holes, 23 per cent free area, 0.04-inch-deep nozzles, and 2-inch plate spacing. Fourteen "cold" HA Column runs were made during the month with the above-mentioned cartridge in a 3-inch-diameter column under Purex HW No. 3 Flowsheet conditions.

The highlights of the study are (1) with the organic phase continuous, the measured flooding frequencies and extraction efficiencies are about the same as those previously determined with stainless steel nozzle plates containing 1/8-inch-diameter holes and (2) with the aqueous phase continuous, the measured flooding frequencies are 10 cycles per minute higher than those measured with the 1/8-inch hole nozzle plate cartridge. However, the efficiencies of the two cartridges are about the same.

Low Acid HA Column Flowsheet. To improve the decontamination performance, a low acid HA Column flowsheet was tried in the Purex Plant. Coincident with the institution of the low acid flowsheet, instability in the HA Column was evidenced by lowered flooding frequency, wandering interface, and bursts of activity. A study was undertaken to determine the effect of a low acid flowsheet on the capacity and efficiency of an A-type column. A dual purpose glass column consisting of a 9-foot-high by 4-inch-diameter scrub section and a 9-foot-high by 3-inch-diameter extraction section was used. The scrub section contained a "standard cartridge" (1/8-inch-diameter holes, 23 per cent free area, 2-inch spacing), and the extraction section contained a "graded cartridge" similar to that in the plant HA Column. No louver plates were included in either section. Nine "cold" flooding runs were made with modified Purex HW No. 3 Flowsheet and with plant flowsheet PPF No. IIA.

Principal conclusions are (1) below a capacity factor of 2.5, flooding occurred first in the extraction section (2) slightly increased sensitivity to operating variables was evident at low acid conditions, and a definite but not marked decrease in flooding frequency was apparent (in the range of variables studied, neither the scrub acidity nor feed acidity appears to be predominant in influencing flooding) (3) the "graded" extraction cartridge does not appear to be ideally suited to low acid conditions since flooding usually occurred at the bottom (densely packed section) under low acid conditions instead of at the color line (loosely packed section) under high acid conditions and (4) efficiency data are not complete, but the efficiency as indicated by color line location appears to have been unaffected by low acid conditions.

The data obtained in this study indicate that the low acid flowsheet may have contributed to, but was not solely responsible for, the instability observed in the Purex Plant HA Column.

Cesium Recovery from Purex Waste. New results were obtained during the month on the radiation stability of cesium zinc ferrocyanide, and a process was also developed

for converting either the ferrocyanide or the calcination-chlorination product to cesium chloride, a material of higher specific activity.

In the radiation stability experiments, samples of cesium zinc ferrocyanide were exposed to 1.9 Mev beta radiation from a Van de Graaff generator. Samples of both the anhydrous material (prepared by heating under vacuum at 200 C) and the mono-hydrate (the normal product obtained by air drying at about 100 C) were studied. Dosage rates were about 1.8×10^8 rads per hour, and dosages employed in the two runs were 2×10^8 to 2×10^9 rads.

The mono-hydrate showed far greater decomposition as expected. The decomposition corresponded to G values in the two runs of 0.067 and 0.076 molecules of gas per 100 electron volts respectively. This agrees well with the value of 0.045 determined earlier with the cobalt-60 source at a much lower dosage rate (4.7×10^5 r/hr). The anhydrous cesium zinc ferrocyanide, on the other hand, suffered very little damage, with an apparent G value ≤ 0.003. For applications of radiocesium in which the highest possible specific activity would be desirable, effort has been directed at devising a process for converting either the ferrocyanide or the chlorinated material to cesium chloride. It has been found possible to dissolve freshly precipitated cesium zinc ferrocyanide by heating with concentrated sulfuric acid, aqua regia, or concentrated phosphoric acid. A successful process was worked out and tested based on dissoltuion in sulfuric acid.

If the calcinated-chlorinated product is the starting material, a water leach dissolves the cesium and zinc, leaving most of the iron behind. The leach solution is then buffered as above, and the zinc and trace iron removed by sulfide precipitation.

Strontium and Cerium Recovery from Purex Waste. A series of ten runs were carried out during the month to test the integrated flowsheets which have been worked out to recover strontium and cerium in conjunction with the recovery of cesium with cesium zinc ferrocyanide. The general flowsheet is similar to that used for scoping purposes except for modifications to eliminate uranium interference with the rare earth oxalate precipitation.

Other work was aimed at determining the path of plutonium in the fission product recovery process and at isolating both the uranium and plutonium in a form suitable for recovery or for recycle to the Purex process. The plutonium was found to concentrate in the ferric hydroxide precipitate and can be readily recovered from the dissolved precipitate by carrier precipitation of either lanthanum fluoride or oxalate. The uranyl peroxide cake (precipitated from the high pH cake solution to eliminate interference with cerium recovery) was found to contain only 1 to 10 per cent of the initial gamma activity and could thus probably be recycled to process. Further, the uranium can be made to follow the plutonium in the ferric hydroxide precipitation by raising the pH, and the two products could be recovered together for recycle.

Neptunium in the Purex Process. Calculations have been made of the amount of neptunium-237 that might be expected in Purex feed. Experiments have also been undertaken to substantiate these calculations, to determine the path of neptunium in the Purex process, and to devise a recovery process.

The calculations showed that neptunium is produced under Hanford irradiation conditions primarily by an n, 2n reaction on uranium-238 rather than by successive neutron

capture by uranium-235. Furthermore, the ratio of neptunium-237 to plutonium-239 is very nearly constant for moderate exposures and has a value of about 0.0036, i.e., the neptunium produced is equivalent to 0.36 per cent of the plutonium. This figure is in reasonably good agreement with a value of 0.32 per cent obtained at Oak Ridge by analysis of some Chalk River irradiated material.

Redox

Calcium Nitrate as Salting Agent for Redox. The feasibility of using calcium nitrate instead of aluminum nitrate as the salting agent in the Redox process is being re-examined in an effort to (1) lower cost of the salting agent (2) lower NaOH comsumption for neutralization (3) reduce waste volume (4) eliminate aluminum contamination in product streams (5) decrease stored waste "bumping" and (6) simplify fission product recovery from wastes.

Preliminary batch contact studies indicate that at comparable salting strength and pH, the same decontamination is obtained whether calcium nitrate or aluminum nitrate is used as salting agent.

Batch contacts simulating extraction scrub, and strip column operation using calcium nitrate as salting agent and both acid and acid-deficient feeds showed that (1) without a dual scrub, the organic product stream (IAP) will contain about 2500 ppm Ca/U (2) calcium content of the IAP is reduced to 50 ppm Ca/U by a single water contact and (3) calcium in the IAP is stripped quantitatively.

Cesium Recovery from Redox Waste

The work reported previously on the development of a zinc ferricyanide scavenging process for removing cesium from first cycle Redox waste was continued. Experiments were completed to evaluate more fully the effects of several variables, including high temperature precipitation, stirring during digestion, time of centrifugation, and presence of other fission products.

Metal Recovery Process

In the fuel cycle, partially depleted uranium trioxide is shipped off-site for conversion to uranium dioxide, uranium tetrafluoride, and, finally, to uranium hexafluoride for U-235 extraction or enrichment in the gaseous diffusion plants. The uranium hexafluoride thus enriched may be reduced to the tetrafluoride, then to metal for recharging into the reactors or for blending with depleted material for use in place of natural material.

A study has been undertaken to investigate the economic potential for a process which produces metal directly from trioxide by electrolysis, much like the method used industrially to produce aluminum. Economic justification is not apparent from available cost information. The cost figures for the related off-site processing steps are being reviewed. The proposal is also being considered from the standpoint of the situation which would exist if HAPO were processing sufficient amounts of enriched uranium fuel for use in the "sweetening" of all depleted natural material.

UO_3 Studies. Further studies aimed at elucidating the factors responsible for uranium oxide reaction characteristics have been concerned with (1) factors affecting the reactivity ratio test (2) reactivity as a function of calcination temperature (3) the decomposition of UO_3 to U_3O_8 (4) electron micrography and (5) the interpretation of reduction kinetics.

Conclusions from this study are that 'continuous' powders vary widely with regard to the reactivity ratio test and have a much greater sensitivity to the conditions of the test than do the standard pot powders The pot powders apparently do not readily sinter, according to electron microscope data, and thus the conversion is aided by the high temperature reaction which yields a fluffy reduction product.

The thermal decomposition of a typical pot powder and a typical 'continuous' powder was studied by means of the thermal balance. The pot powder was observed to decompo at about 20 times the rate of the 'continuous' powder in the range 575 to 590 C.

Removal of Co^{60} from Uranium Recovery Process Stored Wastes. A practical procedure capable of reducing the Co^{60} content of all tanks of uranium recovery process stored wastes to the cribbing limit ($\leq 4 \times 10^{-5}$ μc/cc) has not yet been found. Precipitation of nickel or cobalt sulfide is the most effective procedure yet tested. However, for most tanks, residual Co^{60} concentrations after sulfide scavenging (laboratory scale) are from two to 40 times the cribbing limit

Moving Bed Ion Exchange

The method of moving the resin in the 5-inch-diameter moving-bed ion exchange unit was changed from a hydraulic pump arrangement to a pneumatic system to avoid potential problems associated with mechanical equipment and oil contamination of the resin. Generally, satisfactory results have been obtained

The equilibrium between ferric iron, nitric acid, and Dowex-50W (8X) has been experimentally determined. Within the precision of the data, the results can be represented by the empirical equation:

$$\log\left(\frac{2.20 - Fe_R}{H}\right) = (0.65)\left[\left(\log\frac{Fe_R}{Fe}\right)^{0.76} - 1\right]$$

Where Fe_R = Ferric iron concentration on resin, eq. /l. of wet settled resin.
Fe = Ferric iron concentration in solution, eq. /l.
H = Acid concentration in solution, eq. /l.

New Processes

The first experiment utilizing electromigration in a fused chloride system as a method for separating fission products from irradiated uranium has been completed.

Flurex Process

Flurex Process studies were continued (1) to show the relationship between current density and current efficiency at the mercury cathode (2) to test the membrane permeability of contaminant cations and (3) to investigate some characteristics of Nalfilm 2 (cation transfer) membrane.

As a result of the previously reported successful reduction of uranyl nitrate with the tin amalgam cathode, a comparison run using the mercury cathode was made. The current efficiency was about 97 per cent, surprisingly high in comparison with results of earlier experiments. Use of the mercury cathode also resulted in current efficiencies of 95 per cent, or greater, in three experiments in which cathode current densities of 3 amp/in^2 were maintained. The contradiction between present findings and earlier work has not yet been resolved, but experiments to do so are in progress.

To determine the behavior of corrosion product elements in the Flurex Process, a feed solution containing tenth molar nickel(II), chromium(III) and iron(III) was used in a typical Flurex test. After 20 minutes operation at a membrane current density of 0.33 amps/in^2, the cation transfer membrane resistance became prohibitively high and the experiment was terminated. Analysis of the catholyte showed the presence of nickel and iron. It is therefore, believed that chromium is responsible for the membra blocking.

Nalfilm 2 was used in a study of membrane resistance as a function of uranyl nitrate concentration. The resistance of the Nalfilm 2 was found to be significantly less than that of Nepton CR-61.

Analytical Development

A uranium isotopic analysis method based upon counting the 184 kev gamma of U-235 was previously developed and published. Application of this method to the analysis of enriched uranium samples is now being studied, and gamma counting techniques capable of a precision within about 0.2 per cent have been developed.

In-Line Analysis

A study of the Sargent Oscillometer for in-line monitoring of dielectric constant has been completed and an informal feasibility report has been issued.

Chemical Instrumentation

The experimental high level Alpha Air Monitor and Alarm operated satisfactorily at the Redox Facility. Background tests in the operating galley showed good stability. The detector was placed in the stack effluent sample line and alarmed in four days with an average concentration of five times the MPC in air. A prototype of this instrument was designed and submitted to the shop for fabrication.

Prototype Uranium Polarograph. The prototype polarograph is sampling and analyzing the waste stream from the extraction column in the demonstration unit in the 321 Building, and has detected uranium concentrations ranging from 0.05 to 10.0 grams per liter. Malfunction of the solenoid valves has been the one source of difficulty. The helium sparge system uses about one cubic foot of helium per hour. At this rate the annual cost for helium would be $35.00.

Uranium Photometers. Two uranium light photometers are scheduled for installation in the Purex Plant on Project CG-686. These units are to be installed on the IAF and 2DF streams in series with the existing gamma monitors. A prototypical installation of these combined units has been assembled and tested.

DEL

A prototype of a uranium light photometer incorporating an optical standardization system (''dual beam type'') using interference type filters in place of the standard uranium solutions is being assembled and tested for plant use.

Plutonium Resin Column Controls. A laboratory prototype of the scanning instrumentation to locate the resin level in the column reservoir is 80 per cent complete. This equipment uses conductivity probes and is designed to locate and indicate the resin level to within ± 0.5 inches.

Equipment and Materials

Plug-Piston Pulse Generator. The operation of a 4-inch-diameter graphite plug-piston pulse generator was discontinued after 28 million cycles pulsing water in a demonstration column.

Tests indicate that graphite plug-piston pulse generators will give more than one year of satisfactory operation in the Hot Semiworks.

Rotating Disk Contactor. Solvent extraction studies employing a rotating disk contactor were initiated during the month. The unit consists of 1.8-inch OD rotor disks located midway between 2.2-inch ID stator disks. The disks are spaced 1.5 inches apart in a 2.75 inch ID 3-foot-tall column. Eight ''cold'' extraction and thirteen ''cold'' scrub runs were made under conditions approximating the Purex HW No. 3 Flowsheet.

Significant observations show that (1) extraction efficiencies are comparable to those obtained with a pulse column operating at equivalent throughput rates (2) at comparable percentages of the flooding speed, essentially the same extraction efficiencies were measured with either phase continuous (3) scrubbing efficiencies, as measured by chloride, D. F., were at least 50 per cent lower than those determined in a pulse column (4) with the organic phase continuous, the scrubbing efficiencies at 90 to 95 per cent of the flooding speed were markedly dependent upon the throughput rate, giving higher efficiency at lower throughputs and (5) at comparable throughput rates and percentages of the flooding speeds, lower Cl^- H.T.U.'s were measured with the aqueous phase continuous than with the organic phase continuous.

With the particular unit and systems studied, the rotating disc contactor was generally not equal in performance to pulse columns.

Titanium-Tube Heat Exchanger. The prototypical titanium-tube heat exchanger, fabricated for the Purex Plant, developed transverse cracks in the welds joining the titanium tubes and tube sheet facing. In addition, radiographs of the tubes have shown longitudinal defects in three of twelve tubes. These tubes are to be replaced in the new unit.

Chemical Compatibility. CS 312 graphite, a bearing material, was tested in both the liquid and vapor phase of 60 weight per cent nitric acid at its boiling point, with and without an air purge introduced below the level of the liquid. After 240 hours exposure, the sample in vapor with air purge lost 0.5 per cent in weight. The sample in liquid with air purge lost 0.7 per cent by weight. Without air purge, the sample in vapor lost 0.4 per cent and the sample in liquid lost 1.3 per cent in weight. In both cases,

the samples in the liquid decreased more in hardness than did the samples in the vapor although the changes of hardness were minor.

CSGBF pile graphite was immersed at room temperature in Recuplex CAX, CCl_4, 60 per cent nitric acid, and distilled water. After ten days, the sample in CAX had increased in weight 0.13 per cent. The other samples decreased in weight to the extent of 0.03 per cent. There was no dimensional change noted on any sample. These data indicate the adaptability of the graphite piston pulse generator for Recuplex.

Ceramic samples manufactured of aluminum oxide with a silica binder (Coors Porcelain Company) were tested in boiling five per cent and ten per cent sodium hydroxide. After 192 hours exposure, the samples in five per cent solution had decreased 0.10 per cent whereas the sample in the ten per cent solution decreased 0.3 per cent. No other changes were noted. This study is the beginning of a program to evaluate ceramic materials as materials of construction for process equipment.

Chemical Effluents

Special Studies and Advance Planning. The re-evaluation of geological and hydrological data obtained from the vicinity of 200 East Area continued to explain previous anomalies in the behavior of the ground water, on the basis of the varied permeabilities resulting from the locally upturned beds of the lower or "blue clay" beds of the Ringold formation to and above the ground water table. The north-south orientation and elongation of the 200 East Area ground water mound is due to the less permeable sediments of those beds rising above the water table to the east, hence forcing the ground water flow to the southeast. These beds pass below the ground water table less than 1000 feet north of the southeast corner of 200 East Area, hence explain the presence of contamination in wells southeast of that location.

Geochemical and Geophysical Research. The planned disposal of large volumes of radioactive waste to cribs in the vicinity of the Purex plant was studied to estimate the life of these cribs. The waste streams now discharging to the sites are of much lower radioisotope concentration than is ultimately anticipated, making the life expectancy estimates obtained through soil column experiments highly uncertain. The previously observed high ground-water velocities in the region and the uncertain life of the present cribs make it desirable to investigate replacement crib sites for certain Purex waste streams. The geological and hydrological data now on hand strongly favor the region west and southwest of the 216-BC crib and trench site. Crib performance data, particularly from the Redox 216-S-1 and 2 sites, where no cesium or strontium breakthrough has yet been detected in spite of the large waste volume and total activity discharged there, supports the choice of the region.

The regional hydrology has undergone some highly significant changes during the past year. A comparison of the current water table elevations with data obtained in October, 1955, shows a general rise in the ground water throughout the 200 East Area and much of the surrounding region. The large volume of water discharged from the Purex plant during the past nine months has resulted in a 15-foot increase in the elevation of the 200 East ground water mound. This mound has assumed the orientation previously observed during B-Plant operation but is somewhat more extensive. The northwest-southeast trend of the ridge of high water comprising this mound shows

a distinct westward projection south of the 200 East Area. This formation is apparently caused by the local geologic structure and is probably responsible for the restriction of southeastward movement of ground water beneath the 200 East Area.

The prominent ground-water mound beneath the 200 West Area on the other hand, has undergone a uniform lateral spreading and its maximum elevation has decreased nearly 10 feet. This effect is the result of a greatly decreased discharge rate to the T-Plant swamp. It is important to note that a well-defined northeastward gradient has been formed beneath the 200 West Area which could lead materials toward the zone of rapid eastward flow which exists south of Gable Mountain.

An aquifer performance test in the region south of Gable Mountain indicates that the calculated transmissibility coefficient of the aquifer was 3×10^6 gal/day/ft on unit gradient, and the aquifer was found to have a storage coefficient of 0.20.

Analysis of geological data showed the presence of an extensive caliche bed underlying 200 West Area and part of the region between 200 West and 200 East Areas. This caliche formation, formerly a calcium carbonate crust formed in an arid region, may well represent the upper level of the Ringold formation. It performs the useful function of a well defined marker bed that can be traced from one well to another and used as a reference for correlation. Another marker bed with well defined characteristics was discovered as a result of clay and silt determinations made on well samples; this five-foot bed of glacio-fluviatile sediments having an unusually low clay and silt content was traced through a number of adjacent wells in the 200 West Area.

The ion exchange reaction of Yttrium ion with soils was studied by means of equilibrium experiments. The coefficient for the solution-to-soil distribution using 10^{-8} to 10^{-7} M yttrium chloride with typical Hanford soil was found to be approximately twice that of strontium. The influence of other cations, such as Cs, NH_4, Li, H, Ca, Ba, Mg, Sr, and Ce, on the distribution coefficient of yttrium was examined. When the accompanying cation is in the same molar concentration as yttrium, the distribution coefficient of yttrium ion was approximately halved. No significant influence of cation species was found for the list tested.

Process Development. The uptake of radioisotopes by soil from solutions containing the decontaminating agent Turco 4306-B was investigated. The disposal to the ground of the used decontaminating solutions in the separations areas is dependent on the ability of the soil to remove long-lived radioisotopes from them. The results of equilibrium experiments indicated that the uptake of Pu^{239}, Cs^{137}, and Sr^{90} from such a solution at high pH and high $NaNO_3$ content was approximately equal to the uptake of these radioisotopes from distilled water. At lower pH and lower $NaNO_3$ concentration, the uptake of Pu^{239} and Cs^{137} was unchanged, but the uptake of Sr^{90} was reduced to less than 0.1 of the previous value. The addition of $CaCO_3$ to destroy the Turco compound actually inhibited the uptake of Cs^{137} and Sr^{90}. The data suggest that acceptable disposal of such solutions containing Cs^{137}, Sr^{90}, and Pu^{239} requires adjustment of pH and sodium nitrate content.

The laboratory investigation of the effect of the soil conditioners Krilium on the infiltration rate of water was completed. The addition of 0.5 to 1.0 part per million of Krilium to the influent water had no effect on the infiltration rate but thorough mixing of Krilium with the top 14 cm of soil in the proportion 1 part to 350 indicated a definite

increase in the infiltration rate. The validity of these results can be confirmed only in a field test. However, the necessity for mechanical mixing of Krilium with soil to improve infiltration makes it a less desirable additive than Separan, which increased the infiltration rate when added to the influent water.

A study was begun of the disposability to ground of 110 C waste consisting largely of a Na_2CO_3 wash of Purex organic solvent. A soil column test using the unscavenged waste indicated that removal of plutonium, strontium and cesium by the soil was inadequate for disposal to the ground while a similar test using waste scavenged with $Ni_2Fe(CN)_6$ indicated that the strontium was removed sufficiently for such disposal.

An investigation was started to determine the function of phosphate in waste solutions containing strontium and sodium ions. Previous observations demonstrated that phosphate was necessary to effect the removal of strontium by soil when the solution contained sodium ions. The preliminary results of equilibrium experiments with sodium phosphate solutions and bentonite or kaolinite were interpreted to mean that a chemical reaction occurred between the phosphate and the clay. Similar experiments performed with clay which had been treated with a strontium solution and then washed free of excess strontium yielded results considered to be characteristic of a physical adsorption process. Plans were made to continue the investigation with higher concentrations of phosphate and sodium.

The continued presence of Co^{60} in TBP scavenged supernate above the recommended cribbable limit of 4×10^{-5} μc/cc necessitated recommending tank storage or ground disposal on a specific retention basis of all TBP waste scavenged during October. To date, 4.5 million gallons of high Co^{60} scavenged waste have been disposed of on a specific retention basis at the BC-trench site.

Equipment and Instrumentation. Initial experiments were performed to develop a counte to be used in soil column studies. Movement of Sr^{90} - Y^{90} in the column should be identified with an accuracy of 1 - 2 mm. A collimator was designed and tested using a mica window GM tube as a detector and a thin-walled (10 mg/cm^2) column containing Sr^{90} - Y^{90} in solution as the source. A displacement of 1 mm above the meniscus resulted in a 20% decrease in counting rate, suggesting that adequate resolution may be achieved with this arrangement.

The superiority of TWG tubes over metal wall tubes was demonstrated for counting tritium in a mixture of argon, ethylene and hydrogen. Longer plateaus and more reproducible counting rates were exhibited in tests performed in conjunction with tritium-in-ground-water studies.

BIOLOGY

Radiological Monitoring

Contamination in terrestrial and aquatic organisms as a result of radioactive materials introduced into the atmosphere and Columbia River follows:

Atmospheric Contamination. Concentrations of I-131 in rabbits' thyroids are listed below.

Collection Site	$\mu c\ I^{131}/g$ thyroid Average	Maximum	Trend Factor
West of 200 West Area	3×10^{-3}	4×10^{-3}	+4
100-B Area	2×10^{-3}	2×10^{-3}	+4
East of 200 East Area	1×10^{-3}	2×10^{-3}	-2
4 miles SW of Redox	1×10^{-3}	2×10^{-3}	-
Meteorology Tower	9×10^{-4}	2×10^{-3}	-
Prosser Barricade	9×10^{-4}	2×10^{-3}	-
1 mile SE of Redox	7×10^{-4}	2×10^{-3}	-
Wahluke Slope, NNE	1×10^{-3}	2×10^{-3}	-8 *
6 miles SE of Redox	9×10^{-4}	1×10^{-3}	-10 *
Route 2S, mile 3	9×10^{-4}	1×10^{-3}	-10 *
Wahluke Slope, N	4×10^{-4}	5×10^{-4}	-10 *

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

The average thyroid contamination levels are about one-eighth of those observed one year ago.

Rabbits captured on the Reservation were contaminated by fallout debris, apparently of off-plant origin. Amounts and distribution are shown in the following table.

Sample Type	μc FP's/g sample (Average)	Trend Factor
Bone	6×10^{-5}	-
Feces	6×10^{-5}	-
Liver	7×10^{-6}	-

Swamp Contamination. Concentrations of fission products in waterfowl taken from the 221-U swamp are listed below:

Sample Type	μc FP's/g tissue Average	Maximum	Trend Factor
Coots			
Bone	9×10^{-4}	4×10^{-3}	+4
Soft tissues	3×10^{-4}	7×10^{-4}	-
Diving ducks			
Bone	6×10^{-3}	2×10^{-2}	+3
Soft tissues	7×10^{-4}	2×10^{-3}	+3
Grebes			
Bone	7×10^{-4}	1×10^{-3}	-
Soft tissues	6×10^{-4}	1×10^{-3}	-
Puddle ducks			
Bone	5×10^{-3}	8×10^{-3}	+10
Soft tissues	1×10^{-3}	2×10^{-3}	+2

As expected, the trend factors show a general increase in contamination due to the decrease in migrant birds this month. The levels of contamination are about one-third the levels of one year ago.

Columbia River Contamination. The contamination levels in representative aquatic forms and in waterfowl for October are shown in the following table. Radioactive substances in plankton originated from a variety of isotopes added to the river with the reactor effluent. In the fish and waterfowl, virtually all of the activity is from P^{32} which the animals acquired indirectly from the water via food chains.

Sample Type	Collection Site	μc radioisotopes/g tissue Average	Maximum	Trend Factor
Plankton	Hanford	4×10^{-2}	7×10^{-2}	-
Caddis larvae	Hanford	4×10^{-2}	2×10^{-2}	-
Minnows	Hanford	9×10^{-3}	2×10^{-2}	-2
Whitefish *	Hanford	5×10^{-4}	2×10^{-3}	-
	Priest Rapids	2×10^{-5}	3×10^{-5}	-
	Ringold	6×10^{-4}	2×10^{-3}	-
Shorebirds *	Hanford Reservation	1×10^{-2}	2×10^{-2}	-
Puddle ducks *	Hanford Reservation	3×10^{-3}	6×10^{-3}	+3
Mergansers *	Hanford Reservation	2×10^{-3}	3×10^{-3}	+2
Gulls *	Hanford Reservation	2×10^{-3}	3×10^{-3}	+2

* Values are for flesh. Concentrations in bone are threefold higher for waterfowl and tenfold higher for fish.

The contamination level for most small aquatic animals in the Columbia reached a maximum for the year during the latter part of September and declined slightly this month. Only in the minnows was the decline great enough to rate a trend factor of -2. This pattern is typical of the seasonal change observed in former years and results from lower water temperatures which slow metabolic rates. There was no decline in the concentration of P^{32} in the whitefish since their contamination level usually remains comparatively high through December. The contamination level in fish in the vicinity of Richland is about the same as at Hanford (8×10^{-3} μc/g of minnows, 3×10^{-4} μc/g of bass flesh). Values at McNary Dam are about one-third those at Hanford. During the month the concentration of radioisotopes in the small aquatic forms in the vicinity of Hanford reached values about double those observed one year ago. Such an increase is not evident in adult whitefish as small changes are difficult to discern in these fish because of wide variations between individual specimens.

Current values in puddle ducks and shorebirds are fifteen times those of 1955, and amounts in gulls are twice those of 1955. This is ascribed to a smaller fraction of migrants among current samples as compared to those collected one year ago this month.

Adult chinook salmon are again spawning in the vicinity of the reactor areas. The 41 nests observed thus far is a greater number than at this time in 1955, but is not above normal.

Young whitefish which are being exposed to different concentrations of reactor effluent under controlled laboratory conditions show much the same response as reported last month. Mortality significantly above that of the control occurred in 2 per cent strength effluent. The mortality rate diminished during October, however, with a drop in water temperature.

Continued exposure of young trout to reactor effluent containing "Separan" in concentrations as high as 0.07 ppm has produced no ill effects. This test has been in progress for three months.

Metabolism and Toxicity of Radioactive Materials

Reactor Effluent. To clarify the earlier results which indicated that the deposition of P^{32} in rats fed concentrated reactor effluent is significantly less than predicted by theory, two other experiments were initiated. In one, a group of rats is being maintained on 100 per cent (unconcentrated) effluent. In the other, rats are being fed effluent spiked with P^{32} and concentrated 35-fold.

Plutonium. In earlier studies on gastrointestinal absorption of plutonium, solutions were administered by stomach tube. To test for absorption from the oral cavity and esophagus, an experiment was started in which rats are ingesting plutonium in drinking water.

In studies on the toxicity of plutonium, it was observed that Pu^{239} definitely inhibits oxygen uptake by metabolizing yeast. Since the inhibition occurred immediately after adding the plutonium to the culture and since oxygen uptake is relatively insensitive to radiation, it appears that the effect is one of chemical toxicity. From the amounts

employed it appears that the chemical toxicity of plutonium is at least as great as that observed by other workers using uranium.

Hematological studies were made on 25 rats fed plutonium in amounts ranging from 100 to 400 mg. White cell counts of surviving animals were not depressed after these large doses. This is in contrast to the marked drop in white cell count seen after Y^{91} feeding or X-irradiation of the GI tract. These results lend confirmation to the supposition that deaths from large oral doses of plutonium are due to causes other than radiation effects.

Previous erratic results on the toxicity of orally administered plutonium have been satisfactorily explained on the basis of differences in absorbability of the plutonium administered. Animals succumbing to approximately 50 mg of orally administered plutonium were found to have absorbed an average of .06 per cent of the administered dose, while animals surviving several hundred milligrams of orally administered plutonium absorbed an average of .006 per cent of the administered plutonium. This lower rate of absorption is in agreement with previously determined absorption coefficients obtained in chronic feeding experiments with much more dilute plutonium solutions. The difference in absorption between the two groups of rats can probably be explained by differences in the method of preparation of the plutonium slurry fed, the low absorption being associated with methods of preparation favoring the formation of plutonium polymer.

Calcium and Strontium. A somewhat popular notion in practical hazard control states that the uptake of a radioactive element into an animal or plant may be decreased by diluting the radioactive element with its non-radioactive isotope. Earlier work in this laboratory indicated that this, in general, does not occur. Because of the hazard significance of radiostrontium and because of the chemical similarity of calcium and strontium, the effects of isotopically diluting the radioactive isotopes of these elements on bone and other tissue deposition in the rat were investigated. No isotopic dilution effect was noted.

Iodine. The previous observation that high nutritional plane pigs absorb more radioiodine into their thyroids than low plane pigs was confirmed in a second tracer study.

Two pigs were each given approximately 3.3 mc of I^{131} and sacrificed 15 months later. Their thyroids were damaged and weighed about one-quarter as much as glands from control pigs. These results are like those seen in sheep following a similar thyroid dose, which was estimated to deliver from 20,000 to 30,000 rads.

Radioactive Particles. Acute exposures of mice to low-level $Ru^{106}O_2$ aerosols were initiated. These exploratory experiments indicate a long dose of 0.03 to 0.05 μc from inhalation for one hour of an aerosol containing approximately 10^{-4} to 10^{-3} $\mu c/cc$. Mice killed eight hours after exposure had relatively high concentrations of ruthenium in the trachea, GI tract, and kidney.

The rates of elimination of $Ru^{106}O_2$ and PuO_2 from mice after the twentieth day post-intratracheal injection show an unexpected similarity with half-lives of about 60 to 70 days.

Gastrointestinal Radiation Injury. Studies of Fe^{59} uptake in rat erythrocytes indicate that marrow damage is not significantly involved in the effects of X-irradiation of the intestinal tract or Y^{91} administered orally. No decrease in iron uptake resulted from irradiation of the GI tract in situ to 1,500 r and a reduction of no more than 25 per cent resulted from irradiation of the exteriorized intestine or irradiation from orally administered Y^{91}. Whole body exposure to an X-ray dose of comparable toxicity (600 r) depressed Fe^{59} uptake almost completely during the same time period.

Genetic Effects of Metabolized Radioisotopes. Initial experiments to determine the gene relative biological effectiveness on yeast have suggested values in line with those obtain for growth. However, inviability of cells grown under continuous radiation has been more extensive than anticipated and the results obtained so far have thus suffered by lack of large enough numbers of viabile cells to obtain satisfactory statistical samples. The extensive inviability suggests that the use of biability data may allow an evaluation of RBE at radiation levels lower than those previously possible when growth was used as the sole criterion of damage.

Cultures of yeast, previously grown on media containing S^{35} and varying levels of carrier sulfur, were stored in the lyophilized form to allow decay of the S^{35}. At the end of a three months' holding period mutation, rates in the tubes of highest specific activity were almost twice those obtained in tubes of lower specific activity, indicating a transmutation effect.

Uptake of Radioactive Substances by Growing Plants. The uptake of P^{32} was examined both in nutrient solution and soil cultures. With nutrient solutions the leaf-root ratio rose to a maximum with 0.1 μg P/ml of solution and then declined with higher levels of phosphate carrier. In soil culture a maximum leaf-soil ratio was obtained with 250 μg P/g of soil. This level of phosphorus is approximately 10 times the concentration of available phosphorus in the soil.

SUPPORTING ACTIVITIES

OPERATIONS RESEARCH AND SYNTHESIS

Reactor Data

Based on extensive discussions with personnel of the Irradiation Processing Department a first approximation of data input requirements and processing requirements has been made. Some discussions have been held with the personnel of Facilities Engineering concerning relationships between automation through direct instrumentation and control feedback from a data processing system. In addition to this, the relation of data processing to instrument development was explored.

Economic Liaison

Activities on this program centered around the preparation of a basic memo on the "Economics of Uranium Enrichment".

A memo, HW-46114, was issued which provides a simple method of estimating the cost of mixing uranium streams of slightly different isotopic composition.

A dollar value for incremental plutonium production and an associated pay out period for capital expenditures were proposed for study purposes. Some changes in previously furnished data concerning uranium valuation were indicated.

Factors Affecting Manpower Utilization

In connection with the systematic study of those factors which involve manpower utilization at HAPO, a work-mix concept for radiation work and non-radiation work was conceived. This has proved useful in examining many aspects of an operation involving radiation work. The model developed enhances the study of the influence of such factors as (1) exposure limits (2) dosage rates and (3) methods of control of exposure on the cost of doing the work and the size of the work force required. Illustration and evaluation of this concept will be more feasible when the conversion of personnel exposure data to IBM has been completed.

Investigation of Problem Areas

Investigation and discussion have continued on the study of the factor limiting total reactor capacity at HAPO and the symbolic model of a communication system. Several departments and operations have indicated interest in further work on problems of personnel data processing and their effect on manpower utilization. Further investigation of the possible contribution in this area is being made.

Reactor Model

A report was nearly completed on the mathematical derivation of those "variable discharge curves", i.e., curves specifying in advance the goal concentration of individ

tubes. The use of such curves over long periods of reactor operation under comparatively uniform conditions should minimize fuel element failures and at the same time achieve specified over-all requirements on production.

Matrix Methods Applied to Cost Accounting

Discussions were held with members of the Financial Operation, Irradiation Processing Department on the use of matrix methods in cost accounting. Several rough draft formulations of the basic methods were supplied to them for study.

Mathematical Analysis and Consultation

To enable the Utilities Operation to correctly schedule replacements of supporting structures on high tension utility lines, a mathematical study was made of the applied and resultant forces on a typical structure. Given such factors as (1) the actual weight and position of the structural members themselves (2) the load of the conducting cables and hardware (3) additional loading due to ice accumulation during severe winter storms and (4) the action of winds on structural members and conducting cables, the formula was derived for computing the maximum binding moment which a pole must withstand at ground level When combined with routine measurements of the rate of deterioration of any given pole, this will allow maintenance crews to schedule replacements prior to failure.

Statistics Studies for CPD

The quarterly report to the customer covering production in Z-Plant for the second calendar quarter of 1956 was issued as a Top Secret document. A deleted summary document, HW-45915, with a larger distribution was also issued.

A statistical analysis was performed on the data resulting from tests of the gamma radiation penetrating different areas of leaded gloves. The results of this analysis will be used in determining appropriate methods of controlling hand exposure received by operating personnel.

Control charts were set up for each stage of the Redox dissolving operation. These charts will enable the operators to have increased control over the dissolving time.

Data on corrosion rates in stainless steel pipe are being analyzed by the Huey test to determine if the results are related to diameter or wall thickness.

Statistical services associated with the improvement of the prevision of the ceric sulphate titration method in the 234-5 laboratory are being continued. Assistance has been given in evaluating alternative accountability procedures for the Z-Plant operation. Extensive calculations are also continuing on calibration of Purex vessels.

[redacted]

Statistics Studies for IPD

Several graphs were prepared which compare the warp distribution curves for various slug types under different sets of irradiation conditions.

Two reports were issued in connection with the slug measuring facilities at B and C Basins (1) summarized results of past experiments relating to the B-Basin profilometer accuracy and precision and (2) presents a general discussion of the type of routine check advisable for the C-Basin equipment to insure that these instruments continue to perform satisfactorily once they have been accepted for normal usage.

Some thought was given to the general question of how best to use a restricted number of tubes in answering questions on dimensional stability of irradiated slugs, i. e., is more information obtained by running 2 n tubes to E exposure, or n tubes to 2 E exposure? Considerations entering into this type of problem were discussed with personnel of the Research and Engineering Operation.

Equations of the form $y = a + b \sin 6x + c \cos 36x$ were developed and fitted to weasel curve data obtained from four different channels. Two such equations were fitted to each channel because of the lack of symmetry in the curves. A measure of the total irradiation from each slug is given by the area under the curve when determined between appropriate limits. Equations of the form $A = a + b \left[\sin 3^{\circ}\right] \left[30/\pi\right] \sin 3 \left[2x + 1\right] + c \left[10/\pi\right] \left[\sin 18^{\circ}\right] \left[\cos 18(2x+1)\right]$ give the area under the curve from x to x + 1.

Statistics Studies for FPD

Several rupture rate curves, with confidence limits about the individual points, were constructed for cored slugs based on irradiation history of the past few months.

Graphs were prepared which indicated to what exposure 2 tubes must run without rupture before it could be asserted with α confidence that the rupture rate at 500 MWD/T was < R. Graphs were constructed for different values of α and R.

A high number of non-seating rejects in recent weeks has promoted an analysis of pertinent data to assist in determining assignable causes. An analysis of variance involving different lot types, crews and shifts is being undertaken to determine which of these variables, or combinations, are paramount in contributing to the excessive high number of non-seating rejects. Data on off-cycle rejects in the canning process are also being analyzed to determine the major contributing causes of this type of reject.

The relation between absolute humidity and air temperature at the canning bath and non-seats, poor bonds, bond testing results and voids is presently being investigated.

Some of the variables which are present in the canning process and which may affect the quality of the final product are iron concentration, AlSi content, crew and temperature. Previous studies have indicated that lowered AlSi and temperature tend to improve the residual can wall thickness. However, other deleterious results may be induced. Consequently, a factorial experiment designed to measure the effect of the aforementioned variables on the bonding and non-seat qualities is being investigated.

Consultation has been provided on the use of one-sided tolerance limits in the routine description of the quality of canned product. Consulting services have also been provided on the feasibility of changing the inspection period for measuring silicon content in the canning pot.

Statistics Studies for HLO

Investigations on control of radiation exposure indicate that extensive control measures are needed only for several job types. The distribution of radiation received between successive badge pulls is now being tabulated for these radiation prone jobs. Any statistically valid procedure to control excessive exposure must take cognizance of these distributions.

Aquatic Biology Operation conducts periodic controlled experiments to ascertain the effect of rises in river temperature and increased dichromate concentration on river organisms. Data from several recent experiments were analyzed and reported.

Recent physics experiments on the test reactor have been devoted to measuring nuclear cross sections of various elements. Because of the excessive time involved in completing a single experimental run, it is of utmost importance to ascertain the minimum number of replications of a fixed experimental situation necessary to insure desired accuracy in cross section estimates. Statistical assistance has been given to the problem of evaluating the reliability of the different measurement techniques utilized in these experiments and in obtaining the best estimate of nuclear cross sections.

Data from several more couples in the experiment to estimate penetrations of AlSi into uranium and vice-versa were analyzed. Some thought was given to estimating the parameters in the basic equation (penetration vs. time and temperature) using maxima rather than means at each temperature level as the dependent variable.

Assistance given in connection with corrosion studies included (1) obtaining estimates, with confidence limits, of the parameters involved in relating corrosion rates to pile variables for several sub-groups of the total data (2) calculating multi-nominal probabilities resulting from a corrosion experiment in which the yield values were proportions of experimental units showing definite corrosive attacks and (3) devising a means of treating data consisting in the amount of penetration of different substances as functions of time, in which theoretical reasons existed for knowing that there were breaks in the data, but the breaking points had to be estimated from the data.

Experimental results have been obtained for a corrosion study based on a fractional replicate of a factorial design. The statistical analysis is being carried out and will attempt to measure the significance or non-significance of the main effects and interactions where the factors involved are (1) the kind of material (2) amount of nitric acid (3) temperature (4) sulfate content and (5) time. Each factor has four levels associated with it.

A safety award program was suggested for use in the Hanford Laboratories Operation. To evaluate this program or any similar one realistically, a graph was constructed presenting average time intervals between awards as a function of the number of consecutive days without a major injury necessary for an award, and the expected

frequency rate of major injuries. Another graph was constructed presenting the probability of winning an award as a function of the number of consecutive major injury free days to date.

RADIATION PROTECTION

The average daily emission of I-131 from chemical processing plants was 0.2 curie with a maximum of 0.8 curie per day. This is well within the HAPO standards. The average daily emission of beta-emitting particulate was 0.05 curie. Isotopic analysis of the particulate material emitted in September resulted in a revision in that month's daily average emission rate from 0.15 to 0.06 curie.

The highest beta activity density obtained from the Columbia River water in the history of Hanford was detected on October 16 and 200 yards off the shore and about one mile below 100 D Area. The measurement was 6.3×10^{-5} μc β/cc and was probably the result of extremely low river flow rates.

One new case of confirmed plutonium deposition occurred as a result of an incident in 234-5 Building. There are 196 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 occurrec as measured by the film badge program.

The number of pencil dosimeters read and badges processed during October was greater than any other month in the history of Hanford.

The calibration wells construction project was completed and the wells were accepted from the contractor by General Electric and the AEC.

The radioactive contamination status of eighty acres of irrigable land in the Hanford primary control zone near Ringold was reviewed; appropriate recommendations were submitted to AEC, HOO.

CONDENSED EXPOSURE RECORDS

Type	Number of Readings	Potential High Results	Confirmed High Results
Pocket Chambers - Gamma	348,002	49	0
Pocket Chambers - Slow Neutron	2,198	1	0
Film Badges - Beta - Gamma	63,636	48	0
Film Badges - Neutron	791	0	0
Pu Bioassay	1,065	33	1
F.P. Bioassay	1,169	2	0
U. Bioassay	449	26	26
Alpha Hand Counts	52,285	0	0
Beta Hand Counts	50,468	0	0
Thyroid Counts	0	0	0

REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density μc/ml	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	1.1×10^{-8}	--
Richland, N. Richland, Benton City Wells	alpha	$(<0.5 \text{ to } 1.3) \times 10^{-8}$	--
100 Areas	beta	$(0.14 \text{ to } 4.1) \times 10^{-6}$	--
200 Areas	beta	$(0.8 \text{ to } 1.6) \times 10^{-6}$	--
Pasco, Kennewick, McNary Dam	beta	$(<0.05 \text{ to } 2.3) \times 10^{-6}$	--
Backwash Solids - Pasco Filter Plant	beta	4.8×10^{-2} μc/gm	+2
Backwash Liquids - Pasco Filter Plant	beta	1.9×10^{-6}	--
Anthracite, Sand Filter - Pasco Filter Plant	beta	1.8×10^{-4} μc/gm	+2
Other Waters and Related Materials			
300 Area Wells #1, #3, and #4	U	$(0.87 \text{ to } 2.2) \times 10^{-7}$	--
200 East Wells	beta	$<2 \times 10^{-7}$ to 7×10^{-2}	-4
200 West Wells	beta	$<2 \times 10^{-7}$ to 1.6×10^{-2}	--
Wells Near 200 Areas	beta	$(<2 \text{ to } 3) \times 10^{-7}$	--
107 and 108 Wells	beta	$(<0.02 \text{ to } 1.5) \times 10^{-5}$	-3
Outlying Wells	beta	$(<2 \text{ to } 2.7) \times 10^{-7}$	--
Columbia River - Hanford Ferry	beta	2.5×10^{-5}	--
Columbia River - Below Reactors	beta	1.8×10^{-5}	--
Columbia River - Paterson to McNary	beta	5.9×10^{-7}	--
Columbia River - Shore Mud	beta	$(0.15 \text{ to } 1.6) \times 10^{-4}$	+2
Raw Water - Operating Areas	beta	$(<0.005 \text{ to } 1.3) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	beta	9,000 to 27,000 μc/sec/reactor	--
		$(2.5 \text{ to } 5.6) \times 10^{-3}$	--
Reactor Effluent Retention Basins to River	alpha	<0.04 μc/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 µc/ml	Trend* Factor
Other Waters and Related Materials (contd.)			
I-131 in Farm Wastes to River	I-131	18 µc/day	--
		2.8×10^{-7}	--
I-131 in Columbia River - Hanford	I-131	9.4×10^{-8}	--
300 Area Pond Inlet	alpha	1.0×10^{-6}	-28
Atmospheric Pollution			
Gross Alpha Emitters	alpha	$(<0.4$ to $1.1) \times 10^{-14}$	--
Gross Dose Rate - Separations Areas	beta-gamma	0.4 to 5.7 mrad/day	
Gross Dose Rate - Residential Areas	beta-gamma	0.8 to 13.7 mrad/day	--
Active Particles - Separations Areas	beta	$(0.55$ to $1.1) \times 10^{-12}$	--
I-131 Separations Areas	I-131	$(0.5$ to $2.0) \times 10^{-13}$	-4
I-131 Separations Stacks	I-131	0.2 curie/day	-2
Ruthenium - Separations Stacks	Ru-103-106	<0.02 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.04 to 0.59 ptle/m^3	+2
Active Particles - Project	--	0.05 to 0.51 ptle/m^3	+2
Vegetation			
Environs of Separations Areas	iodine	$(<3$ to $5.7) \times 10^{-6}$ µc/gm	-2
Residential Areas	iodine	$(<3$ to $3.3) \times 10^{-6}$ µc/gm	--
Eastern Washington and Oregon	iodine	$<3 \times 10^{-6}$ µc/gm	--
Non-Volatile Beta Emitters Wash. and Ore.	beta	$(0.12$ to $4.0) \times 10^{-4}$ µc/gm	+2
Alpha Emitters - Separations Areas	alpha	$(<0.7$ to $2.4) \times 10^{-7}$ µc/gm	--

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

LABORATORIES AUXILIARIES

A total of 28 appropriation requests and 12 minor purchase orders were processed during the month. Five appropriation requests were approved for an expenditure of $ 284,351.

Radiographic testing of welds in construction materials for Project CG-558 continued. This project is nearly complete.

Assistance is being given to the Chemical Processing Department in the fabrication of a titanium heat exchanger. Examination of the titanium tubes disclosed numerous cracks. Replacement tubes will be ordered and examined before installation.

An ultrasonic testing method is being developed for the examination of Fly-ash tubing on the power house boilers. The main difficulty rests in the severe corrosion and erosion of the inside surfaces of the pipes. Successful radiographic examination has been demonstrated. However, a quicker more economical ultrasonic test would be desirable.

The program for testing zirconium process tubing was continued. Several special testing equipment pieces were ordered and applicable testing techniques were studied to provide for as complete an examination as possible.

The following schedule presents the status of HLO projects.

MONTHLY PROJECT REPORT

Project Number	Title	Using Component	Est. Total Project Cost	Authorization Information Amount - Date	Project Progress in Per Cent Design	Constr.	Scheduled Project Comp. Date	Remarks and Progress
GENERAL PLANT PROJECTS - FY 1956 (AEC 2-23X-56-L-2)								
CG-635	Redox Stack Particulate Sampler	Radiation Protection	$ 42,000	$ 40,000	Sch. 100 Act. 100	82 70	May 1, 1957	Construction continuing.
CG-664	350° C, Flow Loop Bldg. 314	Reactor and Fuels	$121,500	$121,500 May 11, 1956	Sch. 100 Act. 100	0 0	Aug. 1, 1957	Contract awarded for installation of De-Ionizing Equip. to start in 1/57. Methods of procurement and installation of remainder of equip. under study.
CG-671	Improved Calibrations Facility - 3745 Bldg.	Radiation Protection	$ 22,500	$ 22,500	Sch. 100 Act. 100	100 100	Oct. 2, 1956	Construction completed.
GENERAL PLANT PROJECTS - FY 1957 (AEC 2-28-57 N-2)								
CG-658	Shielded Personnel Monitoring Station	Physics and Instr.	$150,000	Pending Pending	Sch. 0 Act. 0	0 0	To be established	Project proposal awaiting AEC approval.
CG-680	Corrosion Testing Facilities 314 Bldg.	Reactor and Fuels	$171,000 (Inc. $31,000 Transferred Equipment)	$ 29,500 (interim author.) 9/24/56	Sch. 0 Act. 0	0 0	Design Jan. 24, 1957 Construction to be estab.	Preliminary designs and sketches being prepared. Design schedule being formulated.
CA-685	Alterations to 325 and 326 Bldgs.		$ 23,000	$ 23,000	Sch. 75 Act. 80	0 0	Aug. 15, 1957	Directive revised authorizing GE an additional $6,700 to negotiate 325 Bldg. elevator alterations
CA-700	Geological and Hydrological Wells	Chemical Research	$137,000	$137,000	Sch. 0 Act. 0	0 0	To be established	AEC Directive issued authorizing $137,000. USGS will be requested to drill wells.

MONTHLY PROJECT REPORT

Project Number	Title	Using Component	Est. Total Project Cost	Authorization Information Amount - Date	Project Progress in Per Cent Design	Constr.	Scheduled Project Comp. Date	Remarks and Progress
B-5772	High Level Exposure Facility Add. 141-H Bldg.	Biology Research	$ 26,000	Pending Pending	Sch. 0 Act. 0	0 0	To be established.	Project proposal being routed for approvals.
B-5776	Effluent Technology Laboratory	Chemical Research	$ 95,000	Pending Pending	Sch. 0 Act. 0	0 0	To be established.	Proposal prep. halted pending review of funds available for General Plant Projects.
A-00617	Ventilation Improvements 222-U Bldg.	Chemical Research	$ 73,000	Pending Pending	Sch. 0 Act. 0	0 0	To be established.	Project proposal being routed for approval.
None	Expansion of the 1706 KE Bldg.	Chemical Research	To be established	None as yet.	Sch. 0 Act. 0	0 0	To be determined.	Prelim. work on project proposal to be completed 11/1/56.
None	Plutonium Metallurgy Fac. Expansion 231-Z Bldg.	Research and Fuels	$347,000	None to date.	Sch. 0 Act. 0	0 0	To be established	Plant and Equip. Analysis Report submitted. Project Prop. 95% completed by CEO.
EQUIPMENT NOT INCLUDED IN CONSTR. PROJ. - AEC 9950								
CG-620	Melt Plant Modifications - 306 Bldg.	Reactor and Fuels	$143,000	$143,000 3/15/56	Sch. 90 Act. 35	0 0	May 31, 1957	Bids on furnace received and are being evaluated. Change in location to 306 Bldg. will reduce cost. Project proposal being revised. Revised design schedule to be prepared.
CG-660	Modifications and Additions to the Metallographic Cell 327 Bldg.	Reactor and Fuels	$135,000	$135,000	Sch. 36 Act. 43	0 0	Sept. 30, 1957	Bids recieved for metallograph. Additional information requested of vendors. Further design dependent on metallograph dimensions.

MONTHLY PROJECT REPORT

Project Number	Title	Using Component	Est. Total Project Cost	Authorization Information Amount - Date	Project Progress in Per Cent Design	Constr.	Scheduled Project Comp. Date	Remarks and Progress
CG-661	Additional Heat Generation Fac. 189-D Bldg.	Reactor and Fuels	Not determined	$ 22,400 (interim author.) 4/5/56	Prelim. Sch. 100 Act. 100	0 0	To be established.	Prelim. design completed pending AEC approval. Project proposal for constr. to be prepared.
CG-672	Monochromatic Neutron Beam Facility - Bldg. 105-KE	Physics and Instr.	$112,000	$112,000	Sch. 100 Act. 100	0 0	June 30, 1957	Design completed. Revised Proj. Proposal being prepared to extend comp. date. Bids received on major items. Cost estimate being prepared.
CG-681	Hanford Equipment in the E. T. R.	Reactor and Fuels	Not determined	$ 80,000 (interim author) 6/29/56	Sch. 12 Act. 18.9	N. A. N. A.	To be established.	Proj. Prop. being prepared for constr. and procurement funds. Phillips Petroleum officials have reviewed scope drawings.
CG-682	High Level Exam. and Cut-Off Cell 327 Bldg.	Reactor and Fuels	$355,000	$ 16,500	Sch. 34 Act. 60	0 0	15 months after author.	Scope changed: revised proj. proposal prepared requesting $30,500 for design.
Ca-695	Radio Telemetering Network	Physics and Instr.	$ 95,000	Pending Pending	Sch. 0 Act. 0	0 0	16 months after authorization.	Approval as "Equip. not Included in Constr. Proj." awaiting submission of financial plan by G. E.
LINE ITEMS - FY 1958								
B-57129	Critical Mass Laboratory	Physics and Instr.	$2,000,000 (rough est.)	None to date	Sch. 0 Act. 0	0 0	To be established.	Plant and Equip. Analysis Report being prepared. Project Proposal being written for design funds only, and will be ready for approval during November.

EMPLOYEE RELATIONS

At the end of October the staff of the Hanford Laboratories Operation totalled 1157 employees, including 468 exempt and 689 non-exempt personnel. Of the total exempt employees, 106 were acting in a supervisory capacity. There were 421 employees with college degrees, including 396 technical degrees as follows:

BS	MS	PhD
208	102	86

The Non-Exempt Personnel Development Program has been accepted by all HAPO departments and will be implemented effective January 1, 1957.

Technical Graduates on rotating assignments within the Laboratories increased from 23 to 24 and Technician Trainees increased from 9 to 21 during the month.

The permanent addressograph system was completed.

The quarterly report for distribution of salaries by levels and zones for all of Hanford Laboratories Operation exempt personnel was prepared and forwarded through channels.

The master upgrading listing for machinist journeymen at Hanford is now being maintained by HLO Specialist, Wage Administration.

The recruiting for secretaries and stenographers has been expanded to include business colleges in Oregon and Washington and general recruiting in Montana. The results have been favorable. The non-exempt employment and transfer status follows:

EMPLOYMENT - NON-EXEMPT

Requisitions open at end of month	49
Requisitions filled	20
Requisitions cancelled	0
Requisitions received	35
Applications considered	5
Active cases at end of month	40
New requests	21
Transfers effected *	24

* 17 of the 21 new requests have been discussed with the applicant.

A total of $155.00 was approved for 9 suggestion awards. Twenty suggestions were received, representing 3 suggestions per 100 eligible employees. This may be compared with 2.2 suggestions per 100 eligible employees during the month of September. Seven suggestions are currently pending board action and one is pending AEC approval.

HLO participation in the Employee Benefit Plans follows:

	September	October
Pension Plan	96.1%	97.0%
Insurance Plan	99.3	99.1
U. S. Savings Bonds	56.8	57.5
Savings Plan	8.2	8.5

Hanford Laboratories Operation currently has 214 employees subject to military service of which 90 are Reservists or National Guard members. 44 are technically trained or engineering personnel for whom deferments have been granted or are being processed and 80 are non-technical non-veterans of whom 16 are classified 1-A.

Technical recruiting and exempt transfer activities are summarized below. Recruiting efforts were increased primarily in connection with PhD personnel.

PhD Recruiting

	Visits to Richland				Offers			On The Roll
	Cases Considered	Invit. Extended	Visited	To Visit	Extended	Accepted	Open	
Electrical Engineering	1	1	1		1		1	
Metallurgy	1*							
Physics								1
Chemistry **	1	1	1		1		1	

* No HLO Interest
** Soil Chemist

BS/MS Experienced Recruiting

	Visits to Richland				Offers			On The Roll
	Cases Considered	Invit. Extended	Visited	To Visit	Extended	Accepted	Open	
Mech. Eng.	1	1	1		1	1		
Physics	2	1	1		1		1	
Math.	1	1	1		1	1		
Bus. Adm.	1	1		1				
Chemistry	1	1*						
Met. Eng.	1	1*						

* Candidates rejected invitation - had accepted other employment.

UNCL.

TRANSFER CASES - EXEMPT

Total Cases handled since 9-1-56	41
Initiated by employee	30
Initiated by management *	11
Active Cases at end of month	31
New Cases during month	10
Initiated by employee	5
Initiated by management *	5
Cases closed during month	7
Transfers effected within HLO	0
Transfers effected within HAPO	0
Transfers effected to other GE	2
Requests withdrawn	3
Termination	2

*Includes ROF's, transfers proposed by employee's management and requests from other GE departments.

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

Step-I

	No. Discussed	Answered Satisfactorily	Withdrawn	Answered unsatisfactorily-pending Step II	Discussed at Step II	Pending Time Limit
October						
Unit	1	1	0	0	0	*3
Non-unit	0	0	0	0	0	0
September						
Unit	8	2	1	1	4	0
Non-unit	0	0	0	0	0	0

Step-II

	No. Discussed	Step II Answers Given	Pending Step II Answers	Settled this Month	Pending Time Limit	Awaiting Council Action
October	0	0	0	1	**1	3
September	4	1	3	0	0	0

* Step I grievances which Council indicated a desire to discuss at Step II but not scheduled are considered settled at Step I after three months.

** Step II grievances which the Council formally indicated their intention to arbitrate but no further action taken are shown settled at Step II after three months.

DEL

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Unit	1	1	0	0	0	*3
Non-unit	0	0	0	0	0	0
September						
Unit	8	2	1	1	4	0
Non-unit	0	0	0	0	0	0

Step-II

	No. Discussed	Step II Answers Given	Pending Step II Answers	Settled this Month	Pending Time Limit	Awaiting Council Action
October	0	0	0	1	**1	3
September	4	1	3	0	0	0

* Step I grievances which Council indicated a desire to discuss at Step II but not scheduled are considered settled at Step I after three months.

** Step II grievances which the Council formally indicated their intention to arbitrate but no further action taken are shown settled at Step II after three months.

On October 18 a petition was received from the National Labor Relations Board for an election of the Regional Monitors. The date for the election is not yet scheduled.

HLO personnel worked a total of 203,226 employee hours during the month with no disabling injuries. There were 29 medical treatment cases for a frequency rate of 1.43 for October as compared with 2.58 for the previous month. There was one serious incident and five fires. One of the fires resulted in a loss of $175.00. A Safety Program Activities Council has been established for HLO to develop more effective safety activities.

Eight safety suggestions were evaluated with four being recommended for adoption.

There were nine security violations reported during October as compared with four during September. This figure is subject to revisions following determination of responsibility for each incident by Security Audit and Investigation Operation.

FINANCIAL

Budgets of FY 1957 operating costs for Level 3 components were established during October. The recasting of July and August costs to reflect the current organization was also completed. This data will be shown on cost reports for October.

Preparation of the FY 1957 Mid-Year Budget Review was started. Estimates of FY 1957 requirements for General Plant Projects and for Equipment Not Included in Construction Projects were submitted to Contract Administration. Tentative estimates of numbers of employees at the end of each quarter in each component were prepared.

Due to the shortage of funds for General Plant Projects and Equipment Not Included in Construction Projects special efforts were made to submit budget estimates of only the requirements having high priority. The order of priority for General Plant Projects was established. A summary of the Mid-Year Budget Review estimates is shown below:

	Mid-Year Review	Funds Presently Available
General Plant Projects	$ 1,097,000	$ 650,000
Equipment Not Included in Construction Projects	3,197,465	2,170,879

The gross payroll paid during the month was $587,016, of which $326,281 was paid to exempt employees and $260,735 to non-exempt employees. Payment to non-exempt employees represents four weeks. The gross payroll paid during September was $570,300.

A cost of living increase in pay for non-exempt employees (except Technical and Business Graduates) was announced October 26 and made effective October 29, 1956. The increase amounted to .59% of base pay and isolation pay.

Control custodians for reactor and other special materials submitted regular quarterly inventory reports as of September 30, 1956. All reports were reconciled with Property Accounting stock records and were in agreement.

A locator card file of uninstalled equipment was completed. This file provides a reference to location and description of equipment by HEW number.

The requirements for the HLO records control program were established, and an OPG on this subject was issued.

Efforts during the month were directed toward compiling standards data for some of the measurements suggested earlier.

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
CG Stevenson	10/1/56	None	Attend meeting of Wash. State Library Commission.		No
	10/16, 17, 18, 19, 20/56	Sandia Corporation Albuquerque, N. M.	Attend meeting of Technical Information Panel		Yes
RJ Anicetti EA Evans WE Roake	10/1, 2, 3/56	ORNL, Oak Ridge	Attend ceramic information meeting.	LM Doney	Yes
	10/4, 5/56	Mallinckrodt St. Louis, Mo.	Discuss uranium oxides.	JA Fellows	Yes
	10/4/56	ANP, Cincinnati	Discuss uranium oxides.	Dr. Arthur Foche	Yes
WA Snyder	10/1, 2/56	Oak Ridge Nat'l. Lab., Oak Ridge, Tenn.	To present a technical paper on graphite at Ceramics Information Meeting.	LM Doney	Yes
	10/3/56	KAPL - Schenectady, N. Y.	To attend radiation effects conference.	TF Fisher	No
	10/4, 5/56	Speer Carbon Co., St. Marys, Pa.	Discuss graphite Procurement.	WT Elston	No
RW Perkins	10/1, 3/56	Oak Ridge Nat'l. Lab., Oak Ridge, Tenn.	Discuss developments in gamma ray spectrometry and analytical chemistry at ORNL and ANL.	SA Reynolds	Yes
	10/4, 5/56	Argonne Nat'l. Lab., Lemont, Illinois	Same as above	JE Rose	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
MD Freshley	10/2, 5/56	GE, Schenectady, N. Y.	Attend conference on irradiation effects		No
		Aeroprojects, Philadelphia, Pa.	Discuss ultrasonic welding.	WC Potthoff	No
L.D Turner	10/3, 4/56	KAPL - Schenectady	Consultation on hot laboratories and radiation effects.	TJE Glasson	Yes
	10/8/56	National Metals Convention, Cleveland, Ohio	Attend National Metals Convention.		No
	10/9, 10/56	GE - ANP, Cincinnati, Ohio	Consultation on hot laboratories and radiation effects.	W Baxter	Yes
	10/11/56	ANL - Chicago, Ill.	Same as above.	R Goertz	Yes
*SH Bush RG Wheeler	10/3, 4, 5/56	KAPL - Schenectady	Consult on Hanford assistance program and present papers concerning radiation effects at intra-company symposium.	Cliff Weber	Yes
	*10/11, 12/56	KAPL - Schenectady, N. Y.	Consult on Hanford assistance program and attend intra-company meeting on fuel element technology.	Cliff Weber	Yes
	*10/8-10/56	Cleveland, Ohio	Attend ASM Metal Show.		No
JW Healy	10/4, 5, 6/56	Pacific Northwest Sewage & Industrial Wastes Association, Boise, Idaho	Attend meeting and present paper.		No
	10/11, 12/56	Analytical Chemistry & Bioassay, Los Alamos, N. Mex.	Present paper and participate in panel discussion.	M Milligan	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
*DC Kaulitz JE Minor	10/4, 5/56	ANL, Lemont, Illinois	Discuss uranium and plutonium alloy fabrication.	JF Schumer	Yes
	*10/5/56	Chicago, Ill.	Attend High Vacuum Symposium.		No
RB Socky	10/4-12/56	Republic Steel Co., Cleveland, Ohio	Evaluation of non-destructive test for stainless steel tubing.	C Farrow W Kesiner FA Meunier	No
		Brush Development Co., Cleveland, Ohio	Ultrasonic examination of zirconium.	Mr. Johnson	No
		National Metals Exposition	Testing equipment information.	Various equipment vendors	No
JH Rector	10/4-13/56	Commander Mfg. Co., Chicago, Illinois	Observe tapping equipment.	D Levenius	No
		ASM Meeting, Cleveland, Ohio	Attend ASM Meeting.		No
		Lodge & Shiply, Cincinnati, Ohio	Observe flow-turn equipment.	W Busch	No
		Cincinnati Milling, Cincinnati, Ohio	Observe hydro-spin and hydro-form equipment.	Mr. Janke	No
DW Rhodes PP Rowe	10/5/56	Wash. State College, Pullman, Wash.	Attend Thesis Committee meeting for PP Rowe.	Thesis Committee Personnel	No
JR McHenry	10/8-10/56	Univ. of Illinois, Champaign, Ill.	Attend 5th Annual Clay Conference.	RE Grim, Dept. of Geology. WF Bradley, Illinois State Geological Survey	No
	10/10-12/56	Univ. of Illinois	Visiting Department of Agronomy.	MB Russell, Head of Dept. of Agronomy	No
JM Nielsen	10/8, 9/56	Univ. of California, Berkeley, Calif.	Discuss special counting methods.	JG Hamilton A Ghiorso	Yes
	10/11, 12/56	Los Alamos Scientific Lab., Los Alamos, N. M.	Attend Analytical and Bioassay Conf.	MF Milligan	Yes

SECRET

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Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
CH Reynolds	10/8-12/56	Warner & Swasey Lucas Machine Co., Cincinnati Milling Mach. Co., Avey Machine Co. Cleveland & Cincinnati, Ohio	Machine Tool Exhibit at National Metal Exposition.		No
JJ Cadwell DC Kaulitz JE Minor	10/8-10/56	Cleveland, Ohio	Attend ASM Metal Show.		No
RE Peterson RG Wheeler	10/8-10/56	Radiation Lab., Univ. of Calif., Berkeley, Calif.	AEC Computer Symposium.	Sidney Fernbach	Yes
WH Reas	10/9-13/56	Oak Ridge Nat'l. Lab., Oak Ridge, Tennessee	Attend annual technical review of ORNL activities and programs.	FL Culler	Yes
JM Atwood	10/11,12/56	Argonne Nat'l. Lab., Chicago, Illinois	To attend Al Alloy Task Group Meeting.	NR Grant	Yes
	10/15/56	Brookhaven Nat'l. Lab., Long Island, N. Y.	To discuss organic coolant technology.	Miles McGoff	Yes
	10/16/56	Naval Research Lab., Washington, D. C.	Same as above.	RR Miller	No
	10/17/56	MSA Research Corp., Callery, Pa.	Same as above	JW Mausteller	No
	10/18/56	KAPL - Schenectady, N. Y.	Same as above.	TJE Glasson	Yes
	10/19/56	Monsanto Chemical Co., St. Louis, Mo.	Same as above.	HS Litzsinger	No

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
JJ Cadwell JE Minor	10/11,12/56	KAPL - Schenectady, N. Y.	Consult on Hanford assistance program and attend intra-company meeting on fuel element technology.	C Weber	Yes
RW Wirta	10/11,12/56	KAPL - Schenectady	Consult with KAPL Equip. Dev. personnel.	J Davidson	Yes
CA Bennett	10/12/56	11th Midwest Quality Control Conference	Invited speaker.	OA Kral,et al	No
	10/16/56	Wash. D.C. AEC Div. of Production Off. of Oper. & Anal.	Discussion of Economic Liaison.	WJ Devine FB Quackenboss AV Butterworth	Yes Yes
	10/17/56	Second Army-wide Conference Washington, D.C.	Invited speaker.	FG Dressel,et al	No
	10/18/56	Princeton Univ. Princeton, N. J.	Recruiting PhD's.	RN Meals,et al	No
	10/19/56	Argonne Nat'l. Lab. Enrico Fermi Inst. Chicago, Illinois	Consultation on project Bluenose	A Turkevich	Yes
LK Bustad	10/13-19/56	San Antonio, Texas Los Alamos, N. Mex.	Attend AVMA. Discuss studies with Dr. Lushbaugh.	--	--
	10/25/56	Seattle, Wash.	Attend lecture at Univ. of Washington.	LR Donaldson	No
WL Wyman	10/15/56	ANL, Lemont, Ill.	Develop information on equipment and procedures of welding.	CC Stone	Yes
	10/16/56	GE Lamp Wire & Phosphors Dept., Cleveland, Ohio	Same as above.	RG Carlson	No
	10/16/56	Taylor-Winfield Warren, Ohio	Same as above.	FH Cooper	No
	10/17/56	Raytheon Mfg., Waltham, Mass.	Same as above.	(Chief Engr.)	No

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
WL Wyman	10/18/56	New Rochelle Tool, New Rochelle, N. Y.	Develop information on equipment and procedures of welding.	WC Rudd	No
	10/18/56	Air Reduction Dev. Summit, N. J.	Same as above.	Mr. Sullivan	No
	10/19/56	Aero-Projects West Chester, Pa.	Same as above.	FB Jones	No
DW Pearce	10/15/56	Yale University New Haven, Conn.	Ph. D recruiting.	--	No
	10/17-19	Univ. of Illinois Champaign, Ill.			No
DJ Donahue	10/15-17/56	Div. of Reactor Development, U. S. AEC, Wash. D. C.	Attend Reactor Physics Planning Group Meeting.	IF Zartman	Yes
DE Wood	10/17-19/56	U. S. Naval Radiation Defense Lab., San Francisco, California	Attend AEC sponsored shielding symposium.	EP Cooper	Yes
WC Roesch	10/22-25/56	Brookhaven Nat'l. Lab., Upton, N. Y.	Attend Fifth Tech. Cooperation Instrumentation Conference.	JBH Kuper	Yes
PE Brown	10/22-25/56	Brookhaven Nat'l. Lab., Upton L. I., New York	Present paper at AEC Conf. on Instrumentation.	JBH Kuper	Yes
	10/29-30/56	Savannah River Plant, Augusta, Ga.	Conferring with personnel on In-Line Instrument Development.	CH Ice	Yes
	10/30-11/2/56	ORNL, Oak Ridge, Tenn.	Consultations on In-Line Instruments.	JW Landry	Yes

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
DG Foster, Jr. WJ Friesen BR Leonard, Jr EJ Seppi	10/22-23/56	MTR, Phillips Petroleum Co., Idaho Falls, Idaho	To discuss Neutron Cross-Section Program.	JE Evans	Yes
JA Berberet	10/22-24/56	Univ. of Texas Austin, Texas	Recruit Ph. D. 's.		No
	10/25-26/56	Rice University Houston, Texas	Recruit Ph. D. 's		No
CR Lagergren	10/22-23/56	ANL, Lemont, Ill.	Discuss mass spectrometer.	CM Stevens	Yes
	10/24-25/56	KAPL, Schenectady, New York	Same as above	TL Collins	Yes
	10/26-27/56	Univ. of Minnesota Minneapolis, Minn.	Same as above	Prof. AO Nier	No
HV Clukey	10/22/56	U. S. Bureau of Mines, Albany, Ore.	Terminate assistance in radiation protection.	AH Roberson	No
	10/23/56	Oregon Sanitary Authority, Portland, Oregon	CRAG	KH Spies	No
	10/23/56	U. S. Public Health Service, Portland, Oregon	CRAG	HC Clare	No
	10/24/56	Wash. Pollution Control Commission, Olympia	CRAG	EF Eldridge	No
	10/24/56	Wash. Dept. of Health Seattle, Washington	CRAG	EC Jensen	No
RE Rostenbach	10/24/56	Pollution Control Commission, St. of Wash., Olympia, Wn	To introduce HV Clukey who is taking over Columbia River Advisory Group work.	EF Eldridge	No
	10/24/56	Div. of Engineering & Sanitation, Wash. Dept. of Health, Seattle, Wash.	To introduce HV Clukey ------	EC Jensen	No

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Area
LF Kocher	10/25/56	Product Engineering Company	Concerning new film badge.	C Freeling	No
FB Quinlan	10/25/56	JC Ross Co., Seattle, Wash.	Obtain information on die sets for wafer fuel program.	Ted Hudi	No
RF Foster DG Watson PA Olson VH Smith FP Hungate RC Thompson	10/25-26	Seattle, Washington	Attend lecture at Univ. of Washington	LR Donaldson	--
HE Hanthorn	10/25-26	Seattle, Washington	Present speech to the Seattle Society of Professional Engineers.	--	No
AE Smith	10/26/56	Iowa State College, Ames, Iowa	B. S. & M. S. Recruiting trip.	--	No
RE Burns	10/29-31/56	Univ. of Iowa, Iowa City, Iowa	Ph. D. Recruiting trip.	--	No
JM Skarpelos	10/29/56	GE - San Jose, Calif.	Job interview.	FW Snell	No
PF Gast	10/29-30/56	AEC, Washington, D. C.	Meeting of General Advisory Committee.	UM Staebler WK Davis	Yes
RE Heineman	10/30-31/56	Mass. Inst. of Tech. Cambridge, Mass.	Recruit Ph. D. 's.		No

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
HH Huston	10/2/56	Congressional Appropriations Comm., Wash. D. C.	Inspect Plutonium Lab. facilities.	ID Thomas	Yes	200-W, 231
B Menki M Nash C Knessel	10/3/56	AEC, Washington, D. C.	Inspect Plutonium Lab. facilities.	TC Nelson	Yes	200-W, 231
MM Sandomire	10/4-5/56	U. S. Navy Radiological Defense Lab., San Francisco, Calif.	Discussion on beta and gamma counting problems and techniques.	CA Bennett LG Waters JA Merrill HR Helmholz DE Warner RE Connally	No	700, 713 300, 325 3702 100-F, 108-F 200-W, 222-S
S Slenning	10/8/56	Minneapolis-Honeywell Minneapolis, Minn.	Discuss temperature measuring device made by Minn. -Honeywell.	MK Milhollen	No	300, 306
RD Rowe	10/9/56	General Machinery Spokane, Wash.	Discuss technical difficulties on a deepwell turbine pump and design changes on the new splined shaft deepwell turbine pump.	AE Smith J Dunn	Yes	300, 326, 321
LJ Haight	10/9/56	Johnston Pump Co., Pasadena, Calif.				
(Dr.) ME Ensminger	10/10/56	Dept. of Animal Husbandry, WSC, Pullman, Wash.	Discuss current research at Animal Farm and present a seminar.	LK Bustad	No	100-F, 141-M
GF Quinn	10/11/56	AEC, Washington, D. C.	Observe experimental facilities.	OJ Wick	Yes	200-W, 231

Name	Dates of Visit	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
JL Powell	10/15/56	University of Oregon, Eugene, Oregon	Consultant	JE Faulkner	Yes	300, 326, 305-B
AR Schrodt	10/16/56	Walter Reed Research Institute, Wash. D. C.	Discuss Body Monitor and Low Level Counting.	WC Roesch JM Nielsen	Yes	300, 329
Lt. Cdr. NI Berlin Lt. Col C Hansen	10/16/56	AFSWP, Wash. D. C.	Discuss plutonium hazards and inhalation research.	JW Healy RC Thompson LK Bustad VH Smith	Yes	100-F, 108-F, 141-M, 141-S
			Discuss training for Air Force officers.	JW Healy	Yes	300, 3760 100-F, 108-F
AF Scott	10/16/56	AFSWP, Wash. D. C.	Discuss training for Air Force officers.	JW Healy	Yes	300, 3760 100-F, 108-F
(Dr.) RE Scott	10/16/56	Reed College, Portland, Oregon	Discuss inhalation studies.	DE Warner LK Bustad VH Smith	Yes	300, 3760 100-F, 108-F
BR Prentice CJ Walker EJ Schmidt	10/17-19/56	Nuclear System Design Study, APED, GE San Jose, Calif.	Nuclear System Design Study.	RW Benoliel FW Albaugh VR Cooper OF Hill RM Fryar LP Bupp	Yes	300, 328 100, 105KE, 1706 KER, 189 D, 1704 D, 200-E, Purex, 200-W, 234-5, 700, 762
A Lagani	10/22/56	KAPL, Schenectady, N. Y.	Discussion of analytical methods relative to KAPL program.	R Ko HJ Anderson	No	300, 325

Name	Dates of Visit	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
MC Lewis	10/22-23/56	Manag. Consul. Ser. Div. General Electric Co., New York	Discussion of Oper. Research problems.	CA Bennett PR McMurray WR Lewis JB Work RY Dean PM Thompson	No	300, 3760, 325, 327 700, 713
Comdr. EE Roberts	10/23/56	Military Liaison Committee, Wash. D. C.	Discuss inhalation studies.	DE Warner LK Bustad VH Smith	No	300, 3760 100-F, 108-F
Maj. RW Rodden	10/23/56	AFSWP, Wash. D. C.	Discuss inhalation studies.	Same as above	No	Same as above
WN Munster	10/23/56	Division of Production AEC, Wash. D. C.	Discussions on Res. & Dev. Program.	OF Hill	Yes	300, 328
K Rehwaldt	10/24/56	GE Supply Company Seattle, Washington	Discuss opening of Pasco Branch Store.	All Specialists Employee Benefits for HAPO	No	W-10, 1100
CS Flenning	10/25/56	Minneapolis-Honeywell Regulator Company	To discuss thermocouple mountings for sheath thermocouples.	WF Hall	Yes	300 Area
CA Gillespie	10/31/56	Measurement Services General Electric Schenectady, N. Y.	Discuss Hanford Laboratory measurements.	JP Holmes HA Paulsen ZE Carey	No	300, 3702, 3760

INVENTIONS OR DISCOVERIES

All persons 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 the period covered by this report 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	TITLE OF INVENTION OR DISCOVERY
W. V. Cummings, S. H. Bush, D. C. Kaulitz	"Universal Pole Figure Goniometer"
W V. Cummings, R. E. Field, D. C. Kaulitz	"High Resolution X-Ray Diffractometer"
H. R. Gardner	"A Macro Grain Size Technique for Uranium"
W. L. Wyman	"Fusion Welding, Crazing or Melting in a Vacuum, Using Cathode Rays as a Source of Heat"

H. M. Parker
Manager, Hanford Laboratories

END

DATE FILMED

8/12/92