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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT

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JULY, 1957

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Compiled By
Operation Managers

August 15, 1957

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

Date 5/2/93
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TABLE II. PERSONNEL STATUS CHANGES (1)
PROMOTIONS AND TRANSFERS

Date July 31, 1957

<u>Component</u>	<u>PROMOTIONS</u>		<u>EXEMPT TRANSFERS (2)</u>				<u>NON-EXEMPT TRANSFERS</u>	
	<u>Exempt</u>	<u>to Exempt</u>	<u>Non-Exempt</u>	<u>From</u>		<u>To</u>	<u>From</u>	<u>To</u>
				<u>Other</u>	<u>HLO</u>		<u>HLO</u>	<u>HLO</u>
				<u>HAPO</u>	<u>Other G.E.</u>	<u>HAPO</u>	<u>Other G.E.</u>	<u>HLO</u>
Chemical	1	0	4	1	0	0	0	2
Reactor & Fuels	2	0	8	1	0	0	0	5
Physics & Instr.	2	0	1	0	0	0	0	1
Biology	0	0	0	0	0	0	0	1
Operations Res. & Syn.	0	0	0	0	0	0	0	0
Radiation Protection	0	1	0	0	0	0	0	0
Laboratory Auxiliaries	0	0	2	1	0	0	0	2
Financial	0	0	1	0	0	0	0	0
Employee Relations	0	0	1	0	0	0	0	0
TOTAL	5	1	17	3	0	0	0	11
								2

(1) Data through 7/31/57

(2) Transfers within HLO not included

SUMMARYBUDGETS AND COSTS**DECLASSIFIED**

Starting with July business, a change was incorporated in the method of allocating HAPO general overhead to research and development and production. The method to be used in actual costing in FY-1958 was the method applied in compiling the FY-1958 Revised Budget; it is based on allocating to research and development a full share of general overhead costs. This is estimated to be 25% of direct costs.

A firm financial plan for FY-1958 is not expected until September. The preliminary financial plan (1) fails to provide equipment funds for 4000 Program*, (2) provides for only one-half of the funds required for 3000 Program Research and Development, and (3) does not provide funds for continuing work on Washington Designated Programs of Project "C" and Bluenose.

RESEARCH AND DEVELOPMENT1. Reactor and Fuels

Various uranium fuel materials are being scouted. Included are UC, UN, and the solid solutions UC-UN, UC-UO, UN-UO, and UC-UN-UO. Uranium carbide shows a very fast reaction rate with boiling water and thus appears to be of doubtful value in water cooled systems.

The first irradiated coaxial fuel element was dimensionally unchanged by exposure; the central uranium core operated above the alpha-beta transition temperature as planned.

A wafer type I and E fuel element irradiated in the MTR to 800 MWD/T at 70 kw/ft. also had no unfavorable dimensional changes. This type combines the merits of increased cooling surface with compartmentation to reduce tube blocking upon rupture.

Intolerably high gross volume expansions were observed in several U-Mg matrix fuel elements exposed in the MTR. The mechanism of this swelling phenomenon is under study. However, the experience virtually terminates the interest in this type of fuel.

It is well known that the tensile quality of metallic uranium falls rapidly under irradiation. We now know that this fall is practically complete at extremely low burnouts, 0.015 atom percent or less. The goal exposures in production or power reactors far exceed this. Thus, the significant factor in metal failure is closely tied to thermal cycling of an already embrittled piece. This puts a premium on continuous operation or controlled thermal cycling.

Co-extruded zirconium-uranium rods are now available for testing.

*Corrected in August.

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Conversion of the KER-1 loop to organic cooling in the manner planned is contraindicated by heat transfer problems; depleted fuel can be used as an expedient to get on with the work.

We are studying stored energy release from graphite irradiated here at 400° C and other samples at over 400° C in the MTR. The former show easier nuclear annealing; the opposite trend could be expected. However, this means that MTR test data will be conservative, if applied to Hanford conditions. We need more data at other exposures and in different flux patterns to understand the mechanisms.

In PRPR work, design criteria are 90% complete; Phase I detailed design is 53% complete.

The analog computer shows that the PRPR will be agreeably self-limiting for reactivity transients.

Our still preliminary cost comparisons of plutonium and U²³⁵ as fuels will be influenced by growth of U²³⁶ in second-hand uranium fuel; this feature does not influence present enriched uranium prices.

At AEC request a cursory examination was made of the costs of a new site integrating the PRPR, the Plutonium Fabrication Pilot Plant, and the Critical Mass Facility.

2. Chemical Research and Development

Purex oriented work included studies of:

- a. fission product-partitioning as a function of acidity and stage position.
- b. performance of new cartridges for the partition cycle extraction column; these gave 4 times basic design capacity.
- c. operation of annular plutonium cycle column, giving the same capacity factor.

Dingot metal dissolves slowly; the condition can be corrected by addition of carbon. This feature correlates with grain size. Dissolution rate can be made faster than for conventional ingot metal.

A one-shot procedure for isolating Ce¹⁴⁴ from Purex waste is now available.

Occasional recovery of Np from Purex second cycle wastes by n-octylamine can be achieved at low capital cost.

Evolution of oxides of nitrogen from waste tanks correlates with the presence of manganese. This should provide the understanding needed to control the evolution.

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A sensing element responsive to nitric acid and uranium concentrations was developed for the Redox streams.

The Darex and Zimflex processes will have tantalum, titanium or stainless steel exposed to fluorides and chlorides at various temperatures. We are studying corrosion for these combinations.

Scouting work on dissolution of Zircalloy clad fuel elements showed that a metallurgical bond between uranium and zirconium will not be troublesome.

Items in support of the PRP included:

- a. preparation of plutonium impregnated graphite cores.
- b. decontamination studies of the cryolite method of handling Pu-Al cores.
- c. restoration of Pu concentration in spent Pu-Al cores, by coaxing some aluminum out as a volatile chloride.
- d. catalytic stimulation of dissolution of PuO_2 or $\text{PuO}_2\text{-UO}_2$ mixtures with cesium.

Gamma ray spectrometry is now applied to river sediment samples. At McNary Dam typical concentration factors are 2500 for Zn^{65} and 3000 for Co^{60} .

A critical factor in evaluating fuel element characteristics is the conversion ratio. A ten-fold improvement in the accuracy of determination of the Pu content of irradiated uranium has been achieved. This will greatly improve the reliability of the conversion ratio, and hence the resolution of fuel characteristics.

3. Physics and Instrument

Buckling measurements on possible IPR lattices continued.

For CPD, the nuclear safety of a dissolver for 0.94% enriched uranium seemed to be compatible with a practical design.

For the PRP, PCTR tests of uranium oxide clusters in heavy water were made; perturbations through adding Pu-Al elements were also measured.

General physics got fission cross-sections of Pu^{241} over the range 0.02 to 2 e.v.

The principal achievement in atmospheric physics was the measurement of the vertical pattern of contamination as far as one mile from a source.

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Radiological physics, as part of a broad attack on actual exposures of the reproductive organs, measured such radiation exposures during X-ray examinations at the Kadlec Methodist Hospital.

4. Biology

Substantial work continued in the metabolism of zinc, strontium, iodine, cesium and plutonium and the effects of active particles.

Of particular interest is further work on the influence of calcium and inert strontium on uptake of Sr^{90} . Both these elements can stimulate rather than suppress the uptake. This is of vital national significance; had it not been for the isotopic dilution theory of Kornberg and associates, national plans for defense against Sr^{90} fall-out could have included precisely those steps that would increase the hazard.

TECHNICAL AND OTHER SERVICES

Three minor cases of plutonium deposition brought the total to 205.

Work on the 1957 Operation Alert continued until mid-July; preparations in the area of radiological defense are satisfactory.

Emission of I^{131} amounted to 12 curies per week. While this is beyond the formal limit, it is well known that summer emission carries a higher safety factor.

Two members of the Laboratories received exposures to radiation from plutonium close to the conventional weekly limit. Dosimetry for such cases is quite complex; the exposures are not damaging. Of more consequence is the impending approach of numbers of CPD personnel in plutonium work to the annual working limit of 3r. A very careful review of this situation is continuing. The problem is a matter of administrative consistency rather than of radiological significance; this follows because the complex of radiation includes soft components that cannot reach bone, and mostly do not reach the gonads. The geometry of the cases also makes them not truly "whole body" exposures, although they are so scored.

Design and construction on all major projects were on schedule or ahead.

The final draft of the Operation Pool report was completed; all other departments cooperated in review of portions bearing on their fields.

A matrix method of cost allocation was presented to appropriate financial personnel. Reports on statistical analyses included:

- a. rapid determination of hydrogen in fuel elements.
- b. effects of reactor variables on dimensional stability of fuels.

SUPPORTING FUNCTIONS**DECLASSIFIED**1. Financial

The FY 1957 Savings and Improvement Report for HLO was prepared during July and contained 30 items which represented estimated annual savings of \$260,000.

Funds available to HLO for charges against the fee during calendar year 1957 have been reallocated. The revised allocation reflects a decrease of \$900 from the amount originally allocated and includes provision for travel and living variation expense.

Physical inventories of uninstalled catalogued equipment and reconciliation of the physical counts are proceeding on schedule with Radiation Protection completed and Laboratory Auxiliaries, Biology and the Hot Semi-Works in various stages of completion.

(See also BUDGETS AND COSTS)

2. Employee Relations

At month's end, the staff of the Hanford Laboratories Operation totaled 1,171, including 499 exempt and 672 non-exempt employees.

At the July meeting of the Suggestion Board, 18 awards totaling \$155 were approved.

There were 41 medical treatment injuries this month with a frequency of 2.15 as compared to 2.04 for last month. Two unusual incidents were reported and resulted in no loss.

Twelve security violations indicated that the proposed improvements in this area have not yet borne fruit.

Five grievances were received during July, with three being settled satisfactorily at Step I.

There was no action on the three matters pending with H.A.M.T.C.

Manager
HANFORD LABORATORIES

HM Parker:lt

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATIONTECHNICAL ACTIVITIESA. FISSIONABLE MATERIALS - 2000 PROGRAM1. METALLURGY PROGRAM**DECLASSIFIED**Corrosion Studies

Hot Spot Failure of M-388. An M-388 slug suffered a hot spot failure during a recent production test. Metallographic examination showed no corrosive attack on the can but showed cracks in the core and uranium diffusion into the can.

The slug was Number 13 in tube 3572-D. The slugs in this tube were alternately charged M-368 clad and 1245 clad and were part of a lot irradiated under PT IP-43-A-84-MT. The failure occurred July 4, after about 400 MWD/T, and was classified as a hot spot failure. Examination at the Radiometallurgy facility disclosed a longitudinal "hot spot" type crack about 1-1/2 inches long and 4-1/2 inches from the cap of the nine-inch slug. The can was swollen on most of the slug length. Water, undercutting between the can and the uranium, had reacted with the uranium to form oxide after the initial rupture. The slug was sectioned at the point of rupture and at a point about an inch from the cap end. The section at the point of rupture contained radial cracks extending outward from the core. Less extensive cracking was noted on the wafer cut near the end of the slug.

Corrosion of Irradiated Uranium in MIPB (RM-171). The twenty-one-day corrosion test of a 3-1/2 year old, 520 MWD/T, irradiated uranium sample in MIPB at 400 C and less than 300 psi pressure was completed. This piece has been previously tested for four days (90 hours) under the same conditions without showing any sign of corrosive attack. After 10-1/2 days (14-1/2 days total) the MIPB solution was renewed and the sample showed no corrosion. After 21 days (25 days total) the sample exhibited the characteristic signs of uranium carbide formation. The cleaned sample showed a decrease of about 0.15 inch in all dimensions. When cut, the cross section showed a metallic surface with a granular structure. Based on this test, the rate of reaction of irradiated uranium with MIPB is comparable with that of unirradiated uranium.

Radiometallurgical Examinations

Coaxial Fuel Element Examination (GEH-4-15)(RM-175). Dimensions, hardness, and metallography have been obtained from the wafer sectioned from the center of the coaxial fuel element (GEH-4-15). A decrease from pre-irradiated diameter measurements was noted in both the outer and inner cylinders. The diameter of the outer cylinder decreased 0.005 inch OD and 0.001 inch ID. The inner cylinder diameter decreased 0.004 inch OD and 0.006 inch ID. Metallography and hardness data indicate that the

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inner cylinder operated in a temperature range of 750 to 850 C. The data also indicate that the outer cylinder operated at temperatures under 550 C with the exception of a ring, approximately 100 mils thick, around the inside edge of the cylinder. The uranium in this ring area probably operated in the high alpha or low beta phase.

Post-Irradiation Annealing Studies of Uranium. Density measurements have been obtained from a sample of irradiated uranium (618 MWD/T) which was annealed at 800 C for two hours. A heating and cooling rate of 10 C/hr was used above 600 C. The annealing caused a 0.4 percent decrease in density (18.831 to 18.775 gm/ml).

Factorial UO₂ Capsule Experiment. Inert gases were collected from 16 MTR irradiated, Zircaloy-2 capsules which were filled with UO₂ of various packing densities. The gas samples have been submitted to the Analytical Laboratory. The UO₂ samples will be impregnated with gelatin prior to sectioning and examining the interior of each capsule.

Basic Metallurgy Studies

Annealing of Radiation Damage in Molybdenum. Molybdenum and zirconium are being studied by x-ray diffraction after irradiation to improve the basic understanding of irradiation damage in metals. Low temperature (100 to 200 C) annealing studies of irradiated molybdenum are in progress with percent change in lattice parameter with time at a given temperature used as a measure of the rate of damage removal. The samples being investigated have been exposed to integrated fast neutron fluxes in the range of 6.5×10^{16} to 6.5×10^{18} nvt. The rate of damage recovery has been studied at two temperatures, 100 and 135 C. The 100 C anneals have been carried out to 300 hours. Two samples irradiated to low exposures showed no change. This is probably due to the fact that any damage removable by a low temperature anneal has doubtless disappeared at room temperature since these specimens were discharged nearly two years ago. The other samples (with exposures of 2.8×10^{18} , 6.5×10^{18} , and 6.7×10^{18} nvt) show a decrease in lattice parameter on annealing which is linear with log time up to 100 hours. In these samples approximately 25 percent of the total lattice expansion due to irradiation is now removed. Three samples have been annealed at 135 C for a total time of seven hours. At this time it appears that the slope of the annealing curves at 100 C is less than those for 135 C by a factor of 0.75.

Effect of Irradiation on Depleted Uranium Containing 0.028 Percent U-235. The design of advanced fuel elements depends upon some knowledge of the effects of irradiation on the significant mechanical and physical properties. A program has been followed to obtain this information for uranium.

During the past month two tensile specimens of depleted uranium (0.028 percent U-235) that were irradiated one operating cycle in the A-21-NW position of the MTR were removed from NaK containing capsules and tested at room temperature in the Radiometallurgy laboratory. The specimens exhibited no visual effects of irradiation such as surface distortion, corrosion,

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or warpage. Data indicate that beta heat-treated uranium suffers loss of ductility at extremely low burnup (0.00027 a/o burnup in this material is approximately 6×10^{17} nvt equivalent natural uranium exposure). The ultimate strength is increased slightly and the yield strength is appreciably increased. These data are in qualitative agreement with the results of low exposures of natural uranium specimens (10^{16} and 10^{17} nvt). The end sections of these specimens are being sectioned for hardness and metallography.

Irradiation Effects in Structural Materials. Mechanical property data for irradiated specimens of projected structural metals are necessary in establishing material limitations and optimum conditions for reactor service. A number of potential structural materials for which very limited or no data are available have been prepared for irradiation in a HAP0 reactor. An initial charge of six capsules containing a total of 25 sheet specimens of Zircaloy-2, Zircaloy-3, M-388, M-257 (aluminum alloy), AM-350 (high strength stainless steel), HK-31A-H24, and A-3XA-0 (magnesium alloy) has been exposed for a period of approximately three weeks in the KE magazine facility. The temperature of the steel specimens was monitored throughout the irradiation using a 24 ga Cr/Al thermocouple. At equilibrium full power the temperature varied between 98 and 102 C. The capsules were discharged shortly after reactor shutdown and handled satisfactorily with 10-foot tongs in air. The specimens are temporarily stored awaiting shipment to the 326 Building.

Uranium Quality Studies. In order to determine the quality of the uranium metal which may be used for the various production tests, several metallurgical studies were under way, as follows:

High silicon, high carbon uranium cores were centrifugally cast at FMPC. These were examined metallographically for structural soundness and grain appearance. The alloys investigated were of the following compositions: 1880 ppm Si - 339 ppm C, 1360 ppm Si - 284 ppm C, 990 ppm Si - 839 ppm C, and 110 ppm Si - 1103 ppm C. The alloy containing 110 ppm Si had an extremely large grain size (0.750 mm) even though it contained over 1000 ppm C. The remaining alloys containing near or in excess of 1000 ppm Si were of comparable grain size (0.150 mm). A large number of microcracks (about 40 per cm^2) were observed in the high carbon specimens. This unsoundness is apparently independent of silicon content. The distribution of carbides and silicides was random with the exception of the alloy containing 1880 ppm Si. In this specimen the silicides segregated and outlined the gamma grains. The hardness of the specimens varied linearly with the total alloy content.

A series of five uranium-carbon alloys were vacuum cast for dissolution rate studies by Chemical Research Operation. The carbon contents varied from 148 to 1570 ppm. Although the variation of grain size with carbon content in the as-cast state was not pronounced, a definite variation existed for the as-beta-heat-treated state. This relationship may be expressed as a power function. Dissolution rate studies using these specimens and standard production ingot and dingot uranium reveal that a plot of dissolution rate with carbon content contains a large amount of

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scatter; however, an excellent fit is obtained when dissolution rate is plotted against grain size. The discrepancy in the two plots is undoubtedly due to the difference in fabrication history between the cast specimens and the standard production uranium.

A study is being conducted to determine the reaction layers that occur when uranium is heat-treated in lead and salt baths. A $3/4 \times 3/4 \times 1/4$ -inch uranium specimen was treated in a salt bath consisting of 46 percent lithium carbonate and 54 percent potassium carbonate for two minutes at 730 C. Microscopic examination revealed a black carbonaceous layer clinging to the specimen. There was also a thin reaction layer between the black layer and the uranium. This layer was grey in color and hard and friable, although the bond between it and the uranium appeared to be strong. These layers prevented reactions between uranium and lead from occurring when the specimens were subsequently dipped in a 500 degree lead bath for 1300 seconds.

Tests were also carried out to study the rate of reaction between lead and uranium. Uranium specimens, of the same dimensions as described in the preceding paragraph, were prepared by grinding on 600-A silicon carbide paper to provide a smooth, oxide-free surface. Upon removal from the lead bath, each specimen was found to be encased in a Pb-U shell. This shell increased in thickness as the time in the bath increased. The microstructure of the case appeared to consist of UPb₃ particles in a eutectic of Pb-UPb₃. The relative amount of UPb₃ decreased as the distance from the uranium reaction layer interface increased.

New Fuel Element Development

Cold Closure Fuel Elements. Pre-irradiation tests and evaluation of the metallurgical quality of 175 cold closure fuel elements, prepared for in-pile irradiation, were completed the latter part of July. Autoclave testing is now in progress, which will be followed by pre-irradiation measurements, subsequent to shipping these fuel elements to reactor areas for production testing. A test proposal has been issued; the technical supporting document will be issued during the next two weeks.

Self-Supporting Fuel Elements. Fuel elements with supports attached to the fuel element jacket are designed to accurately position fuel elements in smooth bore process tubes. This method of fuel element support is designed to overcome some of the faults of the present system of supporting fuel elements. A total of four tubes of fuel elements, 32 elements per tube, with supports attached were fabricated and made ready for reactor charging under PT-84-A. Four more tubes of 32 fuel elements per tube will be required to complete the requirements for fuel elements for PT-84-A. These fuel elements are now being fabricated. A nondestructive test was developed to determine the adherent qualities of the supports on the self-supported fuel elements. A shearing force of 115 pounds was applied to each end of the supports parallel with its axis. This, as well as the usual final inspection tests, was applied to the self-supported fuel elements for PT-84-A.

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Coaxial Tube Fuel Element. The coaxial tube fuel element is of interest for reactor application because it offers promise of having the increased split failure resistance of a large inner diameter cored element but without the accompanying reactivity deficiency. A specimen of this design has been irradiated in the MTR at 70-75 kw/ft to 200 MWD/T (one reactor cycle) as a heat transfer experiment. The post-irradiation examination has revealed the following information: the dimensions of the specimen were essentially unchanged by the irradiation. Hardness measurements indicate that the minimum temperature of the central piece was at least 660 C. Thus, the central piece operated as beta uranium, or gamma uranium, or some of each. The hardness measurements showed no discontinuity. The calculated temperature drop across the inner piece was 80 C. Thus, beta phase (only) operation could have occurred. The columnar grain structure characteristic of beta phase operation was not found. However, there was no alpha-beta phase boundary in the central tube coaxial element so that this difference may be the cause of the absence of columnar grains.

The grain size in the central piece was approximately 0.1 mm except for a thin (0.006") skin of 0.02 mm grains on the inner surface. A similar fine-grained skin was present on the inner surface of the outer tube. Also observed in the central piece was a fine precipitate which delineates a "ghost" structure which probably corresponds to the beta or gamma phase grain boundaries which existed during operation.

A further observation of interest is that bumps developed on the outer surface of the inner tube-bumps similar to those observed on large-grained low temperature irradiated regular Hanford fuel elements.

Four-Rod Cluster Fuel Element. Approximately 22 pounds of co-extruded zirconium alloy clad uranium rod was received from Nuclear Metals, Inc., as part of a program to develop rod fuel material for four-rod cluster fuel elements to be charged into KER loop facilities. This was the second allotment received bringing the total weight to 50 pounds. The new allotment contained material which was fabricated with integral end caps. This material was radiographed to determine the amount of feathering of the uranium into the Zircaloy-2 end caps. Radiographs showed that in all cases uranium penetrated into the end plug the maximum about 1-1/2" and the minimum 5/8", but there appeared to be sufficient zirconium end plug remaining for protection. In one place a small uranium inclusion did extend up between the can wall and the end plug. Variation in the cladding thickness was noted.

Material which did not have integral end caps was bored out and Zircaloy-2 end plugs welded into the cladding. Both chemical analysis and x-ray examination showed that where uranium was completely removed from the cladding around the weld area no uranium was detected in the weld. Electrolytic etching with aqua regia of the weld area before welding proved a satisfactory method of insuring a clean surface. With material not chemically cleaned, chemical analysis showed the weld to contain five percent uranium.

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Sections of the co-extruded material were heat treated and micrographs made. One section was beta-treated at 670 C for ten minutes. Such treatment resulted in a beta grain size of 0.15 mm. Another section was alpha-treated at 655-660 C for ten minutes resulting in an alpha grain size of 0.040 mm. Due to the method of fabrication a great deal of orientation is expected which will require the material to be beta heat-treated. Effects of this heat treatment on the bond has not yet been determined.

Seven-Rod Cluster Fuel Element For ETR 3 x 3 Facility. Seven-rod cluster fuel elements are to be charged into the 3 x 3 facility of the ETR early next year as part of a program to develop a fuel element capable of operating at high temperature. Components for these fuel elements were designed and ordered during the past month. Because of space considerations of the 3 x 3 facility, a smaller version of the present seven-rod cluster fuel element had to be designed. The spider arrangement consists of a split ring 2.000 inches OD, holding seven 304 stainless steel clad fuel rods in a similar pattern to the present fuel element. The natural uranium rods are 0.460 inch OD, slip fitted into 20-mil, 0.500 OD, 304 stainless steel jackets and welded to 304 stainless steel end caps by the inert arc welding process. These fuel elements are scheduled to be ready for charging the second week of September 1957. Four fuel elements will be required.

Heat transfer calculations have been completed for seven-rod cluster fuel elements operating at design conditions of the 3 x 3 facility of the ETR. These calculations show that at the estimated specific power of 120 kw/ft a core temperature of 590 C will exist. Maximum jacket surface temperature will be approximately 370 C. Localized boiling could occur at this temperature so new calculations will have to be made when firm operational data are available.

I & E Wafer Element Irradiation in the MTR. The I & E wafer element is of interest for present and future HAPO application because the increased surface area permits higher power operation and the wafer feature provides failure safety in a hot water environment. A specimen of this design was irradiated in the MTR to 800 MWD/T at 70 kw/ft and has been returned to HAPO for examination. It was found that several of the wafers had shifted position, but it was also noted that the specimen had been dropped and the mechanical damage was such that one would expect the shifting to occur. Longitudinal and transverse sectioning has revealed nothing unusual except for a small degree of separation of wafers near one end of the element.

K-Through-Hole Irradiation of Seven-Rod Cluster Fuel Element. A basket assembly containing two seven-rod cluster fuel elements was discharged from the KE through-hole facility after 1000 MWD/T. Operational data showed a successful irradiation. These fuel elements will be examined by Radiometallurgy for warpage, growth, and swelling. A burnup analysis will also be made to determine accurate exposure data. This data will also help correlate data taken at a previous test performed at the 305 test reactor.

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A new test has been designed to be charged into a K-through hole facility. The purpose of this test will be to determine the operational stability of cluster fuel elements at higher specific power and longer burnups than previously accomplished. A specific power of 100 kw/ft and an irradiation exposure of 2500 MWD/T is desired. Power measurement will be taken during the test by measuring a temperature differential across the test assembly. A reduction of coolant flow may be necessary to achieve a large temperature differential.

The test assembly will consist of two 20-inch baskets each containing two seven-rod cluster fuel elements made of 1.3 percent enriched uranium. These test assemblies with appropriate instrumentation are planned to be charged into a K-through hole facility in about six weeks.

Seven-Rod Cluster Fuel Element - 305 Test Reactor Experiment Of Seven-Rod Cluster Fuel Elements. A test assembly containing three seven-rod cluster fuel elements within a zirconium KER size process tube was placed into the 305 test reactor for the purpose of determining the relative power generation factor. Although the foils have not been calibrated, an estimate of this factor for KER high temperature operation of seven-rod clusters is 0.959. A formal report will be distributed by Testing Methods Operation.

Diffusion Barriers For Aluminum Jacketed Uranium Fuel Elements. More emphasis was placed on aluminum jacketed uranium as a candidate fuel for the MIPB cooled KER-1 loop because it is doubted that the hydrogen pressure and water content of the KER-1 loop coolant will be low enough to prevent hydrogen permeation and excessive corrosion of magnesium jacketed fuel. Both the bonded and unbonded type of diffusion barriers were considered. A diffusion test was started July 19, in which one hot press nickel bonded, one cold press nickel bonded, and one Al-Si bonded were held at 425 C under a nitrogen pressure of 1500 psi. This test will continue for one month. The purpose of the pressure is to simulate reactor coolant pressure conditions and cause intimate contact between the jacket components and the fuel. Work was started to determine suitable methods of preparing aluminum jacketed elements with graphite or uranium carbide diffusion barriers.

U-Mg Fuel Material. U-Mg fuel material is being studied as a candidate for high exposure use, particularly with an organic coolant. A HAPO-size U-Mg fuel element containing 35 v/o enriched uranium in a Mg 1.5 v/o Si alloy matrix, and five KAPL-prepared, powder metallurgy U-Mg fuel pieces containing about 62 v/o natural uranium in a pure magnesium matrix have completed their irradiation at the MTR and their post-irradiation examination at the HAPO Radiometallurgy facility. Irradiation of these materials appears to cause swelling which is a function of the exposure of the fuel material. The swelling observed is large and no apparent mechanism for the swelling has been deduced from the post-irradiation examination. Examination of the U-Mg fuel material by electron microscopy is planned to determine if sub-microscopic porosity in the U fuel has developed during irradiation to cause the swelling. The swelling data on the U-Mg fuels revealed volume increase up to 10.2 percent for 3000 MWD/T exposure.

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Fuel Evaluation. The GEH-4 fuel testing facility at the MTR provides Hanford with a tool to investigate fuel elements of new and improved Hanford design under a variety of operating conditions. The GEH-4-19-E irradiation, a Zircaloy clad cluster fuel element, was discharged the last of June because of a severe leak which had developed in the head of the in-reactor pressure tube. The reactor had operated for about one full day of cycle 89 before the leak was discovered. The fuel sample was still in good condition and was placed in the MTR canal on standby for reinsertion at a later date. At the beginning of cycle 90, July 15, a replacement fuel sample for the ruptured GEH-4-20-G, UO_2 I & E aluminum clad irradiation was inserted. This replacement fuel slug, which essentially was identical to 4-20-G was inserted as GEH-4-21-G and has been scheduled for one reactor cycle.

Fuel Elements for the KER-1 Organic Cooled Loop. An upward revision by a factor greater than four in the anticipated film drop between the jacket and coolant of the KER-1 Loop fuel loading has necessitated a change in test element design. It appears that the most information will be obtained in tests if the necessary reduction in power per foot of element is made by using depleted uranium instead of making drastic changes in fuel geometry. Accordingly, action was taken to obtain a quota for the equivalent of several tube loadings of depleted metal. If this metal is used, standard diameter fuel elements without a core may be tested in the KER-1 loop.

ORA-1 Loop Testing of Fuel Element Materials. A cluster of five simulated fuel element types has been discharged after 400 hours exposure at an average MIPB temperature of 280-300 C. The fuel element consisting of magnesium clad uranium was found to have ruptured. The mechanism of rupture is not known; however, access of organic to the uranium had converted a large amount of the uranium to uranium monocarbide. Metallographic examination of the uranium core revealed that the inner portion was uranium metal and the outer portion was uranium carbide with some uranium hydride existing at the interface of the carbide and metal phases. Possible mechanisms of the failure are (1) a defective Mg jacket, (2) uranium hydride formation by diffusion of hydrogen from the organic to the uranium through the Mg clad with sufficient swelling to rupture the clad, and (3) corrosion of the Mg clad by water in the organic medium.

The brass clad test element appeared satisfactory from external appearances. Metallographic examination of the clad indicated that dezincification or internal oxidation had occurred. No hydride was observed in the uranium core nor was there evidence of intermetallic formations such as had been observed between brass and uranium in autoclave tests.

The iron clad test element appeared satisfactory from external appearances. Metallographic examination of the core revealed the presence of a few small U-hydride "needles" at the clad-core interface.

Interdiffusion had occurred between the uranium core and the unbonded aluminum clad as evidenced by blistering under the clad surface. Some evidence of the thermal-ratcheting effect noted earlier with Mg clad uranium was also noted with the unbonded aluminum clad test piece.

Metallographic examination of the Al-Si bonded aluminum clad uranium piece revealed possible compound layer thickening and cracking. There was no blistering or thermal-ratcheting observed.

Concentric Cylindrical Fuel Element Components. Preliminary experiments have been made to determine the feasibility of making internally ribbed tubing by a swaging process. This tubing is to be considered as a self-supporting jacketing material for concentric cylinder type fuel elements. The production of external ribbing will also be attempted, but this will be done on a turk's head rather than a swage.

The first attempt to produce internally ribbed tubing was done by swaging 2S aluminum over a floating grooved mandrel. The mandrel was 0.927 inch in diameter and had four grooves cut lengthwise in its surface. The grooves were cut 60 mils deep by 50 mils wide at the bottom and 60 mils wide at the top. The four corners of the grooves were rounded to facilitate the flow of metal into the groove. Swaging dies with a 1.00 inch bore and a five percent side relief were used in conjunction with this mandrel. Aluminum (2S) tubing 1.100 inches OD with a 62-mil wall was used as the starting stock and this was swaged in one pass directly onto the mandrel. Acceptable straight ribbed tubing was produced on the #8 swage after a few unsuccessful attempts. Four-foot lengths of tubing with uniform dimensions and straight ribs have been made.

Design work is under way to produce externally ribbed tubing with a turk's head. In this case the four rollers of the turk's head would contain the grooves for the rib-forming operation. A mandrel, a simple type right cylinder, will be used to prevent collapsing of the tube as it enters the rolls.

Buckling of Long Vertical Fuel Elements. Vertical fuel elements which depend upon their jacketing material for rigidity may buckle under their own weight if they are supported at the bottom. Elastic calculations are completed for the buckling of self-loaded columns with built-in and simply supported ends. The equations developed for the above cases were also applied to the analogous problem of the buckling of gas accelerated control rods.

The plastic and creep buckling of columns is now being studied in order to determine the effects of jacket material properties on the mechanical stability of fuel element columns.

Stresses in Internally Heated Pressure Piping. The pressure piping in the experimental facilities of ETR encounter severe gamma heating. Because of this heating, the combined effects of pressure and thermal stresses must be considered. Formulas have been developed which give the tube thickness for a given pressure and heat generation that minimize the maximum stress. The equations have been programmed on the IBM 650 digital computer so that various cases may be evaluated by referring to series of graphs.

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Emissivity Data of Uranium Oxide. Two basic problems were encountered in determining the emissivity of a composite jacket and uranium oxide system: (1) developing a method of surrounding a tungsten heating rod with uranium oxide, and (2) fabricating a pyrometer with which to measure accurately the temperature of the uranium oxide.

During the past month a method of surrounding uranium dioxide around the tungsten was developed. Uranium dioxide was packed around the tungsten rod contained in a length of rubber hose and hydrostatically pressed at 40,000 psi. A compact was achieved which was cylindrical and of uniform density. Spring back of the UO_2 was noticed which was sufficient to allow the tungsten rod to expand upon heating without cracking the UO_2 covering. This geometry was heated and sintered to a 93 percent theoretical density. Temperatures attained were estimated to be in the range of 1800-2000 C.

Service Work. The #1A swage has been used for applying over a hundred feet of metal sheathing to thermocouple leads. New pointing dies are being made for this machine so that thermocouple beads and closures may be made after the sheathing has been applied.

The large and small salt bath furnaces were used continuously for about eight days to heat treat dies and uranium test pieces.

The vacuum annealing furnace has been used, for ten days, to outgas uranium, anneal zirconium, and to evacuate extrusion capsules.

The forge has been used as a crusher in preparing cobalt powder for the CoAl sintered alloys.

2. REACTOR PROGRAM

Coolant Systems Development

Single Pass Coolant Development. One group of tests to determine the effect of the variations on pH on corrosivity of process water has been completed. The evaluation of the data from these tests shows that a reduction in pH from 7.65 to 7.0 decreases slug jacket corrosion rates by a factor of three to four. The evaluation is being reported in a separate report⁽¹⁾. Another test to determine the effect of lower pH (6.0 to 7.0) on corrosion of fuel element jackets is continuing. The six central zone tubes supplied with water from the 1706-KE Semiworks operated at an average outlet temperature of 95 to 105 C during the month. Four tubes were discharged on July 8, but as yet the data have not been received.

As a result of a failure of the steam condensate line, the mockup tubes are inoperative. It is estimated that they will be in use in another month.

(1) HW-51053, "Corrosion of Aluminum Slug Jackets in pH 7.0 Process Water," R. B. Richman, 6/18/57.

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The latest data from corrosion of M-388 alloy and 1245 alloy slug jackets have been collected and are being analyzed by the Statistics Operation. The general equation used has the form⁽²⁾:

$$\text{Log (Corrosion Rate)} = A + \frac{B}{\text{local water temp.}} + C (\text{slug power}) + D (\text{pH})$$

Tests in High Temperature Recirculating Water. Various fuel elements of new or improved design including the four-rod cluster, Elephant and Cow slugs have been tested in ELMO-7 loop at 300 C and a pH of 4.5. After 950 hours, an examination revealed no significant defects except for bending of support rails on the Elephant and Cow slugs. This may be a result of the high temperature of operation and may not be serious at temperatures less than 250 C. Examination of the effect of flow on Elephant and Cow slugs has been completed using the polariscope. The test showed that the flow was greatly disturbed under the rails indicating a very probable hot spot.

The canned motor pump was installed in ELMO-2 to replace the original mechanical seal pump. The mechanical seal pump was unsatisfactory because severe leakage caused numerous shutdowns. During the shutdown, revisions were made to adapt the loop for additional corrosion tests. The next series of tests will be planned to show data for evaluation of corrosion of aluminum and attack of sensitized stainless steel at a pH of 4.0.

Data from the ELMO-5 loop show that corrosion rates of stainless steel and carbon steel are negligible in water of 290 C at a pH of 8.5 to 9.5.

Some new aluminum alloys obtained from Alcoa are being exposed in ELMO-6 loop. These alloys are some specifically developed to resist intergranular corrosion even at very high temperatures and to give much lower corrosion rates at the temperatures of interest (250-300 C). The alloys contain nickel (1-4 percent), copper (0-1 percent), iron (0.3-1.4 percent), and small amounts of titanium or beryllium. One of the alloys is similar to the A203X except that it contains less nickel.

The new pump for ELMO-3 slug-rupturing loop is now at Hanford. This is a canned motor pump made by Byron-Jackson Pump Company and delivers 100 gpm at 180-ft head. A larger pump, 150 gpm at 500-ft head, will be shipped by August 1.

KER Loops - Recirculating High Temperature Water. Loop KER-2 has been operating at 180 C with pH 4.5 w/H₃PO₄. The charge of 1.44" cored slugs is scheduled for discharge July 26, 1957, and a test with Cow slugs at 180 C and pH 4.5 will be started. Cow slugs will also be charged into Loop KER-4 if the loop has been functionally checked out by the next outage. The test conditions will be 200 C and a pH of 4.5 with H₃PO₄.

(2) HW-44996, "In-Reactor Corrosion in Aluminum," C. Groot and R. E. Wilson, 2/18/57.

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Loop KER-3 was charged with cored 1.44" diameter self-supporting slugs as part of its Phase II operation. It is operating at an outlet temperature of 180 C and a pH of 6-7 with high purity water. The loop is scheduled for discharge in the middle of August and will be recharged with four-rod cluster slugs. These will be operated at 240 C outlet and a pH of 6-7 with high purity water.

A spot water sample was taken of Loop KER-4 in June for radioanalysis. Results from this determination indicate that over 70 percent of the loop activity (total beta count) comes from four isotopes: Na^{24} , Cu^{64} , Si^{31} , and Ag^{110} . Arrangements have been completed with the Analytical Laboratories Operation to do a radioanalysis on a routine basis beginning early in August for each of the water loops.

A study is under way to determine the means by which each of these major contributors to loop activity enter the system. The source of silver is not known with certainty. Silicon, copper, and sodium in all likelihood enter with the loop makeup water. Some copper probably goes into solution from strainer parts.

Pilot Plant and In-Reactor Studies of Recirculating Organic Coolant. ORA-1 is the flow laboratory corrosion loop. Five fuel elements with uranium metal cores were discharged from this loop after about 400 hours exposure at 270 C. The iron-clad and brass-clad elements were in excellent condition. A 2S aluminum-clad, AlSi bonded element was in equally good condition. An unbonded 2S aluminum clad element was full of small bumps, presumably resulting from Al-U interdiffusion. The magnesium clad element was considerably pitted. It had ruptured and the uranium had swelled to about 1-1/2 times its original volume. It is not known if the rupture was a result of can penetration or if the uranium swelled and split the can because of hydrogen diffusion through the magnesium.

The tests in the ORA-2 loop to determine the effect of irradiation on ternary eutectic (55 percent ortho-terphenyl, 20 percent meta-terphenyl, 25 percent biphenyl) was terminated after ten days' operation. Polymerization of the residue from the previous run caused a flow stoppage.

The ORA-3 loop operated continuously during July to give an accumulated test time of 960 hours. The test evaluated an air-operated valve having Crane self-sealing No. 4 packing. The operation was satisfactory, indicating that this seal will be suitable for actual operation in KER loops.

A preliminary discussion was held with IPD concerning the design of a side test hole irradiation facility which will be connected in parallel with Loop KER-1 to provide a greater in-reactor volume of organic.

A recalculation has shown that slug surface temperatures will be higher than previously thought and, as a consequence, standard fuel elements cannot be used in KER-1. The current thought is to use standard dimension slugs containing depleted uranium (0.15 percent). These will be used until non-standard fuel elements can be obtained.

DECLASSIFIEDThermal Hydraulic Studies

Single Tube Flow Anomaly Studies. Laboratory experimentation continued to simulate the transient response of a reactor process tube following an imposed hazardous operating condition. Experimental data were obtained for the pressure, flow, and temperature events following slow and rapid plugging of a K-type process tube system. Although the analysis of these tests has not yet been completed, it is apparent that the pressure buildup in the K-type tubes is not as strong as experienced in tests with B-D-F type tubes. This means that following a rapid plugging of the tube inlet screen, the panellit pressure for a K tube system will dwell longer in the region of the low trip but will not have the degree of high trip backup that is characteristic of the B-D-F type system. Generally, this means that more emphasis will have to be placed on the certainty of the low trip for K-type tubes.

The experimental determination of steady state boiling curves using K process tube geometry was completed and a report written (HW-51358). These curves, obtained for tube powers of 500, 750, 1000, and 1250 kw, extended previous data to much lower flow rates and enabled identification of conditions corresponding to physical burnout. (Heater rods were actually destroyed by melting during the 500 and 1250 kw runs.) From the data it is evident that with front header pressures of 350 psig or above, unstable flow conditions would never be encountered with the plugging of tubes at powers below approximately 1000 kw. This means that plugging occurrences in fringe zones at K reactors would not generally lead to unstable flow conditions. However, should the plugging be severe enough, damage would still result from boiling burnout.

Plugging of Tube Inlet Screens. During startup of H reactor following the CG-558 outage, abnormal flow was detected in twenty process tubes due to plugging of the tube inlet screens with pieces of a plastic material. In two cases an increase in Panellit pressure was observed rather than a decrease as would normally be expected in such cases. A laboratory investigation of some of the exact plugs removed from the reactor did not reveal any cases where an increase in Panellit pressure would result. In fact, no possible means of plugging of the inlet screen could be devised which would result in an increase in Panellit pressure.

In the continuation of a general study of inlet screen plugging, it was observed that for K screens a blockage of approximately 95 percent of the free area of the screen would be necessary to cause a decrease in flow of 50 percent.

C Size I & E Slugs in K Tubes. The pressure-flow characteristics were determined experimentally for C-size I & E slugs (1.474 OD x 0.375 ID) in a K process tube. C-size I & E slugs result in a flow increase of 7.8 percent over normal flow for solid slugs, and an increase of 14.2 percent over normal flow for K-size I & E slugs. However, the ratio of the

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flow rate in the annulus to the flow rate in the hole for the C-size I & E slugs was found to be very nearly equal to the value for K-size I & E slugs. The results were reported in a Confidential-Undocumented report (HW-51411).

Miscellaneous Hydraulic Tests. A flow test was made on a new type of rear nozzle cap to be used on an empty tube after a "quickie" discharge. Data showed that the flow rate was reduced from 70.4 gpm with a normal cap to 21.4 gpm with the new cap, both at a front header pressure of 400 psi.

A laboratory study was made to test the ability of the CG-666 zone temperature monitor RTD's to measure the true temperature of the tube outlet water from a B-D-F type tube. The test results confirm earlier conclusions of K. J. Bell (HW-43319), and show that for a flow rate of about 40 gpm the device will measure true outlet water temperatures up to at least 140 C.

Miscellaneous Calculations. Heat transfer calculations associated with organic cooling in the KER conversion loop indicate that solid slugs would experience unduly high surface and core temperatures. Calculations based on 60 gpm of MIPB (25 percent tar concentration) at an outlet temperature of 600 F show that in a 38 slug train of solid slugs maximum surface temperatures of 700 C could be expected while central core temperatures would approach 1175 C.

Irradiation Test Engineering

Shielding Studies. Counting of bare and cadmium covered gold foils for the calibration of the C Reactor Thermal Shield Test Facility was completed. The data are now being prepared for IBM calculation. The results will give a measure of the thermal neutron attenuation characteristics of the facility as it now stands. The bare gold and cadmium covered sulfur foils have been exposed and removed from the C Reactor test facility. Counting of these foils is under way and is approximately 30 percent complete. These data will yield a measure of the fast neutron attenuation characteristics of the facility. Temperature measurements have been made along the center line of the test facility. The maximum temperature obtained was 50 C at approximately three inches behind the cast iron nose piece. Detail drawings of the water tank-type thermal shield to replace the existing cast iron thermal shield have been submitted to the shops for construction cost estimate.

Temperature measurements taken in the DR Test Well indicated the maximum temperature in the well to be 90 C; consequently, it is possible to use sulfur foils in all layers of the test slabs. Previous temperatures (before fringe poisoning) were high enough to melt any sulfur foils placed in the bottom three or four layers. Sulfur foils for the second test of Magnetite concrete cured at 200 C, were prepared and installed during the reactor outage of July 16. Foils from the first test were removed during the outage and counting of these foils is 30 percent completed.

Irradiation Testing. The monthly status report, "Status of Production Tests of Special Interest to Hanford Laboratories Operation," 7/15/57, HW-51672, was issued. Irradiation tests charged into the reactors during

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the month were: IP-44-A, comparison of vacuum canned and dip canned I & E fuel elements; IP-45-A, evaluation of hot press I & E fuel elements; IP-59-A, corrosion behavior of chromic acid autoclaved fuel elements. No irradiation tests were completed during the month. Plans for irradiating plutonium impregnated graphite samples in a process tube continued.

Fabrication of the Bore Diameter Gauge was completed. Diameter measurements of tube 4574-B were made on July 3. This tube is used for vertical height traverses and is not charged with fuel elements. The data indicate that the vertical diameter was within 0.012 inch of a new process tube.

Nonmetallic Materials Development

Thermocouple Sampling - KE Graphite Stringer RS-6. The thermocouples in the piles have been failing at an excessive rate. The hot junction of the No. 1 thermocouple from the KE stringer RS-6 was recovered and examined. A close inspection of the junction revealed no flaws or evidence of corrosion. Resistance measurements on samples of the lead wire showed no appreciable change from unirradiated wire. However, the nylon-asbestos insulation was very flaky and fell from the wire with the slightest abrasion. It is tentatively concluded that the thermocouple failures in this stringer resulted from a degradation of the insulation allowing the wires to come into contact with each other or with the graphite stringer.

High Temperature Graphite Irradiation. The fifth assembly in the GEH-9 program is being irradiated in the Materials Testing Reactor. This assembly is the new "all ceramic" construction using L-6 vitreous alumina (Al_2O_3) insulators for the thermocouple and heater leads. Previously, thermocouples with asbestos and fiberglass insulation were used and although these couples had been found satisfactory for Hanford irradiations, they failed within hours in the MTR L-42 position. In the current GEH-9-5 irradiations at the Materials Testing Reactor, small cylinders of vitreous alumina 1/8 inch in diameter by one inch long containing two holes to accommodate 24 gauge chromel-alumel wire are used as the insulating material. Results from this irradiation show the thermocouples to be operating satisfactory at 900 C in a fast neutron flux of approximately 10^{15} neutron/cm²/sec. Greater than anticipated gamma heating flux has caused an overshooting of the control point in the number 4 position, and consequently the control point was changed to 900 C instead of 750 C. The other units are operating at 750, 750, and 600 C, respectively.

Stored Energy of Graphite. The stored energy content of graphite irradiated in Hanford reactors as a function of exposure, temperature of irradiation, and annealing temperature has been measured by the National Bureau of Standards. These results are as follows:

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<u>Exposure</u>	<u>Irradiation Temperature</u>	<u>Annealing Conditions</u>	<u>Activation Energy of Annealing</u>	<u>Total Stored Energy</u>
4494 MD/CT	400 C	None	~27 k-cal/g-atom	13.4 cal/g
4494 "	"	3 hr; 800 C	89	0
4494 "	"	3 hr; 1000 C	104	0
4494 "	"	3 hr; 1300 C	130	0
4494 "	"	45 min; 1800 C	164	0

It may be noted that these results differ considerably from the high temperature irradiation results obtained from the GEH-9 irradiation in the MTR L-42 position reported previously and show that the stored energy buildup in the MTR is not evident in high temperature Hanford irradiations, that stored energy buildup might have been caused by the higher exposure and/or higher neutron flux of the MTR irradiations. All stored energy from the Hanford high temperature irradiations is removed at 89 k-cal/g-atom whereas in the MTR irradiation there is some remaining after 104 k-cal/g-atom.

Graphite Burnout Monitoring - PT-IP-25A. Virgin CS-GBF graphite samples charged into bare channel 3580-F in the F Reactor on July 22, 1956, were discharged on July 16, after an effective exposure period of 238.6 operating days. The average burnout rates experienced by these samples are tabulated below as a function of position in the channel. The limits of error are standard deviations from the mean.

Graphite Reactor - F Reactor

<u>Distance in feet from front Van Stone flange to centerline of boat</u>	<u>Average burnout rate in percent per 1000 operating days</u>
11.00	0.077 ± 0.009
20.75	0.236 ± 0.013
30.50	0.046 ± 0.004

These data show that the rate of burnout of the graphite moderator in F Reactor during this period was quite low.

Infrared Studies of Plastics. The two most important chemical effects occurring during the exposure of polyethylene to gamma irradiation have been reported previously as oxidation and changes in unsaturation. A more detailed study of the oxidation of films of different thicknesses shows that this reaction is not limited to the surface as has been suggested in literature⁽³⁾. The relative oxidation of a number of samples of Alathon 3, NC-19, a duPont polyethylene, has been determined from the carbonyl infrared absorption band. Oxidation of a 0.001 inch film at a total dose of 5×10^6 r was assigned a value of 1.00 in the table below and other values are given relative to this.

(3) Ballentine, et al, "Evaluation of Polyethylene Crosslinked by Ionizing Radiation," J. Polymer Sci 13:410-14 (1954).

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DECLASSIFIEDRelative Oxidation of Alathon 3, NC-10

<u>Sample Thickness</u>	<u>Dose 5 x 10⁶</u>	<u>1 x 10⁷</u>	<u>5 x 10⁷</u>	<u>1 x 10⁸</u>
.001"	1.0	1.6	6.2	14.9
.003"	1.8	4.0	16.6	36.1
.005"	2.5	6.2	31.3	34.4
.010"	2.0	5.7	32.0	58.6
.015"	3.1	7.3	35.7	65.0

The extent to which oxidation affects mechanical properties will be determined in a series of experiments now being planned.

Structural Materials Development

B-D-F Size Zircaloy Process Tubes. During the latter part of June, three 48-foot long, B-D-F size, Zircaloy-3 process tubes were produced at the Tube Reducing Corporation for Allegheny Ludlum Steel Corporation. No visible defects were apparent on the exterior surface of this tubing. However, during straightening it was found that the ribs exhibited a twist of 90 degrees in two tubes and 180 degrees in the third tube. The direction of the twist relative to the tube reducing operation was the same in each tube. The most probable cause of this twist is believed to be defective operation of the front grips on the tube reducing machine.

Based on the results obtained to date, discussions were held with Allegheny Ludlum development personnel to determine the best course of action in completing DDR-6. It was agreed that, with only minor modification, the tooling currently available could be used to produce full length B-D-F size ribbed Zircaloy process tubing. To establish the feasibility of this process, fifteen extrusions will be produced late in August from which it is anticipated that approximately 10 to 15 full length tubes will be produced. To obtain the maximum amount of information about the process and the design of tube reducing tooling the present tools for each of the four steps will be studied extensively. Each step of the process will be piloted by carbon steel tube blanks to establish the proper machine settings.

To take full advantage of the knowledge gained to date under DDR-6, new tooling is necessary. Concurrently with the above program, tools will be designed for both a three-step process and a two-step tube reducing process. Extrusions for each will be made with an external rib to provide a uniform wall starting blank and other process changes will be incorporated to improve both the quality of the resulting tubing and to reduce the cost of the process.

Quality Control of Zirconium Alloys. A quality control type corrosion test for zirconium alloys is being developed in cooperation with Corrosion and Coatings Operation. The initial corrosion tests are being performed for 24 hours in steam at 400 C and 800 psi. An experiment was designed to determine the effect of surface preparation on the behavior of Zircaloy-2 and 3. The specimens were prepared by (1) degreasing only, (2) degreasing

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and etching, (3) degreasing and abrading, and (4) degreasing and vacuum annealing. In 400 C steam the degreasing and etching surface preparation was far superior to the others. A wide variety of corrosion rates were obtained for test samples of Zircaloy-3 with and without welds and for Zircaloy-2. Additional samples will be tested to obtain a broad range of corrosion rates in 400 C steam for later comparison with corrosion rates of the same specimens under operating conditions. In this particular test average penetration of the Zircaloy-3 samples was approximately 0.5 mil, compared with approximately 0.06 mil for the Zircaloy-2 samples.

B. WEAPONS - 3000 PROGRAM

Research and development in the field of plutonium metallurgy continued in support of the Hanford 234-5 Building Operations and weapons development programs of the University of California Radiation Laboratory (Project Whitney). Details of these activities are reported separately via distribution lists appropriate to weapons development work.

C. CUSTOMER WORK

Nickel Plated Boron Steel Balls. Corrosion tests performed on nickel plated boron steel balls used in the reactor emergency shutdown system indicated that the nickel plate contained several flaws on each ball. The cause of these flaws is still under examination.

Rewelded Fuel Elements. Several standard fuel elements which had been rejected for faulty weld beads were faced off and rewelded by the Fuels Preparations Department. Some of these rewelded fuel elements were subjected to accelerated laboratory corrosion tests. The accelerated tests indicated that the weld had minor surface contamination. No unusual corrosion was observed, and longer term flow tube tests are now in progress.

Radiometallurgy Service

I & E Slugs (RM-179). The examination of two high exposure I & E slugs irradiated under PT 105-615-A continued. Metallographic examination of transverse sections from slug numbers 83-D (tube 0983-C, 1840 MWD/T) and 82-D (tube 1074-C, 2144 MWD/T) was completed. No unusual changes were observed in the macro or micro structure of the wafer from slug number 83-D. Extensive cracking was observed in the wafer from slug 82-D and apparently caused the ellipticity detected in the slug by diameter measurements. The minor diameter was found to be 1.472 inches, and the major diameter was 1.489 inches. The microcracks were limited to about 1/3 of the uranium cross-sectional area and the major diameter ran through the cracked area. Numerous narrow gaps and larger voids were noted between the AlSi and uranium of both the inner and outer bond areas. Both the macro and micro structures were similar to those of the 83-D wafer.

Failed Calciner Pot 224-U (RM-189). The portion of the calciner pot from 224-U which contained a hole was submitted to determine the cause of failure. Metallographic examination of two samples, one from the area of failure and one from the thickest portion of the pot showed no evidence of microcracks. Macro examination indicated that the failure was caused by the grinding action

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created when the clearance between the rotating blade and the pot was significantly reduced.

Metallography Service

The impellers on some of the CG-558 pumps have shown an excessive amount of metal loss. This loss has occurred on the low pressure side of the impellers and, though extensive, has not been general over the entire surface. A sample of one of the impellers, a cast bronze, was submitted for study to determine if this metal loss was caused by chemical corrosion or cavitation. A metallographic examination revealed that cavitation was the cause of the erosion that was observed.

A malleable iron pipe elbow from the condensate line of the 16-tube mockup in KE failed and caused a serious accident. The elbow was submitted for an examination to determine if the failure could have resulted from inferior material or improper heat treatment of the fitting. Metallographic examination of the elbow as well as other elbows which have been subjected to similar service conditions without failing revealed no significant differences in composition, grain size, or heat treatment. It was found that the subject elbow had been severely weakened by erosion-corrosion. The other elbows submitted for comparison had also suffered some erosion-corrosion and eventually might have failed in a similar fashion.

A "B" Reactor rear face pigtail which had been removed recently from the reactor was found to contain several visible cracks. A metallographic examination of the pigtail showed that these cracks were typical stress-corrosion failures. An investigation of the condition of other "B" Reactor rear face pigtails is planned.

Samples Process During the Month

Total samples processed: 190

Photographs:

Micrographs	167
Macrographs	<u>63</u>
Total	230

The following Trips and Visits Reports apply to activities on 2000, 3000, and 4000 Programs. Technical activities on the 4000 Program are reported separately in HW-51741 A2.

DECLASSIFIED

F. W. Albaugh

Manager, Reactor and Fuels Research
and Development Operation

FW Albaugh:kb

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HW-51741 DEL

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JJ Cadwell	7/1-2	U.S. A.E.C., Washington DC	Paris Program Meeting	AJ VanderWeyden	No
TW Evans	7/8-12	Gordon Research Conf., Meriden, N. H.	Attend conference on "Chemistry & Physics of Metals"	--	No
	7/15	Metals & Controls, Attleboro, Mass.	Consult on fuel element development problems	AR Mathesen	Yes
	7/16	Nuclear Dev. Corp., White Plains, N. Y.	" "	WA Mott	Yes
	7/17	Babcock & Wilcox Lynchburg, Va.	" "	LR Weissert	Yes
	7/18	BMI, Columbus, O.	" "	F Schober	Yes
	7/19	General Motors, Res. Labs., Detroit, Mich.	" "	JB Burnham & J Derrah	Yes
JM Tobin	7/8-12	Gordon Research Conf., Meriden, N. H.	Attend conference on "Chemistry & Physics of Metals"	--	No
EA Evans WE Roake	7/15-16	Atomics Int'l.(NAA) Canoga Park, Calif.	Exchange of information on ceramic fuel element fabrication & testing	B Hayward	Yes
RS Kemper	7/16-19	KAPL, Schenectady	Program discussion re radiation effects in structural materials	CA Bruch	Yes
MK Millhollen	7/25	Oregon Metallurgical Prod. Corp., Albany, Ore.	Discuss casting techniques for production of Zr-2 PPRP end fittings	W Aschoff	No
RJ Anicetti DC Kaulitz	7/29-31	Pacific Scientific Co., Bell Garden, Calif.	Discuss high temperature sintering furnaces	--	No
OJ Wick	7/23-30	Nevada Test Site Las Vegas, Nevada	To witness test	CT Brockett	Yes

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VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RE Nightingale	7/16-17	Atomics Industrial Forum, Stanford U., Palo Alto, Calif.	Present paper	EA Wiggin	No
RE Nightingale JM Davidson	7/18-19	Phillips Petroleum Co., MTR, Idaho Falls, Ida.	Charge Hanford experiment into MTR	RB Johns	Yes
RL Dillon	7/15-16	New London, N. H.	Attend session on corrosion at Gordon Research Conf.	G Parks	No
HP Oakes	7/18	NTH Company, El Cajon, Calif.	Consultation on fabrication of PRPR tubing	W Miller	No
JW Riches	7/23	Damascus Tube Co., Greenville, Pa.	Consultation on fabrication of zirconium tubing	BB Burd	No
PJ Pankaskie	7/24	Carpenter Steel Co., Union, N. J.	"	ND Groves	No
	7/31	Superior Tube Co., Norristown, Pa.	"	HW Cooper	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
JE Duncan	7/1-10	UCRL, Livermore, Calif.	Discuss Whitney Program	ID Thomas	Yes	231, 234-5; 200-W
C Godfrey	7/5-7	"	"	"	"	"
G Baxter	7/5-10	"	"	"	"	"
LP Loewenstein	7/9	Nuclear Metals, Boston, Mass.	Discuss fuel element	MD Freshley	Yes	231, 200-W
CE Weber GT Muehlenkamp	7/9-10	KAPL, Schenectady ANP, Evendale, O.	Discussion of Intra-Company fuel elements	JJ Cadwell SH Bush JE Minor	No	326, 300

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VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
M McEwen	7/3	Monsanto Chemical Co., Dayton, O.	Discussions on organic coolants	DR deHalas	Yes	105-KE, 100-K 328, 300
JS Foster	7/8-9	Can. GE Ltd., Peterborough, Ont.	Discuss PRPR and organic coolants	LP Bupp	Yes	105-K, 100-D
AC Whittier		DR deHalas			105-KE, 100-K	
WN Boves		RM Fryar		No	328, 300	
IL Wilson		PR McMurray			713, 700	
		Atomic Energy of Can., Chalk River, Ont.		H Harty		
				DJ Foley		
				JF Fletcher		
				JC Fox		
J Tarmon	7/9-10	Betz Laboratories, Philadelphia, Pa.	Study of light water treatment for PRPR	RM Fryar	No	713, 700
R Myers				PR McMurray		
				H Harty		
				FH Shadel		
RW Stewart	7/16-17	Allegheny Ludlum, Watervliet, N. Y.	Discuss zirconium fabrication	JW Riches	Yes	303, 300 100-K
RA Rohrabaugh						
WP Eatherly	7/29	National Carbon Co., Cleveland, O.	Discuss graphite experiments	RE Nightingale	Access	328, 326, 300
NJ Nolan				DH Curtiss	Permit	
CA Odening				LP Bupp	Yes	
HN Townsend				M Lewis		
				EM Woodruff		
				WA Snyder		
JP Courtney	7/24	BF Goodrich Chem.Co., Los Angeles, Calif.	Discuss vinyl chloride plastics	R Harrington	No	326, 300
WL Teft	7/25	Silicones Div., Union Carbide Corp., Los Angeles, Calif.	Discuss silicone rubber materials	R Harrington	Access	326, 300
				Permit		

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PLUTONIUM RECYCLE PROGRAMMONTHLY REPORT - JULY 1957REACTOR & FUELS RESEARCH & DEVELOPMENT OPERATIONPlutonium Fuels Development

Al-Pu Alloy Capsules for MTR Irradiations. Spike enrichment of nineteen-rod clusters of Pu-Al, clad in Zircaloy, are being planned for startup of the Plutonium Recycle Reactor. In an effort to further the knowledge concerning the irradiation behavior of Pu-Al alloys, four Zircaloy-2 clad capsules were irradiated in the MTR. Two capsules contained an alloy of Al- 12 w/o Si- 1.65 w/o Pu and two contained an alloy of Al- 1.65 w/o Pu. The specimens began irradiation on May 13, 1957, which was the start of cycle 87. One capsule of each core material remained in the reactor for one cycle and one capsule of each core material remained in the reactor for two cycles. This is the equivalent of about 25 and 50 percent burnup of the Pu atoms, respectively. The specific power generation was about 12.7 kw/cu in, which is about three times the average specific power generation expected in the PRP fuel elements. The irradiation portion of this experiment was successfully completed on June 24, 1957, and the capsules are currently awaiting shipment back to HAP0 for radiometallurgical examination.

Capsule Irradiations in the KER Loop. A tentative forecast for the next 12-month period of the KER loop requirements for the Plutonium Fuels Development group was initiated. Experimental fuel elements of the PRP type are being planned for loop testing in the six-month period starting in September 1957. It appears that approximately two to three feet of space will be required in the high temperature loop (250 C).

PuO₂ Impregnated Graphite Fuel Material. Lattice physics tests on PuO₂ impregnated graphite fuel material will be conducted in the PCTR. PuO₂ impregnated graphite is being furnished to Plutonium Metallurgy Operation by the Chemical Research Operation for assembly into Al test assemblies for PCTR testing.

Fuel Element Fabrication. Various methods of fabricating Pu-Al type fuel elements are being investigated. Some of these methods, however, require use of equipment which is not presently available within the Plutonium Metallurgy Operation. Therefore, the Chemical Research Operation is performing feasibility experiments on developing techniques for producing roll clad rods and swaged powder metallurgy compacts by using standin material of Al and U. It is believed that it would be advantageous if the Pu-Al fuel material were coextruded within a thin-walled Al can, which would be uncontaminated on its external surface, thus simplifying subsequent handling and canning operations. The Canadians have successfully cast Al-Pu alloys into Al cans and the cans were sealed by casting a pure Al plug on the top. It is planned to attempt this technique of producing rolling and extrusion billets. Experiments are planned to investigate the possibility of producing roll clad rods and extrusion clad Al-Pu fuel rods directly.

Equipment is presently being installed in the 272-Z Building to perform non-contaminated development work. At present, a rolling mill for plates and sheets and a 50-ton press are in operation and a muffle furnace and extrusion press will be installed shortly. Several suggestions have been made which would increase the versatility of the extrusion press and these changes are being incorporated in the tooling design. Layout work for the hood detail design has been initiated.

As mentioned above, the fuel element cores for the initial spike loading of the PRP are expected to be Al-Pu alloy. This alloy will be formed by combining Al and metallic Pu or by the cryolite reduction of PuO_2 in Al. Fabrication of the fuel element cores by powder metallurgy techniques are being considered as a method of possibly eliminating the oxide reduction step. The cores will be fabricated by cold or hot compacting a blended mixture of powdered Al and PuO_2 or U-Pu mixed crystal oxides. Compaction is followed by hot extrusion, either with or without an outer Al contamination barrier. A press has been set up for preliminary studies of compaction and extrusion characteristics.

Work has been initiated to develop a method of casting billets for the extrusion press and a mold is being fabricated for use in a continuous casting process. The mold will be made of Al and all the casting services will be anodized. For continuous casting the pouring funnel which will be held stationary will extend to the bottom of the mold at the beginning of the pour and the mold will be lowered at a uniform rate corresponding to the freezing rate of the metal being cast.

UO₂ Fuel Development

M-388 Clad, I & E Cooled, Uranium Dioxide Fuel Elements. Alternate cladding materials for use with uranium dioxide fuel materials in high temperature water are being investigated because of the high cost of Zircaloy cladding. One promising candidate is M-388 Ni-Al alloy. One M-388 clad test element (1.474" OD x 0.375" ID x 8.850" long) was inserted into the MTR GEH-4 facility during the shutdown of the week of July 15, 1957. The test element is now generating heat at a calculated rate of 53 kw/ft. Uranium dioxide cores for sixty-six identical fuel elements were pressed and sintered during July. Arrangements are being made for the irradiation of these fuel elements in a HAPC reactor. The purpose of the proposed irradiation is to obtain fabrication and irradiation experience on a statistically significant number of tubular uranium dioxide fuel elements. Twenty inches of sintered uranium dioxide tubes, 1.705" OD x 0.670" ID, were fabricated for possible irradiation in the KER facilities. The tubes were prepared by isostatically pressing preformed uranium dioxide tubes, machining the green cylinders on a lathe to the required green dimensions, sintering the compacts in hydrogen at 1750 C and grinding them to specified dimensions.

Uranium Dioxide Fuel Materials - Fission Gas Release. Several months ago sixteen Zircaloy capsules containing pressed uranium dioxide powders were irradiated in the MTR to examine the effects of varying packing density, uranium dioxide surface area, U-235 enrichment, neutron flux, and exposure time. The contained gas has been sampled and analyzed by mass spectrometric method. Variation of fission gas release among the sixteen samples is two orders of magnitude. The data are being collected for a statistical analysis.

Swaged Uranium Dioxide Fuel Elements. Two Zircaloy-clad, swage-compacted, uranium dioxide fuel capsules were inserted into the MTR during the July 15 shutdown. The purpose of the test is to examine our methods of calculation of core temperatures and extent of fission gas release of this new type of fuel element. The two capsules contain uranium dioxide compacted to 85 and 90 percent of crystallographic density. Flux positions were chosen to cause core melting in the two capsules. One capsule was in a group of experiments removed from the reactor shortly after startup due to MTR operational difficulty. The second capsule is expected to be discharged from the reactor after one eighteen-day cycle of irradiation on August 5, 1957.

Fabrication of PCTR Elements. In order to obtain lattice constants and other precise measurements, it is necessary to expose candidate fuel elements in the Physical Constants Test Reactor. The uranium dioxide for the central rod of the assembly was formed by extrusion, the inner oxide tube by cold-pressing, and the outer tube by pre-forming, followed by isostatic pressing to attain the necessary green density. All components were sintered in hydrogen at 1750 C and ground to final dimensions. Twenty-one feet of nested tubular fuel element assemblies are now being fabricated for this purpose. Final assembly of inner rod and inner tube sections is complete, but vendor difficulties in providing aluminum tubing for cladding of the outer oxide tube section has delayed completion of the loading. The work is now scheduled for completion by August 15.

Utilization of Castings for Zircaloy-2 End Fittings. Machining of solid pieces of Zircaloy-2 to fabricate large end fittings of the type required for PRPR fuel elements is a costly, time consuming process. Investigation of the present stage of advancement of the production of Zircaloy castings indicates that castings can be utilized. Oregon Metallurgical Corporation, located in Albany, Oregon, is producing Zircaloy and zirconium castings and has done so with excellent results for Westinghouse reactor applications. Test castings for in- and ex-reactor studies are being procured.

Design of PRPR End Fittings. Because complete remote disassembly, inspection, and reassembly of irradiated PRPR nested tubular fuel elements is now being considered, a re-design of top end fittings for this element is under way. Since it now seems unnecessary to provide a Pu spike in the central rod, this rod is being eliminated and only the two oxide tubes will be used. Preliminary designs are being evaluated and altered, and a final design incorporating simple, remote handling devices is 90 percent complete.

Isostatic Pressing of Uranium Dioxide. Modification of the isostatic press to an upper pressure limit of 50,000 psi was completed by replacing the 30,000 psi tubing with 50,000 psi tubing. A study was completed of the effects of varying uranium dioxide ball milling time, pre-forming pressure, and isostatic pressure upon the green and sintered densities and upon the diameters of uranium dioxide tubes pre-formed in a 3.572" OD x 2.543" ID die. The results of this study were reported in the Fuel Development Operation Quarterly Progress Report for April, May, and June, 1957. It was concluded that (1) increases in the sintered density of uranium dioxide upon increasing the isostatic pressure are small compared to corresponding increases in ball milling time of the uranium dioxide, and (2) the sintered diameter of uranium dioxide tubes pre-formed in the same die and isostatically pressed at a constant pressure may be increased by 1.7 percent simply by doubling the pre-forming pressure in the range 5-10 tsi.

Ceramic Fuel Materials. Uranium fuel materials having properties more attractive than uranium dioxide are being investigated. The compounds UC and UN and the solid solutions UC-UN, UC-UO, UN-UO, and UC-UN-UO are of interest because of their reported high thermal conductivity (similar to uranium metal), high melting point (greater than 2000 C), high concentration of uranium atoms (greater than 93 w/o), and corrosion resistance to reactor coolants. Preparation of the materials and their reactivity with various reactor coolants and jacketing materials is being conducted in cooperation with the Chemical Research Operation and the Corrosion and Coatings Operation. Preliminary results indicate that UC would not be a suitable material for a high pressure water reactor since a 1.6-gram pellet reacted completely to U_3O_8 in 100 C water in ten minutes.

Fundamental Studies. A preferential alignment of crystallites in anisotropic materials creates undesirable directional variations in physical and mechanical properties. Anomalous shrinkage data obtained from extruded rods sintered after isostatic pressing suggest the presence of preferentially oriented crystal aggregates. Selected extruded rods were studied by optical metallography techniques without detecting preferential orientation of crystallites. Other rods are being studied by x-ray diffraction techniques in cooperation with the Physical Metallurgy Operation.

Swaging Characteristics of Uranium Dioxide Powders. A number of exploratory experiments have been performed during the past year concerning the simultaneous compaction and cladding of uranium dioxide fuel elements by rotary swaging of uranium dioxide powders within a restraining tube of the chosen cladding material. Need exists for an evaluation of the swage compacting characteristics of various types of uranium dioxide powders, independent of the nature of the cladding materials. To achieve that end, a series of experiments has been started in which various powders will be examined under a standardized swaging schedule in standardized stainless steel capsules. The first tests were performed using "PWR grade" uranium dioxide contained in 5/8" OD, 304 SS pipe capsules. Eighty-one percent of crystallographic density was achieved after a series of cold swaging passes which resulted in 84 percent reduction in uranium dioxide cross-sectional area. Density variation was $\pm$ one percent along the full twelve-inch length of the swaged capsule. Change in the percent theoretical density of the uranium dioxide was closely proportional to the change in percent reduction in diameter. Tube wall thickness was reduced 20 percent after an initial 10 percent increase. Maximum variation in finished wall thickness was 10 percent.

Mechanical Equipment Development

The 35-foot deep Process Tube Test Shaft was inspected by the safety engineer who made suggestions concerning painting, bump, and pinch points and for providing machinery for opening the 200-pound hatch. These suggestions are being followed.

PRPR Design Criteria for Moderator Coolant Circuit, Reflector Circuit, Helium Gas System, and PRP Reactor Building and Services were reviewed. Comments were sent to Advance Engineering Operation.

A prototype mock-up of the nozzle to process tube assembly is being fabricated. Destructive tests of the welded shoulders on the Zircaloy-2 tubing are being made to determine the proper fabrication technique.

A prototype mock-up of the outlet gas seal packing test assembly is being fabricated in the Laboratory Shops. This work was specifically requested by Advance Engineering Operation in order to determine the tendency toward binding during removal.

Fabrication of the bellows test facility has begun. Bellows for testing are being procured.

A prototype mock-up of the fueling vehicle hook and turning device is being fabricated by Laboratory Shops.

A full-size calandria mock-up is under construction at the White Bluffs Shops.

Shield Calculations

Information on the neutron flux incident on the PRPR shields became available during the month. The top primary shield as currently designed (40 inches thick, 65 percent iron shot, 37 percent water) will not give sufficient attenuation of the calculated incident fast flux (3×10^8 n/cm²-sec). It appears that it will be necessary to increase the density of the top shield or to increase its thickness by about three or four inches.

The side thermal shield is to be designed on the basis of using a heavy water reflector even though a light water reflector will be used initially. A heavy water reflector will increase the thermal flux incident on the side shield by a factor of approximately 100. The heat generation in the thermal shield will increase by the same factor; consequently, the cooling system for the thermal shield must be re-examined and possibly redesigned to insure adequate cooling.

Coolant Systems Development

The 19-rod cluster PRPR element has run 550 hours at 300 C in 4.5 pH water. Since the spiral wrappings are of carbon steel wire, the windings have experienced considerable corrosion, undoubtedly accelerated by the 4.5 pH water used for KER slug testing.

The pressure drop of the 19-rod cluster PRPR element has been measured for various temperatures. The drop to be expected when the element is used in a D₂O system is reported in a document⁽⁴⁾.

Water quality requirements for the PRPR secondary cooling (light) water system were outlined to representatives of the Betz Laboratories, Inc., on 7/8/57. On or before July 31, a feasibility and cost analysis of possible methods for treating the secondary cooling water will be received from Betz Laboratories, Inc. It was recommended that approval of the Secondary Coolant System (HW-48114) be delayed until the analysis reports are received from Betz Laboratories.

(4) HW-51181, "HYdraulic Characteristics of PRPR Fuel Elements: 19-Rod Cluster - Interim Report," D. R. Doman, 6/28/57.

Thermal Hydraulics Studies

PRPR Flow Decay After Power Failure. A calculation was completed of the flow decay following power failure to the primary coolant pumps in the PRPR. Using power decay calculations made by Canadian personnel for the NPD, it was found that natural convection alone would not adequately cool the reactor until after approximately 40 seconds from the time of complete power failure to the primary coolant pumps. Consequently, calculations were made of the proper sized fly-wheels to be used on both pumps to provide the necessary backup.

Tubing for Fuel Element Sheathing

Prototype aluminum alloy tubing was ordered from Harvey Aluminum Company to be used for reactivity tests of the nested tubular fuel element. Considerable difficulties were encountered in fabricating the larger sizes of tubing and especially the three-inch diameter tubing. Personnel at Harvey have extended considerable effort to produce this tubing and expect to make delivery by August 1.

Zirconium strip rolled by Superior Steel Company for use by NTH and Damascus Tube Company to produce the three larger size tubes for the nested tubular fuel element was examined on delivery to NTH and Damascus. The strip was of relatively poor quality in comparison to stainless steel strip. However, both companies expressed the opinion that the tubes could be fabricated from this strip. The test run at NTH demonstrated that satisfactory tubing was possible. The sample welds made by NTH exhibited no discoloration of the weld material nor of the heat affected zone. Test welds were performed at the Damascus Tube Company where it was determined that improved gas shielding was necessary to produce a clean uncontaminated weld. Both companies plan to produce production quantities of this tubing during the month of August.

Corrosion of Uranium Carbide

Uranium carbide is being considered as a possible candidate for a sintered fuel element. Higher uranium contents can be realized from UC than UO_2 and the thermal conductivity of UC approaches that of metallic uranium. However, UC powder is known to be highly reactive with water. There was some hope that massive UC would react more slowly, but a 1.3 g piece of UC made by reacting uranium with monoisopropyl biphenyl was completely disintegrating in ten minutes in boiling water. This is a much more rapid corrosion rate than that of uranium metal. A denser, more resistant uranium carbide can be obtained by compacting and sintering, and will be tested.

Plutonium Fuel Cycle Analyses

Activity during the month has been directed towards final formulation of a document on the economics of plutonium fueling of thermal reactors. Self-sustained plutonium recycle operation in which the reactor generates enough plutonium to supply all necessary enrichment beyond that provided by the U-235 in the natural uranium feed is being treated in some detail. In addition, the use of plutonium as a once-through thermal reactor fuel independent of a reactor's ability to produce plutonium is to be treated so as to permit problem definition for possible economic evaluation.

As previously reported, it is believed that self-sustained plutonium recycle can ultimately become competitive with U-235 enrichment under many circumstances provided a weapons grade premium charge is not assessed against the plutonium. Once-through operation requires establishing a dollar value for plutonium as a function of all probable isotope compositions that would be bought and sold on the market. On the other hand, self-sustained plutonium recycle can be evaluated with a dollar value of plutonium established at only one composition point in the plutonium isotope chain.

The value of plutonium and essentially pure U-235 on an open market is dependent in part upon the available heat and nuclear reactivity. The heat content is directly related to the fissionable isotopes contained per unit weight and can be readily related to heat value. The reactivity can be represented by the value of "eta", i.e., the neutrons liberated per neutron absorbed in the fuel. Work to date indicates that it is difficult to assign a dollar value to various combinations of heat content and "eta". Some of the higher isotopes of plutonium and uranium generated during irradiation of Pu-239 and U-235 act as parasites to decrease "eta" by radiative capture and some are fissionable to increase "eta" by fission. The net result is that with irradiation the "eta" of plutonium drops more rapidly than the "eta" of U-235. Analyses of plutonium as a reactor fuel are usually made relative to the established prices for uranium and the currently published costs of variously enriched uranium are based upon the separative work to separate U-235 from U-238. However, these relationships do not account for the cost of separating U-235 from U-236. Calculations show that, in addition to fission product effects, the "eta" value of U-235 drops off with irradiation due to the formation of U-236. Consequently, the value of uranium at a given U-235 composition achieved by irradiating pure U-235 in a reactor is substantially less than the value of uranium at the same U-235 composition derived from a diffusion plant using unirradiated uranium feed. (The nuclear cross section of U-236 is greater than U-238.) Oak Ridge is aware of this effect but has not yet published a relationship for the salvage value of U-235 variously contaminated with U-236.

Experimental Reactor Design

General. The design criteria for the PRPR are estimated to be 90% completed. All criteria not yet approved are being prepared in final form for approval.

The detailed design for Phase I of the PRPR is 53% completed. Phase I includes the containment vessel with inside structural concrete, storage basin, and a portion of the basement area of the service building.

The scale model of the PRPR is 50% completed. The major structural components of the containment area and service area have been placed in the model.

Core Components. The design criteria and scope drawings for the reactor core components have been approved and issued. In the final revisions the top and bottom plates of the calandria and the top plate of the dump chamber were thickened to provide an additional factor of safety in mechanical strength of the vessel.

Reactor Piping. Design criteria for the reactor piping, process tube assembly, and fuel assembly were approved and issued.

It is clear from preliminary stress analyses that additional flexibility will be required in the jumper piping to hold stresses and end reactions within allowable values. Alternate piping layouts incorporating expansion bends are being studied. Space available for locating expansion bends in the outlet piping is limited, but space for this in the inlet piping is not restricted. Material for the jumper piping was changed from type 304 to type 316 stainless steel to take advantage of the higher strength of the type 316 stainless steel at elevated temperatures.

Two process tube inlet fittings, similar to those shown on Dwg. SK-1-6373, were installed on ELMO-7 loop at 1706-KE. Thermal cycling tests have begun.

Charge-Discharge. The design criteria for the charge-discharge system were approved and issued. Detail design of the storage basin equipment was begun by Special Projects Operation, CEO.

Process Piping and Equipment. Design criteria for the moderator coolant circuit were approved. Criteria for the purification systems, the reflector circuit, and the primary coolant circuit are being circulated for approval.

Criteria for the primary coolant circuit were revised in accordance with comments received.

Control and Safety Systems. Design criteria for the control and safety systems have been revised and are circulating for approval.

The degree of safety of the PRPR was demonstrated during the month by the GEDA analog computer in a series of runs made to determine the response of the reactor to various reactivity transients. With the planned usage of heavy water for both moderation and cooling, the most serious reactivity transient envisioned to date is that caused by simultaneous failure and dropping from the reactor of a number of shim rods. GEDA results show that if 18 shim rods were somehow to fail simultaneously, resulting in a reactivity gain of 18 mk in about 0.7 seconds, the dump mechanism would effectively limit the resulting power surge to about 320 MW and would then rapidly shut the reactor down. The energy released in this surge (175 MW-sec) might cause premature failure of the fuel elements but otherwise would probably have no detrimental effects on the reactor components.

Instrumentation. All scope drawings and criteria for PRPR instrumentation have been completed and are being prepared in final draft form.

Shielding. Comments on the shielding criteria have been received and the criteria and scope drawings are being prepared in final form.

Helium System. Criteria for the helium system are being prepared in final form.

Thermal Stress Analysis. Work was begun on the determination of the allowable rate of cooling down of the reactor and auxiliary equipment as limited by thermal stresses. Flow rates and heat transfer rates in the primary and secondary coolant circuits have been checked. Calculations of fluid temperatures in the primary coolant circuit during cool-down are being made. These will be used in determining transient temperature distributions in the equipment during cool-down so that thermal stresses may be evaluated.

Site Relocation Study

At the request of the HOO-AEC, two preliminary area layouts and construction cost estimates were prepared for a proposed new site located approximately 2-1/2 miles north of the 300 Area. These layouts were prepared to include the PRPR facility, the Plutonium Fabrication Pilot Plant, and the Critical Mass Laboratory. The proposed site location and the utilities are planned so as to accommodate future expansion.

Reactor Physics

Three-Group Flux Distributions. Radial reflector reactivity values calculated by the three-group VALPROD program are as follows:

<u>Reflector</u>	<u>Radial Buckling, Δb</u>	<u>Reactivity Relative to H₂O, mk</u>
Empty	590	-19.7
H ₂ O	514	--
D ₂ O	272	+73.4

Vertical reflector calculations were also performed. A case with 10-inch D₂O reflector top and bottom and a case with 20-inch D₂O bottom and none on the top were compared; the reactivity was 0.9 mk higher in the former case. The effect of moderator dump was checked at several points. Starting from the 10-inch top and bottom case, the level of the moderator is lowered 10 inches to the top of the fuel. The loss of reactivity is 6.6 mk. An additional 14-inch level drop produces a further loss of 11.2 mk, so that the total for two feet level drop is 17.8 mk. Another comparison was obtained by starting with the 20-inch bottom reflector with no top reflector. Here, the first 10-inch drop results in a loss of 6.4 mk, with the next 14 inches producing a loss of 13.7 mk, or a total of 20.1 mk for the first two feet. Since a symmetrical location of the fuel rods in the tank is to be preferred for shielding reasons, it is concluded that the small increase in dump shutdown rate achievable by placing the top of the rods at the operating level of the moderator is not worthwhile.

Plots of the three-group vertical fluxes in the core, reflector, and inner part of the shield have been prepared and distributed. Unfortunately, the VALPROD program is not capable of providing flux values much beyond the midpoint of the shield since the calculation is done in fixed-point arithmetic and the significant figures are lost when the flux values become too low. Similar plots of the radial flux distribution will be distributed in the near future.

Primary gamma intensity and current in the reflector has been analyzed. Numerical computation of results is now under way.

Lattice Physics. Calculations were carried out in an attempt to understand the effect of flooding of the gas annulus due to a calandria leak during startup. These results are as follows:

Thermal Utilization	$\Delta f = +6$ mk
Resonance Escape	$\Delta p = +7$ mk
Thermal Leakage	$\Delta F = -3$ mk
Fast Leakage	$\Delta P = +9$ mk

With reduced moderator level the leakage terms would be higher. Even with 25 mk total, the maximum rate of flooding, assuming simultaneous gross rupture of each shroud tube at the bottom, would be only 5 mk/sec, which is not particularly serious.

Additional calculations were performed on D₂O coolant loss. With a single rod of Pu-Al at the center of a 19-rod UO₂ cluster, the results are:

$$\begin{aligned}\Delta f &= +3 \text{ mk} \\ \Delta \eta &= +1 \text{ mk} \\ \Delta p &= -3 \text{ mk} \\ \Delta \epsilon &= +2 \text{ mk}\end{aligned}$$

If the cluster is uniformly enriched with equilibrium Pu,

$$\Delta f = +5 \text{ mk}$$

Further calculations are being performed in an effort to understand the current PCTR experiments. It should be stressed that these experiments measure multiplication constant, not reactivity, and the increase of leakage resulting from loss of coolant is sufficiently large that no hazardous increase of reactivity can be inferred from the results to date. There is also no reason at the present time to expect undue difficulty in interpreting the experimental results, although this work is still far from complete.

Hazards Analysis. Excursions resulting from a range of step and ramp reactivity inputs, with fuel temperature and moderator dump effects included, were run on the analog computer. Results are included in the hazards report.

Fuel Cycles. In the study of the effect of moderator temperature on maximum attainable exposure in plutonium recycle, Westcott cross sections have been used. This has resulted in the natural choice as a parameter of the quantity r , which is essentially the fraction of epithermal neutrons in the reactor spectrum. As r is not yet in common use, the desirability of relating it to a more usual quantity, such as p , which also characterizes the reactor spectrum, has become evident. For this purpose the data previously obtained in the study have been used to calculate p , η , and f as functions of r . These new results will be included in the study report as aids in interpretation.

DECLASSIFIEDPHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATIONMONTHLY REPORTJULY 1957FISSIONABLE MATERIALS - 2000 PROGRAMREACTORSTUDIES RELATED TO PRESENT PRODUCTION PILESGraphite Diffusion Length of the Sigma Pile

Remeasurement of the diffusion length of the Hanford standard pile has given the value 53.0 cm. at the graphite stack density 1.658 gram/cubic centimeter.

Fast Effect

Multigroup calculations very similar to those used in data reduction of fast neutron sphere transmission experiments are being applied to the calculation of the fast effect in heterogeneous reactors. This technique will permit a clean assignment of fission-energy radiative capture either to the resonance energy band or to the fast fission spectrum band, according to an experimenter's preference. The descriptive completeness of this technique will also facilitate an understanding of the difference between the usual experimental quantity, the U-238 to U-235 fission ratio, and the fast effect.

Gold Cadmium Ratios

A multiple collision analysis of some experimental gold foil cadmium ratios has been started as a test of multiple collision calculations and to try to establish the shape of the cadmium ratio curve for foil thicknesses thinner than could be measured.

STUDIES RELATED TO FUTURE PRODUCTION PILESExponential Measurements on 1.66" Slugs

Buckling measurements were continued in the small graphite-uranium exponential piles in support of the IPR Program. The fuel elements consisted of 1.66" diameter solid, natural uranium slugs which were canned in aluminum tubes 1.735" in O.D. with a 0.028" wall thickness. The canned elements were positioned in aluminum process tubes which were 2.125" in O.D. with a 0.065" wall. Measurements were taken in an 8-3/8" and a 10-3/8" lattice. The bucklings are given as follows:

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<u>Lattice Spacing</u>	<u>Process Tube Condition</u>	<u>Buckling</u>
8-3/8"	Wet	$99.4 \times 10^{-6} \text{ cm.}^{-2}$
10-3/8"	Dry	$138.5 \times 10^{-6} \text{ cm.}^{-2}$
	Wet	$71.2 \times 10^{-6} \text{ cm.}^{-2}$

In the wet measurements the amount of water contained in the annular region around the fuel element is 5.06 cc/cm. of process tube length.

A 9-3/8" lattice exponential pile has been built, and the buckling of this lattice will be determined next.

STUDIES RELATED TO SEPARATIONS PLANTS

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Dissolver Problem

A series of exponential type experiments were undertaken to provide data for the safe (nuclear) design limits of new dissolvers which have been proposed by CPD for processing 0.94 percent enriched uranium. The type of dissolver being considered would consist of an annular region with an outside diameter of about 7 feet; fuel elements would be dissolved in the annulus. The problem is to determine the thickness of the annular region such that the system will be subcritical when reflected internally with uranyl nitrate solution with the possibility of the system being externally reflected with either water or nitrate solution.

In order to specify the safe dissolver annulus thickness, it is necessary to know the reflector savings of the enriched uranyl nitrate solutions; the experiments were designed primarily to obtain this quantity. During the mid-three weeks of July, the experimental work was continued on a two-shift basis; a total of 13 measurements have now been completed.

Relaxation length measurements were taken in heterogeneous lattices composed of 0.925" diameter uranium rods which were enriched to 1.007 percent by weight U^{235} . Each lattice consisted of 85 rods (44" in length) which were water moderated and positioned in a hexagonal pattern. The lattices were reflected with either enriched uranyl nitrate solution or water; the uranyl nitrate solution was separated from the lattice region by means of a 1/16" thick stainless steel container. The experiments were conducted with 1.00 percent enriched uranium since fuel elements of this enrichment were available and since previous calculations had indicated that 0.94 percent enriched uranium would gain reactivity with exposure where the maximum gain would be equivalent to 0.98 percent enriched uranium. The reflector savings was investigated as a function of the H_2O/U volume ratio in the lattice for different concentrations of uranium in the nitrate solution in the reflector. Measurements have been taken with three different lattices. The buckling was measured for the uranyl nitrate solution (homogeneous system) at a concentration of about 500 gm. of uranium/liter of solution. The experimental work is continuing; the effect of the stainless steel container on the reflector savings is now being investigated. Preliminary results may be summarized as follows:

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1. For a heterogeneous lattice (0.925" rods with an H_2O/U volume ratio of 1.74) the maximum reflector savings achieved with the 1.00 percent enriched uranyl nitrate solution is ≈ 9.5 cm. for a concentration of 600 gm. of uranium/liter; the quantity 9.5 cm. may be compared with 7.25 cm. for a water reflector.
2. For 1.00 percent enriched uranyl nitrate solution with a concentration of 500 gm. of uranium/liter about 7-9 inches of reflector corresponds to an effectively infinite thickness; i. e., further increases in the reflector thickness do not result in additional reflector savings.
3. For a buckling of $4000 \times 10^{-6} \text{ cm.}^{-2}$ (maximum material buckling expected for a heterogeneous lattice of 1.00 percent enriched uranium in the annulus) the critical annular thickness is estimated to be about 13 inches when reflected externally with water; for a concentration of 1000 gm. of uranium/liter (uranium in the form of uranyl nitrate, no excess nitric acid) the critical annulus thickness is estimated to be 12.4 inches.

Homogeneous Criticality Experiment

Further work was continued on the measurement of k_{∞} for homogeneous, slightly enriched UO_3 at H/U ratios of 6 and 7, and for 1.07 percent enriched uranium at an H/U ratio of 6. The k_{∞} values will be given when the data have been analyzed.

Critical Mass Facility

A scoping study was completed for a minimum critical mass facility with tentative location adjacent to the Hot Semiworks in 200-E Area. A thirty-five foot diameter, steel hemisphere is planned to house the reactor assemblies; a twenty-five by fifty foot single story building will be located adjacent to the reactor building to house utilities and serve as a laboratory for handling plutonium. A large ten by fifty foot control trailer located near the 2704-C office building will serve as a control center. The total cost for this facility, excluding the mechanical portion of the reactor assemblies, is estimated at \$715,000.

The minimum facility will be a portion of a larger facility for which \$2,000,000 had been requested in the FY 1958 budget and now is requested in the 1959 AEC budget. The total facility will consist of another reactor and service building and an operations building which will house reactor controls, laboratories, shops, and offices.

A project proposal is now being prepared which will ask for funds for the minimum facility in FY 1958.

In order to reduce the radiation hazard to a minimum, earth mounds will be placed around the reactor assembly and service building so that only scattered radiation will contribute to the dosage in the surrounding area. Experimental results from the P-11 burst and from the two bursts at ORNL have been used as a basis for calculating the radiation dose from a burst of 3×10^{18} fissions (about 10 times larger than any burst known to have occurred in a critical mass laboratory). It is concluded that at 400 feet from the reactor the dose

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from such a burst would be less than one rem. Radiological personnel in the 200 Areas have set the requirement that the potential dose must not exceed this value at any area to be occupied by personnel while there is a possibility of a burst occurring.

Studies in support of determining burst magnitudes under various conditions are being continued.

Nuclear Safety, Critical Mass Consultations

1. 234-5 Building Nuclear Safety

- (a) RMC "button" line design drawings were reviewed as these were submitted by the Contact Engineer of the Research and Engineering Operation (CPD).
- (b) Design criteria were established to ensure nuclear safety in the design of new plutonium solution storage facilities in Room 166 of the 234-5 Building.

2. Reactor Fuels Processing

A study was made of the nuclear safety parameters for homogeneous uranium solutions of all enrichments. The results are being issued as Document HW-51364, Nuclear Safety in Processing Uranium Solutions of All Enrichments.

A rough draft for a document entitled Processing of Enriched Uranium in the Redox Plant by members of Hanford Laboratories and Chemical Processing Department has been reviewed for the nuclear safety information contained in this document.

3. Dissolution of Plutonium-Aluminum Alloy Fuel Elements

A study was made of the criticality conditions that might result in the processing of plutonium-aluminum alloy fuels containing 5 percent plutonium, in connection with the feasibility of dissolving such elements in the Redox Plant.

4. Consultation Service to AEC

A nuclear safety specification was prepared for the AEC in connection with an off-site project shipment of plutonium metal shapes with a normal metal production shipment. The results were reported to AEC in Document HW-51694, Nuclear Safety in Off-Site Product Shipments by P. F. Gast.

Neutron Age Measurements

Calibrations of the indium foils for determination of flux traverses are nearly complete.

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INSTRUMENTATION AND CONTROLAnalog Computer**DECLASSIFIED**

Investigations of excursions likely to occur for complete loss of coolant flow in a Hanford-type reactor were continued. A new set of equations for the metal temperature were incorporated in the simulation.

An attempt is being made to set up a program which will show the change in the flux distribution due to a variation in the buckling across the reactor.

Components

Parts of the optical system for positioning the reactor charging machine were fabricated for the Equipment Development Operation of the Irradiation Processing Department. The system will utilize a system of lenses and photocells in the charging head.

The assembly of the experimental Radioisotope Analyzer using pulse techniques was started. The instrument was designed to continuously and automatically measure and indicate the amounts of specific radioisotopes in streams containing mixtures of radioisotopes.

Several types of multiplier phototubes are being investigated to obtain information such as gain vs. voltage, signal to noise ratios, dark current, etc. This information will be of value for phototube-type usage in later projects.

REACTOR DEVELOPMENT - 4000 PROGRAMSTUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAMPCTR Lattice Measurements

The analysis of the PCTR data obtained for clusters of 19 fuel rods is proceeding. Results are now available on all the lattice cases containing 19 rods of UO_2 . Preliminary numbers are available for the 7-inch lattice whose fuel cluster contains 3 Pu-Al rods in the middle ring of 6 rods, alternating with 3 UO_2 rods. The Pu-Al rods actually used had a 30 mil zircalloy sheath containing 0.504 inch O.D. Al alloy having 1.78 percent by weight of Pu. Otherwise the lattice cell dimensions are the same as reported previously. The above mentioned results are as follows:

<u>Lattice</u>	<u>Fuel Cluster</u>	<u>Coolant</u>	<u>k_{∞}</u>	<u>F</u>
8"	19 UO_2 rods	D_2O	1.048	0.982
7"	16 UO_2 , 3 Pu-Al rods	Air	1.072	0.904
7"	16 UO_2 , 3 Pu-Al rods	D_2O	1.060	0.909

The wet-to-dry increase in k_{∞} for the 19 rod UO_2 , 8" lattice is, therefore, 0.012, using a value of k_{∞} for the dry lattice of 1.060 reported last month. The wet-to-dry increase in k_{∞} for the 16 UO_2 , 3 Pu-Al rod, 7" lattice is also 0.012 from the above results.

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The values of the thermal utilization for the Pu-enriched cases were obtained using the poisoned cell flux traverse. Since the thermal utilization for the dry lattice is expected to be higher than that for the wet lattice, contrary to the data given above, an examination of the change in flux traverse upon poisoning the cell must be made. Confirmation of the calculations is also necessary.

Instrumentation

Design work was started on optical viewing and measuring instruments to be installed in a fuel inspection cell located in the PRP reactor building. The cell is still in the advance planning stage. The viewing equipment recommended consists of one close inspection viewer providing 1X and 5X magnification and one wide field viewer for obtaining a four-foot diameter field of view. The proposed measuring equipment consists of a lens and mirror system capable of giving diameter and warp measurements to within ± 0.001 inch.

Neutron-Proton Scattering Cross Section

Computed angular distributions of the neutron-proton scattering cross section in the laboratory neutron energy range 1-15 mev. indicate insufficient asymmetry to be a primary cause of the discrepancy between computed and experimental neutron slowing down lengths in light water.

Crystal Spectrometer

Pu²⁴¹ Fission Cross Section

Fission cross section data were previously obtained on samples of mixed plutonium isotopes. Since then isotopic compositions of these samples have been obtained and the relative absolute values of the Pu²³⁹ and Pu²⁴¹ fission cross sections have been remeasured. These fission cross section data have now been reduced to obtain the Pu²⁴¹ fission cross section over the neutron energy region 0.02 ev to 2.0 ev. The detailed analysis of these data in terms of theoretical formulae will not be attempted until the completion of measurements in the region 0.002 ev to 0.005 ev. The Pu²⁴¹ data appear to be of good quality giving the variation with energy to a precision of about ± 1.2 percent in the energy region below about 0.3 ev. The low energy resonance has an apparent center at 0.253 ev as determined from the half maximum values and a width of 118 mv. The data do, however, show a marked asymmetry in the wings of the resonance indicating, perhaps, fission interference.

Cold Neutron Cross Sections

The liquid nitrogen cooled beryllium filter has been mounted on the crystal spectrometer to allow the measurement of neutron cross sections in the energy region 0.002 ev to 0.005 ev. An investigation has been made of the properties of mica crystals as neutron monochromators for this energy region. Measurements will be made of the fission cross sections of U²³⁵, Pu²³⁹, and Pu²⁴¹ in this energy region.

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DECLASSIFIEDMultichannel Analyzer

The 256 channel pulse height analyzer has been received from Radiation Counter Laboratories. The analyzer required the correction of several manufacturing faults but these have been accomplished. The instrument has been performance-tested on several gamma ray spectra and has operated completely satisfactorily. Modifications have been started to adapt the input to the digital output of the vernier chronotron for neutron time-of-flight measurements.

REACTOR OPERATIONSPCTR

Operation of the Physical Constants Testing Reactor continued routinely during the month. Four unscheduled shutdowns occurred, three were due to faulty control rod magnet contact and the other to electronic failure.

Measurements were completed on the 8-inch D₂O lattice with 19 element cluster fuel rods.

Measurements were continued on the critical mass studies for the Chemical Processing Department.

The last graphite pieces needed for the PCTR core heater for lattice temperature reactivity experiments are being machined. These are shims to position the heater tank in the core cavity and blocks for the removable central cell. The first experiment, using normal uranium, is scheduled after completion of the PRFR annual fuel element and plutonium impregnated graphite fuel element tests. The synthetic high exposure fuel pieces are being prepared by Plutonium Metallurgy Operation.

An unusual maintenance item during the month resulted from a decrease in reproducibility of reactivity measurements. It is believed that the trouble has been located in the actuator shafts of two control rods. A slight amount of play has been corrected and tests are in progress to determine the effectiveness of the repairs.

As a method of increasing the PCTR reactivity, necessary for experiments where large amounts of poisons are inserted in the cavity, the substitution of aluminum for stainless steel in the control rod sheath tubes is being investigated. Drawings have been prepared and are being checked at the Technical Shop for cost and fabrication technique.

The proposed project for the addition to 305-B Building is being cost estimated. Provision is to be made for a counting room, calculation room, supervisor's office, change room, and an equipment maintenance and storage area.

TTR

The measurements of the cadmium ratios along the vertical axis and south horizontal axis have been completed except through the fuel annulus. The cadmium ratios are for 0.001" gold foils with 0.046" cadmium covers.

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Reactivity measurements of two samples of graphite were made to determine the amount of boron that will be deposited at elevated temperatures in an experiment being conducted by Materials Development. One of these samples was a monitor, the other had been exposed to BF_3 gas at an elevated temperature. The difference in reactivity of the two samples indicated that $10.1 \pm .5$ mg of boron had been deposited in the treated sample.

The oven for the temperature controlled thermal column has been delivered. Progress is being made on its installation.

Two unscheduled shutdowns occurred during the month as a result of losing the "on-scale" signal while the source was being withdrawn. As the source becomes weaker the standard withdrawal procedure is no longer satisfactory.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

Major effort was again devoted to field experiments designed to measure the distribution of concentration of tracer materials emitted from elevated sources under various meteorological conditions. Three measurements of the vertical distribution were successful; one attempt to measure the horizontal ground level distribution during a period of unstable temperature stratification failed.

A particularly noteworthy and significant result of this experimental program was the successful measurement of the vertical distribution of concentration at a distance of 5000 feet from the source on two occasions when the temperature stratification in the lower atmosphere was stable. (Prior to these experiments measurements were available for distances up to 2500 feet from the source only.) The observed variances of the vertical distribution of concentration for these two experiments have been listed in the following table (Confidence limits at 95% level):

<u>Field Test No.</u>	<u>Variance, σ_z^2 (meters²)</u>			
	<u>500'</u>	<u>1000'</u>	<u>2500'</u>	<u>5000'</u>
37-A	24 $\pm$ 1	55 $\pm$ 2	97 $\pm$ 5	117 $\pm$ 5
38-A	30 $\pm$ 2	79 $\pm$ 4	165 $\pm$ 6	181 $\pm$ 8

These measurements, which are without precedent in the annals of atmospheric diffusion investigations, clearly disprove the commonly accepted modification of Sutton's equations for stable atmospheres and, in turn, require the assignment of a damped harmonic functional relationship between the Lagrangian correlation of the turbulent component of the fluid motions and the lag time in Taylor's classical theory on turbulent diffusion. These measurements also clearly confirm the result suggested from earlier experiments, namely, that the unwarranted extension of Sutton's theory to the stable case and moderate to large distances leads to significant under estimates of the airborne concentration of stack effluents.

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DOSIMETRY**DECLASSIFIED**

The gonad dose to patients during X-ray examinations at Kadlec Methodist Hospital was measured. Water and masonite phantoms took the place of actual patients. The results are in reasonable agreement with published values for similar examinations. The Kadlec X-ray machine had no external filter during the measurements because this is the way it was used for many years. The Health and Safety Operation is gathering statistics on the frequency of the different examinations during that period so that an estimate of the average annual gonad dose to the general population from this source can be made. The largest doses are given during examinations of the lower torso. There is variation of about a factor of ten in the dose to an individual in these cases because of differences in body size and shape and in examination technique. These cases provide a major part of the annual dose to the population and so will cause comparable uncertainty in it. It is hoped that the uncertainty can be reduced by detailed study of a sample of individual X-ray radiographs.

The new pulse method of reading pencils gave leakage rates of about 1 mr/day in agreement with results with a minometer. This "leakage" is made up of roughly equal parts of insulator leakage, dose from local radioactivity, and dose from cosmic rays. The pulse method can measure the leakage of a pencil overnight; the minometer takes at least a week. The pulse method is independent of the charging voltage of the pencil. If the charging voltage is lowered from that required by the minometer, readings will be limited to smaller doses and to smaller dose rates, but insulator leakage should be practically eliminated. This would make the pencils valuable for environmental and gonad dose measurements. Tests with lower charging voltages are now in progress; initial results indicate insulator leakage is much reduced.

The difference between absorbed dose and exposure dose made necessary a correction to our Co^{60} measurements. Theoretical analysis provided a method for making this correction. The correction increases our results by half a percent. The correction results from the lack of electronic equilibrium brought about by the exponential absorption of the Co^{60} gamma rays. The theoretical methods used are of considerable help in understanding the difference between absorbed dose and exposure dose. Analysis was also made of non-equilibrium near point sources and anisotropic sources and of the relation of free air chamber and cavity chamber measurements.

Radioactivity measurements of some rocks revealed a few that are purer than lead. The rocks were obtained from the Oregon and Washington Bureaus of Mines and are commercially available. The radioactively pure ones were some samples of olivine, soapstone, and serpentized peridotite from a small area in Skagit County, Washington. Bulk samples are being ordered for further tests as shielding for low background counters.

Two neutron dosimeters were compared in neutron fields on the top of a reactor. Roughly speaking, one instrument measured only neutrons above 1 Mev; the other, above 0.1 Mev. The former gave about one-half the dose rates of the latter. This means that about one-half the dose was delivered by neutrons below 1 Mev. Measurements of the average energy with the double moderator system confirmed this by showing that the average energy was below 1 Mev. This is the first experimental confirmation that our concern with low energy fast neutrons is

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justified.

The positive ion accelerator was shut down during the month for annual maintenance.

The calorimeter for use in α measurements at the electron Van de Graaff was installed and is being calibrated.

INSTRUMENTATION

Development continued on the Transistorized Scintillation Alpha Hand Counter and an experimental model is complete except for the assembly and installation of the power supplies. This instrument is designed to replace the present Four-Fold Alpha Hand Counters with an instrument of about one-fifth the weight and volume.

The fast neutron Scintillation Exposure-Rate Meter was field tested at 105-KE and 105-F. The data obtained at 105-F were compared favorably with data from the De Pangher double-moderated BF_3 tube system at various locations on the pile. Comparison information between the scintillation instrument and the "Neut" was obtained at 105-KE. Further data will be taken.

The design was started on an instrument for measuring the alpha, beta, and gamma contamination on a four-inch by eight-inch filter. The instrument will employ two scintillation detection systems which simultaneously measure and indicate the filter alpha and beta-gamma contamination components. At present, two instruments are required with the filter being placed first in one, then the other. In addition to the manpower saving, the reliability of the data is expected to be improved.

Both the analog and digital systems for the dual-filter Alpha Air Monitor have been fabricated and tested synthetically. Both systems accept alpha and background pulses from the two filters and, by means of balancing circuitry and filter collection efficiency differences, balance out the background counts to obtain better airborne alpha sensitivity. Both systems are expected to alarm at a level of about 200 MPC of Pu alpha in three minutes. Field tests are continuing on the prototype High Level Alpha Air Monitor and Alarm.

Development on the zinc sulfide particle detector and recorder for the Atmospheric Physics Unit is continuing. A new approach that appears promising is to expose the zinc sulfide particles on filters first to an incandescent lamp and secondly to a multiplier phototube. The resultant current is meter-indicated and chart-recorded. The peak readout current is directly proportional to the number of particles on the filter.

CUSTOMER WORK

Weather Forecasting and Meteorology Service

<u>Type of Forecast</u>	<u>Number Made</u>	<u>% Reliability</u>
8-Hour Production	93	86.2
24-Hour General	62	85.5
Special	158	81.6

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Summary of the Weather

The average temperature and total precipitation were both somewhat below normal during July. There were numerous windy periods, particularly during the evening hours. However, there were no cases of unusually strong or destructive winds.

A telephone recorder designed to relay the current weather forecasts and observations directly to all plant customers was installed and tested. Official use of this system was scheduled to begin on August 5, 1957.

Optical Service

The routine optical shop work consisted of the fabrication of ten lenses, four quartz windows and two periscope eyepieces; the installation of the 105-DR Discharge Area Periscope; the calibration of a microscope; the servicing of three three-power crane periscope heads; and the polishing of eight sodium chloride and thallium bromide windows.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

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VISITS TO HANFORD WORKS

<u>Name</u>	<u>Dates of Visits</u>	<u>Company or Organization Represented & Address</u>	<u>Reason for Visit</u>	<u>H. W. Personnel Contacted</u>	<u>Access to Restricted Data</u>	<u>Areas and Buildings Visited</u>
AE Cohn WJ Hamm	July 10-11	U.S. Army Signal Corp Labs. Fort Monmouth, N. J.	Discuss Instrumentation.	LV Zuerner	No	300:329 3745 3745-A 3745-B
RE Kerr	July 25	North American Weather Consultants Goleta, Calif.	Discuss Field Experimentation Techniques.	GR Hilst JJ Fuquay	No	200-W: 622

VISITS TO OTHER INSTALLATIONS

<u>Name</u>	<u>Dates of Visits</u>	<u>Company Visited and Address</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>
GR Hilst	July 15-17	University of Washington and Friday Harbor Seattle, Wash.	Conference with Staff Members.	PE Church RG Fleagle	No
BR Leonard, Jr.	July 17-18	Idaho Falls Operation Office, Idaho Falls, Idaho	Present HLO cross-section program and attend Meeting of Nuclear Cross Section Advisory Group.	JE Evans	Yes

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Chemical Research & Development Operation

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ORGANIZATION AND PERSONNEL

C. E. Linderorth, transferred into Chemical Effluents Technology as Supervisor - Process Demonstration and Analysis.

Dr. Roy K. Uenishi, Chemist I, was hired and assigned to Chemical Research.

E. W. Neuvar and R. T. Alleman transferred from Relations and Utilities as Technical Graduates and were promoted to Engineer II.

M. W. Walkup, Chemist II, terminated from Analytical Laboratories Operation to make homemaking her full time activity.

Pauline M. Carver and Verlene Peterson, Secretarial, transferred in from Relations and Utilities.

Doris H. Larson, Secretary, transferred to Physics and Instrumentation Operation.

B. W. Adler and M. S. Harbison, Laboratory Assistants, went on leave of absence.

RELATIONS

A dinner meeting was held for the professors attending the Summer Institute of Nuclear Energy.

T. F. Evans visited at Arco, Idaho to compare data on continuous type dissolver studies.

RESEARCH AND DEVELOPMENT

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Analytical Chemical

Fluctuation of isotopic content of reactor effluent water was insignificant except for Mn-56. The Mn-56 concentration decreased to its value prior to the spring run-off.

An increase in capacity of about 40 per cent appears possible in the KE Radiological Laboratory with the same personnel complement. For a trial period reactor effluent samples were analyzed in three days instead of the normal five days. With reasonable changes, rearrangement of work schedules and additional equipment, the increased processing is considered feasible.

Analytical Chemistry

Direct analyses of uranium and plutonium in plant dissolver solutions were completed and reported to Reactor and Process Development Operation, IPD. The needed precision, $\leq \pm 1$ per cent was achieved for all values reported. The determination of plutonium to that precision is better by four per cent than previously reported analyses of dissolver solution.

DECLASSIFIEDOrganic Coolants - Analytical Service

The organic coolant analytical laboratory was moved from the basement of 1706-KER to 183-KE Building.

Methods for the determination of viscosity and density at $400^{\circ} \pm 0.1^{\circ} \text{F}$ were perfected and placed in use. A General Electric silicone oil, SF-96, proved a satisfactory bath media at high temperature.

Automatic Analyzing Monitor

Assembly was completed of all components of the monitor and initial shakedown tests were made. Modification in the sample delivery and treating cycles improved this phase of the monitor. Other changes included reducing the delivery line piping to a minimum for decreased hold-up time and installing capillary orifices for limiting flow rates.

Continued improvement in the performance of the electronic components was achieved through circuit modifications. Special capacitors were installed to permit a long time constant and greater stability of the count rate meter at low counting rates. Improvement in the Streeter Amet printer performance resulted from changes in the control circuits. The coincidence circuit was revised to employ crystal diodes rather than the 6BN6 tube previously employed. Improved performance is expected after final adjustments are made in the circuit.

Evaluation of Slug Rupture Detectors

Estimates were made of Sr^{89-90} introduced to the Columbia River from ruptured elements during the last months of 1956 and the early months of 1957. For corresponding months for which data were available, the Sr^{89-90} concentration in the reactor effluent water during periods of no ruptures was also obtained. The concentration of Sr^{89-90} measured at Pasco was compared with the sum of the average concentrations predicted to result from ruptures and from reactor effluent water in the absence of ruptures. The comparison revealed that actual Pasco concentrations were generally lower than the predicted by a significant factor. The agreement was believed to be satisfactory, however, when consideration was taken of the acknowledged cleanup in transit of particulate material introduced to the river and the uncertainty in the estimate of fission products released from a rupture. The present data are compatible with the assumption that from 15-40 per cent of the material initially present remains water borne at Pasco. This range of values may be compared with a range of 40 to 80 per cent measured for several other isotopes appearing in reactor effluent. The significance of reported data is that the method used for converting numbers of ruptures and severity to the resulting concentration of fission products released to the water is a reasonably good approximation and one which may likely be useful in interpreting rupture monitor response.

Arrangements were made to obtain rupture monitor records and samples of water taken from the header producing the rupture signal. The water samples will be analyzed to determine fission products present. A relation will be charted between rupture monitor signal amplitude and rate of fission product release.

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Process Assistance

Sampling tubes were installed at the KE reactor for evaluating the effect of M-388 (Ni-Al alloy) clad fuel elements on the kind and amount of radioactive isotopes in reactor effluent water. A sampling and analysis program was specified to give the necessary information.

A program was initiated to better define the sources of predominant isotopes in reactor effluent, in order that practicable measures might be developed for reducing concentration of isotopes in the Columbia River. As⁷⁶ and Np²³⁹ are to be given extensive study first, since they contribute so predominantly to the present fraction of the MPL at Pasco. Activation analyses of all possible inert arsenic contributors was requested. An initial experiment was performed to estimate the uranium present on the exterior of fuel elements and thereby evaluate the uranium as a potential source of Np²³⁹. The limited data show that about 3 - 4 micrograms per slug could be removed by treating with nitric acid.

Uranium Oxidation - Melting Experiments

The literature search continued to determine the extent of prior work in this area. So extensive are references in this field, it was decided to prepare a summary report and bibliography which will be issued shortly. The induction furnace available was tested further using iron, stainless steel, and aluminum pieces as the heated medium. Maximum temperatures were not high enough to carry out the anticipated experiments with uranium.

SEPARATIONS PROCESSES

Effect of Carbon Content on the Rate of Dissolution of Uranium

Experiments were performed to determine the feasibility of increasing the rate of dissolution of Dingo uranium by addition of carbon. Samples for this study were prepared by A. L. Bement of the Fuel Fabrication Development Operation, who also measured the grain size on polished samples of the metal heels remaining after the dissolution studies and on slug wafers which had been used in earlier dissolution studies. The results obtained are summarized in Table II. Dissolution rates reported are initial values obtained by measuring the weight loss as a function of time for alloy samples immersed in boiling eight molar nitric acid.

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EFFECT OF CARBON CONTENT AND GRAIN SIZE ON RATE OF DISSOLUTION OF
URANIUM IN BOILING 8 M HNO₃

<u>Sample</u>	<u>ppm C</u>	<u>Grain Size^(a)</u> <u>(mean dia.-mm.)</u>	<u>Initial Rate</u> <u>of Dissolution</u> <u>(g/cm², hr.)</u>
I	150	0.3 - 0.5	0.15
I	320	0.13 - 0.18	1.1
I	1570	0.05 - 0.065	2.2
I	810	0.08 - 0.1	2.3
I	1110	0.065 - 0.1	2.6
II	40	0.25 - 0.30	0.32
III	630	0.15 - 0.18	0.71

I - Samples prepared by A. L. Bement by fusing Dingot metal with high-carbon master alloy prepared from same Dingot metal, using graphite crucibles with zirconia liners.

II - Wafer cut from Dingot metal slug.

III - Wafer cut from Fernald production metal slug.

(a) Data of A. L. Bement

It will be noted that increasing the carbon content increased the rate of dissolution of the samples (type I) prepared for this study. However, comparing the results with these samples with those obtained for samples of different history it appears that a better correlation is obtained for dissolution rate against grain size than against carbon content.

The fact that dissolution rates three to four-fold higher were obtained with the high carbon alloys (type I) than were obtained with Fernald production metal (type III) suggests the possibility that the methods of manufacturing Hanford slugs can be altered to produce finer-grained material and that this material might dissolve at a significantly greater rate, thus enabling the processing rate in the separations plant dissolvers to be increased.

PUREX

Mini Runs - Phase II Flowsheet

A second series of Mini runs was made to investigate the effect of scrub stream acidity on decontamination performance of flowsheets of the type planned for the Phase II Purex plant. In these runs, as in those reported last month, the shielded twenty-one stage Mini unit was employed as a dual-purpose HA unit and an unshielded sixteen stage unit was used as a supplementary scrub section (HS unit). Both units were operated at 35 C as in the runs reported last month. An additional batch stripping step was included in the present runs in order to estimate "C" column decontamination behavior.

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Stream compositions, flows, and entry points were as follows:

<u>Stream</u>	<u>Composition</u>	<u>Relative Flow</u>	<u>Entry Point</u>
			(Aqueous waste withdrawn at stage No. 1.)
HAF	1.8 M UNH, 1.0 M HNO_3 (20% Full-Level F.P. Activity)	75	Stage No. 12
HAX	30% TBP(a) in Soltrol	345	Stage No. 1
HSS	Run 7-16 1.0 M HNO_3 Run 7-15 2.0 M HNO_3 Run 7-17 4.0 M HNO_3	67	Stage No. 37
HSR		67	Stage No. 20
1BSU (Synthetic)	30% TBP(a) in Soltrol 0.35 M HNO_3	67	Stage No. 18
3WB (Synthetic)	8.0 M HNO_3	25	Stage No. 6

(a) Vacuum-distilled TBP..

Decontamination data obtained are shown in Table I.

TABLE I
EFFECT OF HSS ACIDITY ON DECONTAMINATION
IN PUREX PHASE II FLOWSHEET
DECONTAMINATION FACTORS

<u>Run No.</u>	<u>HSS</u>	<u>Zr-Nb</u>			<u>Ru</u>		
		<u>HAF/HAO</u>	<u>HAF/HAP</u>	<u>HAF/HCP</u> (a)	<u>HAF/HAO</u>	<u>HAF/HAP</u>	<u>HAF/HCP</u> (a)
7-16	1 M HNO_3	1.0×10^4	1.1×10^4	9.9×10^4	1.7×10^3	2.3×10^3	1.1×10^4
7-15	2 M HNO_3	6.1×10^3	1.36×10^4	5.0×10^4	6×10^2	2×10^3	2.4×10^4
7-17	4 M HNO_3	1.0×10^4	2.3×10^4	8.7×10^4	3.8×10^3	1.5×10^4	5.5×10^4

(a) HAP contacted with five equal-volume portions of HCX to simulate HC column operation.

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Little change in zirconium-niobium decontamination was observed on increasing the HSS acidity from one molar to four molar nitric acid. However, only about the first ten or twelve Mini scrub stages were effective for zirconium-niobium in these runs, the zirconium-niobium profile being essentially flat through the last twelve to fifteen Mini scrub stages. Thus the zirconium-niobium decontamination factors observed in all these runs may represent the limiting values attainable with the solvent used in these runs.

Ruthenium continued to scrub through all twenty-five Mini scrub stages although at a much reduced rate through the last twelve to fifteen stages. Most of the additional ruthenium decontamination obtained on increasing the HSS acidity occurred in the extraction section. The ruthenium scrubbing rate was about the same in all cases.

Plutonium waste losses were 0.02, 0.04, and 0.16 per cent for runs 7-15, 7-16, and 7-17, respectively. It may be noted that these losses are much lower than those observed in the runs reported last month. It is believed that mechanical malfunctioning accounted for the high uranium and plutonium waste losses and may have accounted for the higher decontamination observed in the earlier runs.

Decontamination factors of 4 to 12 were obtained in the exhaustive batch stripping operation which was used to simulate the "C" column in the present runs. In view of this it is planned to repeat certain of these runs with plant solvent where effects due to "irreversible" extraction of fission products may be "saturated."

Solvent Extraction

Purex 1BX Column. Studies directed toward the development of a Purex 1BX Column cartridge having increased capacity under Purex Phase II Flowsheet (HW-47889) conditions were completed.

In addition to the flooding studies reported last month, two steady state runs were made under the following conditions:

Column Diameter	3 in.
Column Height	13 ft.
Cartridge	(1)
Column Temperature	35 C
Flowsheet	Purex Phase II
Pulse Amplitude	0-8
Run Duration	8 hr.
Capacity Factor	1.5 and 3.0

Note: (1) Alternate groups of four stainless steel sieve plates (33 per cent free area) and one linear polyethylene sieve plate (23 per cent free area), all on 2-inch spacing. Louver plates flanked by polyethylene plates four inches above and below were located at approximately three-foot intervals.

Uranium and nitric acid concentrations in the effluent streams were consistent with the flowsheet values. No abnormal performance was observed during prolonged operation. Analysis of the aqueous phase at intermediate column heights indicated that equilibrium was reached after 2 to 3 hours of operation.

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Highlights of the study include:

1. The present Purex 1BX Column cartridge is adequate for operation at a capacity factor of 3.2.
2. The mixed plate cartridge described above would be adequate for operation at a capacity factor of 4.0. (Stable operation was achieved at a capacity factor of 5 and a pulse frequency of 50 cycles/min.).
3. Although efficiency studies were not made, visual observations of the dispersion under identical operating conditions indicate that the mixed plate cartridge should at least equal the present plant cartridge in efficiency.

Annular Pulse Column. Studies were started to determine the operating characteristics of a pulse column utilizing the annulus between a 16-inch and a 12-inch diameter pipe as the contacting zone. The 1.5-inch thick annulus has a cross-section equivalent to an 8.8-inch diameter cylinder. The column was packed for a height of 19 feet with one inch fluorothene Raschig rings. Initial operation was undertaken under Purex 2A Column conditions (Phase II Flowsheet) with heated feeds and a pulse amplitude of 0.72 inch.

Stable operation was obtained at a volume velocity of 1040 gal./hr-sq.ft., sum of phases (equivalent to a plant capacity factor of 4) and a pulse frequency of 90 cycles/min. Channeling of the aqueous phase down the inside wall was evident at low throughput rates and was most noticeable in the upper half of the column.

Anion Exchange Process for Plutonium Recovery

A run was made to determine the effects of small amounts of uranium on plutonium behavior in the Purex anion exchange step. A 45 cm column of Dowex-1, X-4 (50 to 100 mesh) was loaded at 50 C out of a feed containing 7.2 molar nitric acid, 0.05 molar sulfuric acid, 0.82 g/l plutonium and 1.0 g/l uranium. The column was washed with four column volumes of 7.2 molar nitric acid and the product eluted with 0.35 molar nitric acid. The small amount of uranium present in the feed did not measurably affect the capacity of the column for plutonium, and the plutonium product met the specification for uranium. The product plutonium contained only 28 ppm uranium, corresponding to a decontamination factor of 4.5×10^4 for uranium.

A run was made to evaluate an eight per cent cross-linked Dowex-1 (50 to 100 mesh) resin for possible use in the Purex anion exchange step. A 45 cm column was loaded at 60 C out of a feed containing 0.5 g/l plutonium in 7.2 molar nitric acid at a flow rate of 20 ml/min., cm². The resin capacity was 89 mg Pu/ml resin at 50 per cent breakthrough, which is about what would be expected at 50 C with the four per cent cross-linked resin which is scheduled for use in Purex. Elution was carried out at 60 C with 0.35 molar nitric acid at a flow rate of 0.5 ml/min., cm². Elution behavior was quite poor. The maximum product concentration reached was 47 g/l and this was followed by very severe tailing. Only 90 per cent of the plutonium was removed at an average product concentration above 25 g/l. This resin is, therefore, not considered suitable for the Purex anion exchange step because of this poor elution behavior.

A report is in preparation summarizing the studies made in support of the Purex anion exchange cycle.

WASTE TREATMENT, FISSION PRODUCT RECOVERY**DECLASSIFIED**Evolution of Nitrogen Oxides from Purex Waste

The following observations have been made during laboratory studies concerning the source of oxides of nitrogen evolved from Purex Waste Tank 241A-103.

1. No oxides of nitrogen are produced by prolonged boiling of a synthetic waste (prepared from data supplied by Purex Technology Operation personnel).
2. Oxides of nitrogen are released rapidly if the waste is made acidic.
3. No visible evolution of NO_2 occurs if MnO_2 or KMnO_4 are added to the waste but NO_2 is evolved rapidly if manganous salts (SO_4^{2-} or NO_3^-) or hydroxide are added.
4. Off-gas from the boiling (123 C) synthetic waste contains CO_2 much in excess of that present in air used to sparge the waste (simulation of air-lift circulators).

In a plant test, MnO_2 (11 lb.) was added to the 103 tank. Off-gas NO_2 content rose slightly (from 10 to 40 ppm) and then receded. During a recent Purex shut-down, waste resulting from permanganate washing of solvent was added to the 101 tank. This is the first waste containing manganese added to the tank. Contents of the tank had just reached the boiling point. No visible evolution of NO_2 occurred.

Further studies will concern possible evolution of nitrogen oxides from the waste solids at high temperature (250 C and higher).

Radiolysis of Stored Aqueous Wastes - Related Studies

Samples of concentrated sodium nitrate and sodium nitrite solutions have been irradiated to very high doses (8×10^9 r) to obtain information on the equilibrium point in the nitrate-nitrite conversion. The experimental results indicate that the equilibrium concentration of nitrite ion is in excess of 4.4 M when formed by radiolysis of 7.5 M NO_3^- solutions.

Radiolysis of sodium nitrate solutions confirmed earlier work and showed that the principal decomposition product is NO_2 (perhaps as NO) with traces of N_2O . Radiolysis of sodium nitrite solutions, however, has produced only N_2O with or without added sodium hydroxide and in the presence or absence of oxygen. In the latter experiment, NO_2 in concentrations below about 0.05 per cent could be present but would not be detected by the analytical procedure employed.

2000 Program - Waste Disposal Processes

Study of the high-level waste storage problem was continued with a review of historical and anticipated near future waste storage construction costs. Expansion of facilities to include the 241-SY Farm is expected to cost about 60 per cent more per gallon than the final cost of the existing complex and flexible 241-SX installation. Purex farm costs are expected to be appreciably greater than this. Such costs encourage renewed research and development activities on alternate disposal methods. Although specific technologies are not adequately developed, methods are of interest which involve (1) the highly efficient separation and compact segregated dry storage

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of the long-lived fission products and (2) processing of wastes to achieve minimum volume for ultimate dry storage of mixed fission products. Such processing is of interest also in connection with the PRP fuel cycle.

WASTE TREATMENT AND BY-PRODUCT RECOVERY

Cesium Recovery

A series of experiments have been carried out to determine and optimize the centrifugation and filtration characteristics of the hydrous oxide precipitate which is formed when a Purex IWW waste solution is neutralized prior to cesium recovery by zinc ferrocyanide scavenging. It was found that filtration (through a ten micron, size G, Micrometallic stainless steel filter) generally gave smaller cake volumes than did centrifugation, that elevated temperatures gave superior results, and that the precipitates thrown down by slow addition of gaseous ammonia filtered much more rapidly than those with caustic. Other observations were that the sodium nitrate and sodium sulfate present in partially neutralized IWW have a profound effect on the character of the precipitates and that the volume of a mixed cake containing iron, uranium, and aluminum is not necessarily an additive function of the volumes obtained with only iron, uranium, or aluminum present. A detailed report on the filtration experiments is in preparation.

Cerium Recovery

Interest has recently been shown for the recovery at Hanford of eight megacuries per year of cesium-137 and two megacuries per year of cerium-144. Since two megacuries of cerium is a small fraction of the total cerium produced per year, it would be desirable to recover this amount of cerium by means of an intermittent batch operation. A method was accordingly developed for precipitation of cerium from Purex IWW solution prior to removal of iron. This involved oxidation of cerium to the (IV) state by digestion with persulfate followed by quantitative precipitation as the iodate. Fair decontamination from the other fission products was obtained by this procedure. The use of periodate to both oxidize and precipitate cerium gave somewhat lower recoveries of about 80 per cent.

Other experiments were aimed at clearing up the difficulties which have been experienced in the variable behavior of cerium and rare earths in the "Integral" flowsheet. Thus, it has been Oak Ridge experience that cerium and the rare earths remain in solution when iron is precipitated at low pH. In "Integral" flowsheet tests, this behavior has occasionally been realized; however, more often a major part of the cerium has precipitated with the iron. Since the principal difference between the Oak Ridge waste and Purex IWW is the lower iron concentration in the former, dilution of IWW was tried. A two-fold dilution followed by careful precipitation of iron resulted in retention of 94 per cent of the cerium in the supernate. Future experiments will attempt to determine whether this behavior is indeed due to the iron concentration or to gross salt content.

Americium Recovery

It has been previously demonstrated that americium follows the rare earths in the "Integral" flowsheet and that it can then be separated from them by ion exchange techniques. A method for direct recovery of americium from IWW was also desired in

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event the integrated flowsheet was not used. Preliminary experiments have shown that it is possible to precipitate over 99.9 per cent of the americium from a synthetic IWW solution with lanthanum fluoride after neutralizing to an acidity of 1 M. The fluoride cake is then metathesized with sodium hydroxide, the hydroxides are dissolved in acid, and americium (and plutonium) are separated from the rare earths (and lanthanum) by either of the ion exchange processes previously investigated.

Neptunium Recovery.

The extraction of neptunium with tri-n-octylamine has been investigated as a means of isolation from Purex process streams such as the 2DW boil-down or IWW solutions. The tetravalent oxidation state exhibited large extraction coefficients either into the pure amine or into a solution of the amine in a hydrocarbon, such as xylene or kerosene. The neptunium was stripped from the organic phase with water. These facts suggest that it may be possible to recovery and concentrate neptunium by a batch extraction-scrub operation vice anion exchange. This would have the important advantage of eliminating the gassing problem and, perhaps, the radiation decomposition difficulties which are associated with ion exchange.

The effect of tri-n-octylamine concentration on the extractability of neptunium is shown in Table III.

TABLE III

EFFECT OF AMINE CONCENTRATION ON
NEPTUNIUM (IV) EXTRACTION

Conditions: 8.0 M HNO_3 , 0.01 M ferrous sulfamate, indicated volume per cent tri-n-octylamine in xylene.

<u>% Tri-n-octylamine</u>	<u>E_a^0</u>
1	0.55
5	12
10	37
20	106
50	284
100	720

It will be noted that quite high extraction coefficients are obtained even with a ten per cent amine solution. The effect of nitric acid concentration is shown in Table IV.

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DECLASSIFIEDTABLE IVEFFECT OF NITRIC ACID CONCENTRATION
ON NEPTUNIUM (IV) EXTRACTION

Conditions: Ten per cent tri-n-octylamine-xylene, indicated nitric acid, 0.01 M ferrous sulfamate.

<u>M HNO₃</u>	<u>E_a^o</u>
2	45
4	66
5	60
6	58
7	55
8	37
9	28
10	14

The extraction is relatively insensitive to acidity, and large distribution coefficients are obtained over the range 2 to 8 M nitric acid. Stripping a ten per cent n-octylamine solution with water gave a neptunium (IV) distribution coefficient, E_a^o , of 0.57. This could probably be reduced much lower by using an oxidizing or complexing strip or by stripping with dilute caustic, as is done in the amine extraction process for recovering uranium from ores.

Mini runs were made during the month to determine the path of neptunium in the 2D column under conditions of the proposed Purex phase II flowsheet. Feed was 1.5 M UNH, 0.3 M HNO₃, 0.01 M ferrous sulfamate, relative flow 100. The scrub was 1.3 M nitric acid, flow 67, and the extractant was 30 per cent TBP - Soltrol, flow 366. Eight Mini stages were used for extraction and eight for scrubbing. Over 90 per cent of the neptunium added in the feed was found in the 2DW, and none was detected in the 2DU. These results inspire confidence that all of the neptunium can be routed to the 2DW in the Purex plant; however, plant tests will undoubtedly be required to firm up the conditions since the neptunium (IV) split is very sensitive to acidity and degree of solvent saturation. Also, the plant 2D column employs a compound scrub which cannot be readily simulated in the laboratory equipment. This may result in reflux of a large amount of nitric acid (and perhaps neptunium).

Continuing work on the anion isolation process showed that the previously observed column gassing was completely eliminated by substitution of un-dried four per cent cross-linked Dowex 1 resin for the dried ten per cent cross-linked previously employed. No trouble was experienced with synthetic solutions containing up to 8 M nitric acid and 0.1 M semicarbazide, even when the solutions stood in the column over night. Conversely, with actual plant solutions, gassing was extremely severe and soon plugged the column. Further experiments suggest that this phenomenon may be due to the high concentrations of iron (0.2 to 0.3 M) which result from concentration of the solution; however, no way has yet been found to eliminate this difficulty.

Special Geological Studies

The Geological Survey and the Hatch Drilling Company are both operating slightly but not critically behind schedule, the former because of slow drilling at a

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500-ft. depth in one well and a crooked casing and parted weld in the second well. The Hatch Drilling Company was delayed when several faulty welds failed, forcing the redrilling of one well and the introduction of a liner into the second. A visit to Hanford by a representative of the pipe fabricator resulted in steps to prevent a recurrence of the faulty welds at the steel plant, and recommendations for reinforcing suspected bad welds in the field to eliminate further problems.

Geophysical seismic crews of Geophysical Service, Inc., the selected contractor, are reported to be immediately available for the planned geophysical evaluation survey. Uncertainty regarding the availability of funds is evidently resulting in a critical delay of the work such that guidance of well drilling in FY 1958 and 1959 will be less sure than desirable and possible reduction of that work in FY 1959 may not be achieved.

Observation Wells

Positive identification of Sr^{90} in ground water samples from a well adjacent to the abandoned 216-S-1 and 2 crib was repeated. No other ground water samples contained a detectable concentration of radiostrontium and none contained a detectable concentration of radiocesium. The completion of two additional monitoring wells in the vicinity of the Redox plant helped resolve the contamination pattern in the ground water in that region. Contamination from the 216-S-1 and 2 cribs, the 216-S-7 crib, and the 216-WR crib that reaches the ground water moves in a southeasterly direction. Ground water contamination in wells due east of the Redox plant was identified as originating at the 216-WR crib. This movement conforms closely with the ground water contour pattern as now visualized. The southeasterly movement is a somewhat more satisfactory travel path than would be easterly movement because the material thus moves through the Ringold formation for a greater distance. The upper Ringold has a lower permeability and a higher exchange capacity than the unconsolidated glaciofluvial formation which is intercepted by the water table east of 200 West Area.

The concentration of radioactive material in the ground water adjacent to the Purex A-8 crib continued to increase. The average concentration in samples obtained in July was 3×10^{-3} uc/cc. Samples from a well 400 feet southwest of the crib averaged 1×10^{-4} uc/cc. The wastes discharged to this crib during April, May, and June averaged 4.7×10^{-2} uc/cc, total beta emitters. Thus, the ground water concentration immediately beneath the crib is just slightly less than 0.1 of that of the wastes being discharged to it. This ratio between gross beta concentration in the waste and that in the ground water is approaching that at which breakthrough of long-lived isotopes has been previously observed. No prediction of crib life can be based with assurance on this generalization, however, because of the great differences in the chemical nature of the various waste streams.

Disposal to Ground

The fourth batch of in-farm scavenged waste was limited to less than one column volume on the basis of poor Cs^{137} retention by soil. Samples of two additional batches of scavenged waste were tested by means of soil columns. One batch demonstrated good adsorption of Sr^{90} and Cs^{137} but disposal was limited by a high Co^{60} content. The other batch of waste was limited to the disposal of three column volumes by Cs^{137} breakthrough.

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Laboratory tests were continued to evaluate the capacity of the Purex A-8 crib. Samples of this waste were being tested at month end. HW-51399 (Unclassified), "Calculation of Purex A-8 Crib Capacity," was issued, reporting progress to date on this work.

Two samples of aluminum coating waste were tested by passing them through laboratory soil columns. The possibility of direct ground disposal of this material was evaluated. One of the samples showed Cs^{137} and Sr^{90} breakthrough after passage of one-half column volume of effluent. The other sample produced a breakthrough of Cs^{137} after passage of one column volume. In both tests Co^{60} displayed very poor retention on the soil.

The cyanide and ferrocyanide ion content of several samples of scavenged waste was determined. Farm-scavenged waste contained less than 15 ppm ferrocyanide ion and 1-2 ppm cyanide ion. Building-scavenged wastes contained 170-210 ppm ferrocyanide and 1-2 ppm cyanide ion. Soil column tests indicated no appreciable retention of these ions in soils.

Gelling of Wastes - Field Work

A review of the aluminum coating waste gelling program was made in the light of present available data. It was decided that the 'cold' field tests should proceed. Results of these tests are expected to define the pumping, metering and mixing equipment necessary for the process. Some qualitative information should also be obtained from observing the gel over a period of several weeks.

Soil and gel samples from the 6-inch diameter laboratory column were analyzed for moisture content after moisture movement through the soil column had essentially stopped. The remaining gel volume was approximately 30 per cent of the original gel volume and contained 45 per cent moisture. The soil under the gel was wetted uniformly to a depth of 50 inches; a lower concentration of moisture was noted in the last 12 inches of soil. This relatively high loss of moisture to the soil (5-feet of wetted soil per foot of gel bed depth) indicates the need for additional laboratory and field development work directed toward providing an impermeable barrier between the gel and soil, retaining virtually all the radioactive material in the dehydrated gel, or changing the recipe of the mixture to produce a gel with improved moisture and cesium retention properties.

ANALYTICAL DEVELOPMENT AND INSTRUMENTATION

Mass Spectrometry

Evaluation of the pulse counting technique for isotopic analysis with the mass spectrometer has resulted in the conclusion that the scanning method yields better precision than the pulse counting method in the case of macro samples although the latter method has the advantage of requiring much smaller samples. Since sample size is not limiting in the analytical work anticipated, the scanning method will be used exclusively because of its better precision and greater instrumental simplicity.

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DECLASSIFIEDPolarography

The testing of the modified circuit of the square wave polarograph has continued, and the ideal (theoretical) resolution was demonstrated. The instrument has a good output linearity below 1×10^{-4} moles per liter, and the sensitivity for many elements is excellent. A concentration of about 5×10^{-6} M lead ion and of about 2×10^{-5} M uranyl ion (in nitrate) is detectable.

Alpha Energy Analyzer

The feasibility of performing alpha energy analyses of very small samples was tested. Since the instrumental background is about one count per minute, and the background in any one energy peak width is a fraction of this, it appears feasible to do an alpha energy analysis with a total sample of about one alpha count per minute. This was verified by analyzing a Pu-239, Am-241 mixture at several levels down to 1.57 total alpha counts per minute. The data are given in Table V. The precision values are 2σ -values based on counting statistics only. The background was constant, and there was no instrumental drift over a ten day period. Alpha energy chambers having a much lower background can be constructed. These have the advantage of permitting equivalent precision in much shorter counting times.

TABLE VALPHA ENERGY ANALYSIS OF SMALL ALIQUOTS OF A Pu-239, Am-241 SOLUTION

Source	Total Alpha, c/m	Pu Peak, c/m (Channels 4-9)	Am Peak, c/m (Channels 12-17)	Alpha % Pu	Alpha % Am
Background	1.08 ± 0.03	0.55 ± 0.02	0.22 ± 0.02	--	--
1	26.1 ± 0.9	18.7 ± 0.8	5.38 ± 0.4	78 ± 3	22 ± 2
2	3.23 ± 0.1	2.23 ± 0.09	0.86 ± 0.06	72 ± 3	28 ± 2
3	1.57 ± 0.06	1.13 ± 0.04	0.31 ± 0.03	78 ± 4	22 ± 2

Controlled Potential Coulometry

A controlled potential coulometric analysis method was applied successfully to the high precision determination of plutonium in Redox dissolver solutions. The solutions from two special single channel dissolutions, including an I and E slug channel, were analyzed by the method, which was adapted for the purpose as a joint effort with the Analytical Laboratories Operation. A precision (estimated 2σ for a single determination) of ± 0.6 per cent was obtained. The method used was briefly as follows:

1. A sample containing 50 to 100 μ g of plutonium (0.5 to 1.0 ml of dissolver solution) was selected and the valence adjusted to Pu (IV).

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2. Two successive precipitations of lanthanum fluoride were carried out in the sample to separate the plutonium from the uranium and much of the fission products.
3. The combined precipitates were dissolved in perchloric acid, diluted and then added to a citrate buffered solution for analysis.
4. The plutonium was pre-reduced coulometrically at a mercury cathode at - 0.2 volts and then titrated at + 0.08 volts. This oxidation-reduction cycle was repeated several times.
5. A synthetic dissolver solution containing a known amount of plutonium was carried through the same procedure to obtain a calibration.

Sample System Development

An improved sampling system containing an in-canyon degasser has been tested in the 321 Building. Tests to date have been carried out with a temporary set up constructed primarily of plastic tubing and metal fittings. The system lifts a solution with a specific gravity of 1.2 to a height of 28 feet with the aid of an air lift. A degasser at the 28-foot level separates the liquid and air phases and provides a sufficient pressure differential for driving the solution through the sample cell. Solution begins to flow through the sample cell 3 minutes after the jet is turned "on". The cell drains (back to the degasser) in about 30 seconds after the jet is turned "off". The advantages of this system are:

1. Only a minimum of piping modifications are required for installation at Purex.
2. No valves are required in the canyon or in the process lines.
3. The jet remains in the sample pit.
4. Sample cells fill in less than half the time previously required.

Anion Exchange Resin Level Indicator

Carbon electrodes have been found satisfactory for use in the high acid anion exchange system. The electrodes consist of 0.12-inch diameter carbon rods pressed into stainless steel holders. This element is housed in an insulator bushing inside a standard "Swagelok" fitting. The electrodes have been electrically tested and delivered to the Purex plant for installation.

Gamma Absorptometer

A laboratory model sample cell for use in the Redox LAFS stream has been constructed and is being tested. The cell contains sensing elements, for both pH and gamma absorptometric measurements, and will permit the simultaneous determination of nitric acid (pH) and uranium concentration on the same sample. The primary development problem associated with this cell concerns the optimum geometry for gamma attenuation at the nominal 325 grams uranium per liter. With the gamma photon beam passing

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diametrically through a cylindrical section of the sample, favorable results have been obtained with solutions containing up to 400 grams uranium per liter.

Interface Detector

The float-type interface detector has been tested on the 321 2A Column. The detector-controller system has controlled the interface level to $\pm 1/8$ -inch at pulse frequencies up to 70 cycles per minute at capacity factors up to four. On the basis of these tests CPD-R&E has recommended that a float-type detector be installed in the Purex 2A Column.

EQUIPMENT AND MATERIALS

Valves

Hammermill Rotary Feeder Valve, 224 UA Building. A 5-inch diameter vane-type rotary feeder valve (SK-2-43235) similar to the 3-inch diameter rotary valves (SK-2-43229) has been designed. The 5-inch model is intended to replace the existing 8-inch diameter solid rotary valve that feeds uranium trioxide from the X-22 collection bin to a hammermill.

The existing valves allow excessive air leakage past the rotor. The air fluidizes the powder and prevents it from feeding to the hammermill. The fluctuating discharge rate impairs hammermill operation.

Rotary Feeder Valve, Task II, 234-5 Building. A 3-inch diameter vane-type rotor (SK-2-6540) with 0.018-inch thick Elgiloy vanes was fabricated for the 234-5 Building continuous Task II Hood 9A rotary feeder valve. This work was performed at the request of Finished Products Technology Operation to provide a back-up valve for the solid rotor unit being installed as original equipment.

Pumps

Redox Spare (Bingham Deepwell Turbine). Immediately on startup of the pump on the 16-inch column teststand a heavy vibration resulted in fracture of the glass bearings and destruction of the Polypenco K-51 foot bearing. This pump operated 200 hours (April 1957) when first installed. The shaft seized and the motor windings burned, stopping the first test.

The Peerless Pump Company has recently reported serious difficulty with the discharge head sections of similar pumps. Inadequate heat treatment subsequent to welding has resulted in the heads warping out of line several weeks after final machining. The head section of the Bingham pump has been sent to the shops for alignment checking.

Titanium Clad Model-S Chempump. Inspection after 2511 hours service pumping 60 per cent nitric acid revealed the following:

1. Negligible wear of the titanium journals.
2. Impeller end Carbolube AP-80 bearings wore 4.6 to 18.6 mils.

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3. Opposite end AP-80 bearings wore 4.6 to 5.7 mils.
4. The Teflon thrust washers wore about 6 and 9 mils, respectively.
5. The PEDO designed shaft lugs and impeller locking lugs were worn to about one-half their original 3/16-inch thickness.
6. The impeller backing plate was grooved and worn about 1/32-inch.

The bearing wear was eccentric as usual. The wear on the shaft lugs and impeller locking lugs is attributed to hydraulic and/or dynamic unbalance that created an oscillating vibration without loosening the impeller hold-down screw. A new method of attaching the impeller must be developed before this pump can be recommended. The Phillips Chemical Company Arco Operation has encountered similar trouble with two stainless steel Model S Chempumps on test at that site.

Pulse Generator - Graphite Plug - Piston Pulser. The graphite plug-piston pulser previously operated for 28×10^6 cycles in the vertical position to determine the feasibility of using this type unit in the Recuplex facility. Continued failure of the Teflon bellows in high concentration plutonium streams makes it desirable to replace the present pulser.

Materials of Construction

Lexan. A polycarbonate recently announced by the General Electric Company, has been tested for 37 days by static emersion at room temperature. The samples were unaffected by 60 per cent nitric acid, 10 per cent nitric acid, Purex HAX and distilled water. The surface was slightly etched in 50 per cent caustic. Carbon tetrachloride, Reguplex CAX and hexone caused severe softening. Gamma exposure to a total dose of 10^8 r caused no detectable change in dimension or hardness. Exposures greater than 10^8 r made the sample quite brittle. Radiation causes a loss of the superior impact strength which this material possesses.

Corrosion Studies

Gold Gaskets for Titanium Piping. Gold appears satisfactory as a gasketing material in contact with titanium metal from a corrosion standpoint. A simulated titanium flange with a gold gasket was exposed to boiling 65 weight per cent nitric acid for a total of 240 hours. Weight loss measurements and solution changes were made every 48 hours. There was no evidence of acceleration of corrosion due to the couple. Since earlier work showed severe galvanic attack of stainless steel in contact with gold, corrosion studies involving all three of these metals (gold, titanium, and stainless steel) in contact will be made.

Titanium and Tantalum in Darex Dissolver Solution. A time and temperature study of the corrosion of A-55 titanium under Darex dissolver conditions (5 M HNO_3 - 2 M HCl) is in progress. Titanium samples are being exposed to this solution in closed glass capsules maintained at temperatures of 115, 125, 135, and 145 C. Time study samples are being exposed at 145 C; samples are removed each 24 hours for inspection. Equilibrium corrosion has not been attained in 96 hours. The rate for the third period (72-96 hours) was 0.006 ipm. A similar study will be made using tantalum coupons now being fabricated.

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Tests are in progress to determine the minimum concentration of HNO_3 required to maintain a titanium surface passive to attack by 1 M HCl . Preliminary results indicate HNO_3 concentrations as low as 0.01 M will maintain a passive surface.

Corrosion of Titanium in Nitric Acid. The corrosion rate of wrought A-55 titanium in boiling 60 weight per cent nitric acid at a metal temperature of 140 C (heat transfer conditions) increased to a maximum of 0.0015 ipm at 100 to 120 hours and then decreased to 0.0004 ipm at 1100 hours. Similar rates were obtained in 30 weight per cent nitric acid; the rate at 400 hours was 0.001 ipm.

Corrosion of Stainless Steels in Ammonium Fluoride Solutions. Long term tests are in progress to determine the corrosion of stressed and unstressed 304-L and 316 stainless steels by 4 M NH_4F (liquid and vapor phases). So far (ca. three weeks exposure) corrosion has been negligible (< one mil/mo.) and the stressed coupons have shown no evidence of stress corrosion cracking.

In short (48 hours) exposures of stainless steels to 4 M NH_4F - 0.2 M HNO_3 (pH 6.1) uniform corrosion at about three mils/mo. was obtained.

NEW PROCESSES

Dissolution of Zircaloy Clad Fuels

Experiments have been done in an attempt to confirm results reported last month in which it appeared that a nitric acid treatment applied to Zircaloy-2 which has been partially passivated by an oxidizing treatment increased the rate of dissolution by ammonium fluoride.

Samples of Zircaloy-2 were prepared for this study by heating for several days at 440 C in oxygen. The oxidized samples were exposed to various concentrations of boiling nitric acid and were then exposed to boiling six molar ammonium fluoride. No change in appearance and negligible weight loss (ca. 0.002 per cent) was noted for the oxidized coupons on exposure to nitric acid.

Results obtained are summarized in Table VI.

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DECLASSIFIEDTABLE VIEFFECT OF PRETREATMENT IN BOILING HNO_3 ON DISSOLUTION OF ZIRCALOY-2BY BOILING 6 M NH_4F

<u>Pretreatment</u>	Weight Lost by Zircaloy-2 in Boiling 6 M NH_4F (Grams lost from 17 gram sample.)		
	<u>10 min.</u>	<u>20 min.</u>	<u>30 min.</u>
260 hours in oxygen at at 440 C	0.04, 0.05	0.5, 0.55	1.42, 1.42 *
260 hours in oxygen at 440 C + one hour in boiling 10 M HNO_3	0.20	1.41	3.53
110 hours in oxygen at 440 C	0.07	0.87	2.32
110 hours in oxygen at 440 C + four hours in boiling 8 M HNO_3	0.25	1.68	3.28
110 hours in oxygen at 440 C + four hours in boiling 16 M HNO_3	0.25	1.53	2.93

A greater rate of attack was observed for those pieces which had been exposed to a nitric acid pretreatment. The difference is not as great as had been anticipated, however, possibly because the Zircaloy coupons used had square edges and considerable attack occurred at these edges even in the control experiments. It is planned to repeat the experiment with highly polished cylindrical pieces having hemispherical ends which earlier work indicates represents the worst case.

An experiment was also performed to test the ammonium fluoride dejacketing operation on uranium cores metallurgically bonded to Zircaloy-2. The sample used in this experiment was obtained from G. T. Geering of the Fuels Design Operation. It was prepared by co-extrusion of uranium and Zircaloy-2 at elevated temperature. The sample used in this experiment was a right cylinder cut from a longer cylinder so that the uranium core was exposed at both ends.

The 30 mil Zircaloy-2 jacket was removed by a 32 minute treatment with boiling six molar ammonium fluoride solution (in 200 per cent excess). The (Dingot) uranium core was then immersed in boiling eight molar nitric acid and the change in weight and dimensions followed with time. The rates of penetration were essentially the same at the ends (which had not been bonded to the Zircaloy-2) as on the sides

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(which had been bonded to Zircaloy-2). Thus 11 mils were removed from both the diameter and the length in 2.1 hours and in 3.2 hours 18 mils had been removed from the diameter and 20 mils from the length. At the time the dissolution was terminated (11.4 hours) 62 per cent of the uranium had dissolved and no residue insoluble in nitric acid had been observed. The average rate of dissolution was about 80 per cent of that which had been previously observed on dissolving a wafer cut from a Dingo metal slug.

On the basis of this preliminary experiment no severe complications are expected in applying the ammonium fluoride dejacketing operation to uranium cores metallurgically bonded to Zircaloy-2.

Flurex Development

An interim report (HW-51314) summarizing development data to date and outlining two possible Flurex flowsheets was issued during the month. The report emphasized the back-transference of hydrogen ion from a nitric acid anolyte and the consequent loss in current efficiency for transfer of uranyl ion through the cation membrane. Suggested means of maintaining high current efficiency were the use of dilute (0.01 M) HNO_3 or of dibasic aluminum nitrate as anolyte. The report stated that the use of NaNO_3 or NH_4NO_3 as anolyte (by adding NaOH or NH_3 to the anode compartment) offered no advantages over the use of HNO_3 due to comparable back-transference of Na^+ and NH_4^+ through the anion membrane. Subsequent work indicates that this conclusion was in error. In most of the earlier runs, sulfate or nitrate instead of fluoride was present in the cathode compartment as a matter of convenience in cell operation. It now appears that, while fluoride back-transfers through the cation membrane to a very small extent, sulfate and nitrate do so appreciably and account for some loss in current efficiency previously attributed to transfer of Na^+ or NH_4^+ from the anode compartment. In recent runs involving 0.1 M NaNO_3 and NH_4NO_3 as anolytes and fluoride in the catholyte, current efficiencies for uranium transfer greater than 90 per cent have been obtained. Further work to verify these observations and to define optimum flowsheet conditions using NH_4NO_3 or NaNO_3 as anolyte are in progress. Dibasic aluminum nitrate appears unsuitable as an anolyte. The hydroxide groups are not readily removed from the aluminum complex and, consequently, will not neutralize hydrogen ions produced at the anode.

Tests of physical and electrical properties of membranes after exposure for 1500 hours at 60 C to anticipated process solutions confirms observations previously reported for shorter exposures. Anion membranes (Nalfilm 1 and Permutit 3148) show little change in properties. Cation membranes (Permutit 3142 and Nalfilm 2) show marked decrease in resistance. Tests for other properties are not yet complete.

REACTOR DEVELOPMENT - 4000 PROGRAM

Impregnated Graphite Studies

During the month 40 pieces of plutonium impregnated graphite (0.5 inches diameter by 1.31 inches long) were prepared and transferred to Plutonium Fuel Development Operation for canning prior to a PCTR test. The average concentration of plutonium oxide as determined by weight gain was 56.2 ± 7.2 mgs Pu/cm^3 ; the variation from piece to piece and from batch to batch being considerably greater than that observed

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with uranium. This valuation has not so far been correlated with any process variable although it is believed that uniform washing and careful drying of the pieces are important. Because of the tendency for plutonium nitrate to form glasses, the early drying cycle is also believed important.

PYROCHEMICAL PROCESSING OF ALUMINUM-PLUTONIUM FUELS

Cryolite Method

No significant decontamination from non-volatile fission product elements can be expected to result from the remelting of irradiated Pu-Al alloy fuel in contact with cryolite in a graphite crucible. This conclusion is based upon the results of an experiment wherein a lump of pile-irradiated UO_2 was reduced in aluminum by the cryolite process to simulate the reprocessing of Pu-Al. Following a one-half hour equilibration period at 1050 C, activities due to Ce-Pr, Zr-Nb, and Ru-Rh were found to have remained in the metal phase. This is in agreement with thermodynamic calculations which would predict these elements to be readily reduced by aluminum. Some activity due to Cs-Ba, however, was found in the salt phase and not detected in the metal phase. Some degree of decontamination from Cs, Ba, and Sr might be predicted, as thermodynamic data indicate these elements may tend to be oxidized by Al_2O_3 and thus transfer to the salt layer.

It should be emphasized that while the cryolite process does not afford an appreciable decontamination factor, this does not preclude its use for the preparation of virgin fuel or for the reconstitution of partially depleted Pu-Al fuel.

Reconstitution of Al-Pu by Segregation in the Melt

Further evidence has been obtained that plutonium (presumably as PuAl_4) may be concentrated toward the bottom of an alloy casting which is permitted to freeze very slowly. Using the similar Al-U system as a stand-in, a one-half inch diameter by six inch long rod of 1.7 weight per cent uranium in aluminum was cycled through the 650-670 degree temperature region for three hours. Relative uranium concentrations, as determined by X-ray fluorescence analysis, from 1/4 inch thick wafers cut from the rod, gave a concentration of uranium two and one-half times higher near the bottom than at the top end. It was estimated by graphical integration that the lower quarter of the rod contained 32 per cent of the uranium.

In an experiment with Al-Pu alloy wherein the casting was cooled through the liquid to solid transformation region over the period of one-half hour, a relative plutonium concentration 65 per cent higher near the bottom has been estimated by gamma counting of solid samples. Analytical data are not yet complete.

Reconstitution of Pu-Al Alloy by Reaction with Zinc Chloride

A processing scheme wherein partially depleted Pu-Al fuel is concentrated by the removal of aluminum as the volatile chloride by reaction with ZnCl_2 appears to be chemically feasible. The reaction proceeds smoothly and without violence at 450 to 500 C with the formation AlCl_3 sublimate. If the amount of ZnCl_2 is stoichiometric, the residue will be PuCl_3 and zinc metal. On the other hand, if the amount of ZnCl_2 used is sufficient only for the removal of some desired quantity of aluminum,

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the product contains only Pu, Al and Zn which alloy upon raising the temperature to 650 C. The Pu-Al-Zn alloy may then be "de-zincd" by heating in vacuum to 1000 C. Preliminary experiments have demonstrated that any desired degree of concentration may be achieved as determined by weighings. Chemical analyses are not yet available.

Dissolution Studies

Because of the possible use of AlSi as a substitute for aluminum in the aluminum plutonium fuel material, a cursory examination of the dissolution characteristics of AlSi and AlSi alloys of uranium and plutonium was begun. A 200 gram quantity of AlSi-2 w/o U alloy was prepared and recast into one-half inch diameter rods for the preparation of samples for dissolution studies. Preliminary experiments, indicate the dissolution rate in coating removal solution (ten per cent NaOH-20 per cent NaNO_3) is extremely slow, the reaction apparently inhibited by formation of an adherent coating. Vigorous agitation results in an increased dissolution rate. Dissolution in 13 M HNO_3 - 0.05 M $\text{Hg}(\text{NO}_3)_2$ is also very slow (incomplete in 24 hours at the boiling point) and is apparently also inhibited by somewhat adherent porous residue which is principally metallic silicon. Reaction rate in 8 M HNO_3 - 0.05 M $\text{Hg}(\text{NO}_3)_2$ is considerably faster. Further studies will be made on AlSi-Pu alloy which has been obtained from Plutonium Fuel Development Operation.

Plutonium Oxide Fuel Material Studies

Continuing studies on the dissolution of plutonium dioxide and of plutonium dioxide-uranium dioxide fuel materials have shown that the nitric acid dissolution is catalyzed by small concentrations of cerium. Thus, cerium concentrations of 0.005 to 0.015 M reduced the time for complete dissolution of a refractory plutonium dioxide in boiling concentrated nitric acid from about fifty hours to thirteen hours. It is probable that higher cerium concentrations may result in even faster rates of dissolution. Thus it appears that the dissolution of irradiated plutonium oxide fuel materials is not a critical problem. Mixed crystal $\text{PuO}_2\text{-UO}_2$ dissolve in nitric acid alone while the less tractable mixtures can be brought into solution by fluoride or cerium catalysis.

A quantity of $\text{PuO}_2\text{-UO}_2$ is being prepared for fabrication and irradiation of an experimental fuel element in cooperation with Ceramic Fuels Development.

Isotopic Composition and Duration for 20 Per Cent Burnout Per Cycle

Detailed calculations were well along to define the fuel element (Pu) isotopic composition and recycle time for set conditions of reactor operation and 20 per cent burnout. Although this work is not yet completed, a recycle time of about 45 days is indicated for the 20 per cent burnout. Fuel utilization for more than six cycles before discard is required is also indicated.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Environmental and Radiation Chemistry

Routine gamma spectrometric analysis of vegetation contamination was begun utilizing an RIDL 100 channel pulse height analyzer. The samples are 150 grams of vegetation

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nine ounce glass bottles composited from ten portions of vegetation obtained in a fixed pattern over one of a series of zones covering the Hanford environs. The five daily samples can be cut up, composited, weighed and counted by one person in about two and one-half hours. At the present high levels of contamination of associated radioisotopes from bomb fallout I^{131} can be determined with a sensitivity of 2×10^{-6} uc/g. Zr^{95} - Nb^{95} , Ru^{103} - 106 , Ba^{140} , and Ce^{141} - 144 are determined routinely from the same measurement. The present gamma spectrometric method does not give the Ru^{103} , Ru^{106} , Ce^{141} , and Ce^{144} values individually, but as Ru^{103} plus Ru^{106} and Ce^{141} plus Ce^{144} . A chemical separation from a single vegetation sample was made, and the Ru^{103} to Ru^{106} ratio was determined to be about two to one and the Ce^{141} to Ce^{144} ratio was one to three. Since the contamination has accumulated over a long period of time and from several sources these values do not allow determination of the period of contamination, but do indicate that some of the contamination is from fission product material less than about 200 days old.

In addition to the radioisotopes on vegetation mentioned above, $1.5 - 2.7 \times 10^{-4}$ uc/g Cs^{137} were measured on two consecutive weekly samples from a zone near Purex. These are the first samples of vegetation to contain sufficient Cs^{137} to be measured by the gamma spectrometric procedure for vegetation, although it was known to be present at low levels from the observations made on rabbits taken from the environs.

A sample of mud from near the upstream lock at McNary Dam was analyzed by multi-channel gamma spectrometry and found to contain 360, 87 and about $5 \text{ uc/g} \times 10^6$ Zn^{65} , Cr^{51} , and Co^{60} , respectively. These values represent a concentration in the mud over that in the water of factors of 2500 for Zn^{65} , 35 for Cr^{51} and about 3000 for Co^{60} . These findings are consistent with the observations of the tendencies of these radioisotopes to be associated with the particulate material present in the Columbia River water. The increased concentrations of these radioisotopes in the river mud should be reflected in the bottom feeding fish. Arrangements have been made in cooperation with the Aquatic Biology Operation to determine the concentrations of these isotopes in suckers taken from the McNary reservoir.

Comparison was made of ashing and chemical wet ashing as preliminary steps in determining uranium and plutonium in vegetation samples. Improved yields were obtained by the wet ashing procedure. No uranium or plutonium was found in small (four to ten grams) samples of vegetation taken about 25 miles from the dissolving facilities, indicating that larger samples are necessary and procedures giving improved yields must be developed.

Improvements were made in the preparation of source mounts for 4π beta standardization of radioisotopes. The usual method of making a thin film mount conducting by applying a thin metal layer on each side by vacuum evaporation can be replaced by spraying the film with a commercial anti-static plastic spray. This greatly simplifies and shortens the calibrating method and eliminates the high loss of films which occurred during the vacuum coating operation.

Geology and Hydrology

Six wells recently drilled in the region north of Gable Mountain were surveyed and leveled. This permitted the determination of the water table elevation at these points, thereby revising to some extent the current concept of the pattern of ground

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water contours in that area. Some revision of estimates of the influence of a "Gable Mountain Canal-Lake System" is being made as a result. To assist with these calculations a pumping test was made in a well located near plant coordinates N 77,000 - W 54,000. The aquifer in this region includes both glaciofluvial and Ringold sediments, having an average permeability of 4,500 gpd/ft².

Two other pumping tests were performed, both in the vicinity of 200 East Area. Data from a well located about three miles east of 200 East Area indicated a coefficient of transmissibility of 3,000 gpd/ft and an average permeability of 150 gpd/ft². This very low permeability was measured in the middle zone (cemented conglomerate) of the Ringold formation. A permeability of 400 gpd/ft² had been determined previously for this material at another location. Pumping data from a well about four miles southeast of 200 East Area indicated a transmissibility of 1,850,000 gpd/ft. The glaciofluvial sediments comprising the local aquifer at this location have an average permeability of 26,500 gpd/ft². This high permeability again supports evidence of high ground water velocities southeast of 200 East Area. A very striking difference is thus evident between the aquifer permeabilities eastward and southeastward from the 200 East Area. It is estimated that as much as 600 times as much water flows southeastward from the 200 East water mound as flows eastward from this region.

Detailed calculations of the effect of a Gable Mountain lake and canal system on the regional water table are being made, based on the latest hydrologic data from the region. The increased level of the water table in the area would definitely result in the formation of springs, swamps, and seep lakes in the region southeast of the 100-F Area. Such formations would have a pronounced influence on the general ground water pattern. A somewhat more detailed ground surface contour map than is available would be required to refine estimates of the extent of this influence. The calculations indicate that no serious ground water problems should be experienced in the 100 Areas, following formation of the inland lake, during periods of low or moderate river flow. The influence of the lake during high river stages is still under study.

Contacts were made with geologists of the Corps of Engineers, Seattle and Walla Walla districts, and with two of their drilling contractors now drilling deep water supply wells at the Hanford Works, to procure geological data from those wells. Other contacts were made with local representatives of the Standard Oil Company of California to obtain what data can be released from the deep exploratory well being drilled by that company on the crest of the Rattlesnake Hills. Data from all three wells will be important for correlation purposes and eventually in evaluating the possibility of disposal of wastes to other than shallow depths at Hanford.

Soil Chemistry

An attempt was made to utilize the results of differential thermal analyses of the clay fraction of soils to identify the formations from which they were obtained. Specifically the DTA analyses of samples of Palouse soil, the caliche bed, and the Touchet formation were examined. These materials were identified by correlation of geologic horizons between wells. It was felt that a technique was needed to identify these materials when obtained from wells for which such correlations are not possible.

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The soils display significant differences with regard to capacity for removing radio-isotopes from wastes and their identification is important to permit calculation of the capacity of new cribs. The clay mineral content, pH, mechanical analysis, calcium carbonate content, and 15 atmosphere moisture content of samples of these soils were determined. Montmorillonite was found in all samples of Palouse soil and also in some of the Touchet and caliche samples. Both chlorite and calcite are distributed throughout the three horizons. It was found that differences in magnitude of the characteristics measured are no greater than those between different samples of the same horizon. From this it was concluded that positive identification of these three horizons must continue to depend on the determination of stratigraphic relationships.

Evidence of the important function of calcite in the soil in the removal of strontium from wastes was confirmed. Equilibrium adsorption experiments were conducted using a sample of 200 West soil both with and without the addition of calcite. The following data were obtained:

<u>Test</u>	<u>K_d</u>
Soil alone	1.3
Soil plus 10% calcite	0.3
Soil alone, solution treated with 0.2 M phosphate ion	32.5
Soil plus 10% calcite, solu- tion treated with 0.2 M phosphate ion	509

No significance can be attached to differences between the first two tests, but the last two represent a very significant improvement in strontium uptake. It is evident that calcite enters into the reaction whereby phosphate ion improves the adsorption of strontium by soil. The phenomenon may represent the phosphate activation of additional exchange sites on the calcite crystal. Further study of the reaction is planned, particularly to evaluate the possibility of improving crib capacity with the addition of calcite.

Geochemical and Geophysical Research

Additional permeability packer studies were made using a scale well in a sandbox. After taking care to reduce the pore clogging effect by air in the model, excellent agreement was obtained between the permeability previously determined by measuring water flow rate through the sandbox and that determined with the packer. These results permit considerable optimism on the usefulness of the full scale packer in a well-perforated, cased well.

271-U Building for CET

The 271-U Building will play an important role in providing office space for personnel in CPD, according to landlord representatives, and it appears unlikely that CET would be given the minimum space requested. The lay-away status has only recently been confirmed by the AEC, hence firm allocation of space has not been made. Possible alternate locations of space are being explored.

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Samples of process water additives were analyzed for arsenic to test these chemicals as possible sources of the As^{76} found in reactor effluent. The following analytical results were reported:

<u>Chemical</u>	<u>Per cent As</u>
Sulfuric Acid	5×10^{-6}
Alum	$<6 \times 10^{-5}$
Sodium Dichromate	$<6 \times 10^{-4}$
Process Water	$<3 \times 10^{-6}$ (3×10^{-2} ppm)

Calculations indicated that 4×10^{-4} ppm arsenic in the process water is needed to account for the amount of As^{76} detected in reactor effluent. These data indicate that standard laboratory analytical techniques are not sensitive enough to evaluate the arsenic contribution of the chemicals so samples of these materials were submitted for activation analysis. In addition plans were made to conduct an in-pile experiment on the formation of As^{76} by the addition of 10^{-4} ppm arsenic to the water charged to a process tube in the 100-K facility. This program is scheduled to begin August 4.

Waste Treatment Studies

Preliminary laboratory tests were performed to assist with the evaluation of possible techniques for application of soil column tests to determine crib capacities. The most promising technique studied is based on the kinetic diffusion design theory which has been applied to soils by investigators at the University of California. The theory is based on the solution of equations derived from rate of transfer and material balance considerations.

The experimental phase of a study of the adsorption of RuO_4 on activated alumina was completed. Alumina was found to be an excellent adsorbent for RuO_4 although a small amount of water in the system seriously interferes with the adsorption. The process was found to include both chemical and physical adsorption. The physically adsorbed RuO_4 can be readily desorbed, but chemisorbed RuO_4 is permanently fixed at room temperatures. The results indicate that activated alumina might be used as a filter medium in a process plant to effectively reduce airborne ruthenium contamination.

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Manager
Chemical Research & Development

VR Cooper:bp

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
W.D. Holland	7/3/57	Students of the AEC Radiological Fellowship Program	To receive additional training, discuss work of Development & Corrosion Chemistry.	J.F. Honstead	Yes
J.S. Parks				J.R. McHenry	
M.C. Schumacher	7/11/			R.E. Burns	Yes
F. Swanberg					
R. Walton	7/22/	Phillips Petroleum, Fluor Corp.	To obtain information on control of ruthenium in waste calcination.	R.L. Moore	Yes
F. Selik		Idaho Operations Office		H.H. Van Tuyl	
J. Stevens				M.T. Walling	
E. Edwards					
G.A. Burney	7/31/	Savannah River Plant	Exchange information on neptunium recovery, fuel element dissolution, and ion exchange.	R.L. Moore	Yes
E. L. Field		Aiken, South Carolina		J.C. Sheppard	
				E.E. Voiland	
				W.L. Lyon	
				W.R. DeHollander	

VISITS TO OTHER INSTALLATIONS

T.F. Evans	7/1/	Phillips Petroleum Idaho Falls, Idaho	Discussions of development activities - specifically, Metal Dissolution.	C.E. Stevenson	Yes
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BIOLOGY OPERATION MONTHLY REPORT - JULY 1957

A. Organization and Personnel

Dr. R. W. Wager, assigned to the Pharmacology Operation, terminated July 11 to accept a teaching position in Florida.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Samples of terrestrial and aquatic organisms are routinely collected and assayed for radioactive contaminants released to the atmosphere, impoundments, and the Columbia River.

Atmospheric Contamination

Concentrations on I^{131} in the thyroid glands of rabbits are tabulated below, in decreasing order:

<u>Collection Site</u>	<u>$\mu\text{C } I^{131}/\text{g thyroid}$</u>		<u>Trend Factor</u>
	<u>Average</u>	<u>Maximum</u>	
East of 200 East Area	7×10^{-3}	7×10^{-3}	- 3
Prosser Barricade	6×10^{-3}	7×10^{-3}	-
100-B Area	3×10^{-3}	6×10^{-3}	- 2
West of 200 West Area	3×10^{-3}	3×10^{-3}	-
One mile SE of Redox	3×10^{-3}	3×10^{-3}	- 3
Meteorology Tower	2×10^{-3}	2×10^{-3}	- 4
Four miles SW of Redox	1×10^{-3}	2×10^{-3}	-
Route 4S, mile 14	2×10^{-3}	3×10^{-3}	+ 2*
Wahluke Slope, NE	2×10^{-3}	2×10^{-3}	+ 3*
Three miles S of White Bluffs	2×10^{-3}	2×10^{-3}	+ 2*
Wahluke Slope, E	1×10^{-3}	1×10^{-3}	- *

* The last four trend factors compare values with samples obtained in May rather than June, because collections are made bi-monthly.

Current values are approximately equal to those observed one year ago.

Concentrations of mixed fission products were present in the following tissues and amounts:

<u>Sample Type</u>	<u>$\mu\text{C FP's/g sample}$</u>	<u>Trend Factor</u>
	<u>Average</u>	
Bone	5×10^{-5}	+ 2
Feces	5×10^{-5}	- 4
Liver	7×10^{-6}	-

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These data show a significant deposition in bone from the increased fallout which occurred just prior to last month's collections. Similar amounts were detected in thirteen reptiles, birds and mammals collected at the various stations.

Swamp Contamination

Waterfowl obtained at the 221-U swamp contained the following concentrations of mixed fission products:

<u>Sample Type</u>	<u>uc FP's/g sample</u>		<u>Trend Factor</u>
	<u>Average</u>	<u>Maximum</u>	
Coots			
Bone	7×10^{-4}	9×10^{-4}	- 3
Soft tissues	1×10^{-4}	2×10^{-4}	-
Diving ducks			
Bone	3×10^{-3}	3×10^{-3}	- 2
Soft tissues	3×10^{-4}	3×10^{-4}	+ 3
River ducks			
Bone	2×10^{-4}	2×10^{-4}	- 25
Soft tissues	6×10^{-4}	7×10^{-4}	+ 2
Shorebirds			
Bone	1×10^{-3}	2×10^{-3}	+ 2
Soft tissues	2×10^{-4}	5×10^{-4}	+ 3

These values are approximately one-fifth those of one year ago.

Columbia River Contamination

The contamination levels for beta emitters in small fish, which serve as an index for other aquatic forms, and in waterfowl for July are shown in the following table. Virtually all of the activity reported is from P^{32} .

<u>Sample type</u>	<u>Collection Site</u>	<u>uc beta emitters/g tissue</u>		<u>Trend Factor</u>
		<u>Average</u>	<u>Maximum</u>	
Minnows	Hanford	2×10^{-3}	6×10^{-3}	+ 6
Whitefish *	"	1×10^{-4}	4×10^{-4}	+ 8
Shorebirds *	"	8×10^{-4}	2×10^{-3}	--
Swallows *	"	6×10^{-4}	2×10^{-3}	+ 3
River ducks *	"	4×10^{-4}	1×10^{-3}	+ 2
Terns *	"	3×10^{-4}	9×10^{-4}	--
Mergansers *	"	3×10^{-4}	7×10^{-4}	--
Gulls *	"	2×10^{-4}	6×10^{-4}	+ 5

* Values are for flesh. Concentrations in bone are about ten times higher for fish and three times higher for waterfowl.

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The substantial increase in contamination of river organisms is typical of this season and is associated with higher water temperatures and reduced flow rates.

Banding of fledgling birds reared on the Hanford reservation was undertaken and bands were placed on 654 gulls, 14 terns and 1 shorebird.

Effect of Reactor Effluent on Aquatic Organisms

Young whitefish were subjected to four per cent strength reactor effluent and to an equal quantity of the effluent which was varied in concentration to simulate conditions which may exist when the flow of the Columbia River fluctuates widely during each 24-hour period as a result of power production at Priest Rapids Dam. No effect was evident at the end of two months of exposure.

During the past two months the mortality of young whitefish held in Columbia River water 3° C higher than normal has been less than that of the controls. This was unexpected and is the reverse of results obtained during the egg stage during the cold part of the year.

Biological Chains

Intensive sampling of organisms living in a pond spiked with Cs¹³⁷ was continued. Although data have not been completely processed, it is obvious that marked biological concentration of the isotope has occurred.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM AND TOXICITY OF RADIOACTIVE MATERIALS

Zinc

The concentration of Zn⁶⁵ in the bone of rats sacrificed 64 days after a single injection is essentially unchanged from the concentration present 24 hours after injection. Over this same period concentration of Zn⁶⁵ in the liver decreased by a factor of 100. The amount of Zn⁶⁵ excreted in the feces over a period from 20 to 70 days following a single injection is decreasing with a half-life of about 20 days. Previously reported early tissue distribution and retention of Zn⁶⁵ was confirmed in additional animals injected for the primary purpose of studying gonad distribution and dose. Results pertinent to the gonad dosage rate problem are not yet available.

Strontium

Rats conditioned for 29 days on diets containing 0.1, 0.5, and 2.0 per cent calcium were placed on diets containing Cr⁵¹O₃, Ca⁴⁵ and Sr⁹⁰. Groups of animals at each calcium level were sacrificed after 3, 6, and 13 days on the radioactively labeled diets. A fourth group will be sacrificed at 24 days. Analytical results are not yet available.

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The experiment on testing the validity of calcium as an isotopic diluent of strontium for suckling lambs using calcium gluconate is now completed. Although the statistical analysis of the data is incomplete, there appears to be a reduction in Sr^{89} deposition in bone with added calcium, but not in stoichiometric amounts. The addition of Ca gluconate to three times the normal concentration of milk appeared to reduce the Sr^{89} deposition by about 50 per cent. There was also a suggestion of reduced uptake when Na gluconate was added, although this was not statistically significant.

Iodine

Breeding is continuing in the swine study.

Cesium

Rats on chronic oral Cs^{137} intake for 400 days were sacrificed. Analytical results are not yet available. Animals injected with Cs^{137} for study of its distribution in the gonads have been sacrificed at one hour, one day, one week and two weeks following injection. Analytical data pertinent to estimation of the gonad dose are not yet available.

Plutonium

The removal of plutonium contamination from pieces of rat skin was studied using various decontaminating agents in the ultrasonic bath. Results were of dubious significance due to erratic analytical results. Indications were not promising but further experimentation with additional controls and better analyses seem called for.

Radioactive Particles

All planned exposures of mice to $\text{Ru}^{106}\text{O}_2$ aerosols were completed. The mice are being retained for long-term turnover, tissue distribution, and tumorigenesis studies.

Strontium⁹⁰ sulfate particles have been prepared for administration as an aerosol to mice. Acute and chronic inhalation experiments are planned.

Isotonic sodium chloride, spirits of ammonia, and "Alevaire" aerosols were tested as possible therapy agents following deposition of radioactive particles in the lung. Neither these nor 3 per cent potassium iodide (an expectorant) in drinking water caused a marked increase in excretion of $\text{Ru}^{106}\text{O}_2$ following exposure of mice to $\text{Ru}^{106}\text{O}_2$ aerosol.

Gastrointestinal Radiation Injury

In studies with rats made iron deficient by bleeding, there was no indication of a decrease in Fe^{59} absorption from the duodenum following intragastric administration of a lethal dose of Y^{91} .

DECLASSIFIEDRelative Biological Effectiveness

Chlorella, as an autotroph grown in the presence of light, yielded the same RBE value for tritium as compared with P^{32} as previously observed with yeast and bacteria. The precise RBE value is still undetermined because of inability to obtain duplicatable dose values with the P^{32} solutions.

Genetic Effects

No report.

Uptake of Radioactive Substances by Growing Plants

The effect of strontium carrier on the uptake of Sr^{90} was tested with the Neubauer technique on the same soil and under the same conditions as reported in May for the effect of calcium carrier. As with calcium, the strontium did not depress the uptake of Sr^{90} but instead stimulated the incorporation of Sr^{90} by the barley leaves. The addition of one milligram of strontium (as $SrCl_2$) per gram of soil increased the concentration of Sr^{90} in leaves five times above that obtained when no $SrCl_2$ was added. This increase was slightly greater than when $CaCl_2$ was added as carrier. It appears that one milligram of calcium per gram of soil produces maximum stimulation of Sr^{90} uptake since the addition of amounts greater than this progressively depressed the concentration of Sr^{90} in the leaf tissue. However, the addition of highly toxic amounts of $CaCl_2$ did not depress the uptake of Sr^{90} below that observed with soil to which no $CaCl_2$ had been added.

Using organic resins saturated with strontium containing some Sr^{90} , no stimulation of the per cent uptake of the Sr^{90} was observed as the concentration of resin in the root environment increased. However, there was also no depression of the uptake of the Sr^{90} .

Bean plants grown in solutions containing Ca^{45} and Sr^{89} were tested for removal of these two isotopes from the roots. Water removed approximately equal amounts of the Ca^{45} and Sr^{89} . Dilute solutions of HCl markedly increased the amount of Sr^{89} removed from the roots but did not affect the removal of Ca^{45} . These tests of removal rate will be continued with a view to exploring the role of pH in the stimulatory effects observed when $SrCl_2$ and $CaCl_2$ are used in studies of carrier effects.

Research Services

The third animal bearing an exteriorized pancreatic duct and injected with Zn^{65} (in support of work conducted by the University of Washington Medical School) was sacrificed due to a failure in the internal cannulation. Three liters of labeled pancreatic juice, however, were collected and forwarded.

HA Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:es

C. Outside Visits and HLO Visitors

Name	Dates of Visits	Company of Organization Represented and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
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VISITORS TO HAPO

Deans Bird and Aagard, Mr. Conrad and Dr. Hines	7/15/57	University of Washington, Seattle, Wash.	Discuss graduate training programs and inspect Biology facilities.	WJ Bair RC Thompson	No	100-F, 108-F, 141-M, 146-FR
Dr. Vic Beard	7/16/57	Div. of Biology and Medicine, AEC, Wash.	Tour biology facilities and discuss biological monitoring.	DE Warner LK Bustad	No	100-F, 108-F, 141-M, 146-FR
Dr. Ruth Patrick	7/26/57	Curator, Limmology, NAS, Philadelphia, Pa.	Visit Aquatic Biology and discuss river monitoring. Doing work assoc. with Savannah River.	RF Foster	No	100-F, 146-FR

VISITS TO OTHER INSTALLATIONS

H.A. Kornberg	7/13-23/57	Gordon Research Conf. Meriden, N.H. AEC, Washington, D.C.	Attend conference. Discuss budget matters w/AEC.	PB Pearson	No	
J.F. Cline L.K. Bustad F.P. Hungate V.G. Horstman	7/15/57	Washington State College, Pullman, Wash.	Present a panel discussion at Am. Society of Animal Production	M.E. Ensminger	No	

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DECLASSIFIEDD. Lectures

a. Papers presented at meetings

The following papers were presented at a "Symposium on Isotopes in Agriculture" at the meeting of the American Society of Animal Production (Western Section) in Pullman, Washington, July 15, 1957:

J. F. Cline - "Benefits of Isotopes in Plant Agriculture"

V. G. Horstman - "Techniques and Equipment Used in Handling Isotopes in Animal Agriculture"

F. P. Hungate - "Biological Effects of Isotopes in Plant Agriculture"

L. K. Bustad - "Benefits and Biological Effects of Isotopes in Animal Agriculture"

b. Seminars

None

E. Publications

a. Documents

Kornberg, H.A. and Staff of the Biology Operation, "Biology Research - Annual Report 1956," Document HW-47500, January 4, 1957 (UNCLASSIFIED).

b. Open Literature

None

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OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

July, 1957

DECLASSIFIEDORGANIZATION AND PERSONNEL

Mr. A. H. Wiggins has accepted a position with the Experimental Statistics function and will report to work in September following the completion of his work at the University of California.

OPERATIONS RESEARCH ACTIVITIESEconomic Studies

Appropriate methods of applying economic ground rules suggested by the Commission to project proposals are being investigated. During the month, information on the present five-year plan was collected in order to define a base system from which the increment attributable to a project or a group of projects could be measured.

Matrix Methods of Cost Allocation

Preliminary presentation of the examples developed to date indicated a need for a more detailed description of the mathematical process involved. Additional charts illustrating in detail the ability of the mathematics to identify all costs with an ultimate end product were prepared. The augmented presentation was given to Financial personnel in HLO, to Procedures and Computing personnel, and to members of Contract Administration. One of the strong appeals of this system is the potential for rapid and relatively easy preparation of budgets. It is becoming apparent that this system emphasizes the distinction between the managerial responsibility for allocation of effort and the financial responsibility for appropriate distribution of the cost in accord with this allocation.

Attitude Surveys

Coordination of the forthcoming plant-wide attitude survey continued. To date the following phases of the survey have been completed: (1) a new method of analyzing and presenting the survey results was developed and adopted; (2) schedules have been prepared and agreed upon; (3) procedures to be used by data processing personnel and individual departments for the analysis and reporting of results have been recommended and adopted; (4) changes in the basic questionnaire and supplementary questions have been agreed upon, and the questionnaires are presently being printed; (5) procedures for conducting a "sensitivity survey" have been recommended and adopted.

Further discussions were held with Employee Relations personnel in the Relations and Utilities Operation concerning consulting assistance for a contemplated community attitude survey. To guide the planning of the survey, a report was issued comparing the use of HAPO talent to conduct the survey with the use of outside consultants. Discussions were also held with Attitude and Morale Measurements personnel of the New York office on July 17 concerning various aspects of the survey and their participation in the survey. The results of this discussion were reported to Employee Relations personnel.

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DECLASSIFIEDPaperwork

A preliminary investigation of the HLO paperwork has been completed and a scoping report defining the nature of the problem and recommending an approach to its alleviation has been issued. Assistance will be given to the Procedures function of the Financial Operation in carrying out a proposed survey of the necessary information input and output at various levels within the organization.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS2000 Program - Fissionable Materials

Data from recent Coating and Corrosion Operation experiments to investigate the pertinent variables influencing aluminum corrosion are being evaluated statistically to determine whether or not they are consistent with current corrosion models. Positive agreement would extend the range of applicability of the present models and thus enhance their predictive worth.

Discussions were held with personnel of Reactor Lattice Physics Operation on the statistics of estimating a number of functionally related counting rates. Several alternative estimation procedures were evaluated.

Mathematical assistance in connection with a problem in determining the optimum manner of collection, organizing, and analyzing data was given to a member of the Chemical Instrumentation Operation.

4000 Program - Reactor Development

Mathematical consultation was provided to Theoretical Physics Research in developing an analysis of the neutron spatial and energy distribution to be expected in a gas-moderated nuclear reactor. As is typical of such problems, the mathematics involved the derivation of a partial differential equation which had to be solved in a multi-region domain subject to appropriate boundary conditions. Although the differential equation was not one of the standard ones occurring in mathematical physics, it was amenable to standard treatment. Its eigen-solutions were related to the classical generalized Laguerre polynomials. The properties of these functions were easily deduced, and were such that a complete and explicit solution to the problem was available without the usual cumbersome and tedious process of repeated approximations.

A complex definite integral was explicitly evaluated for the Advanced Engineering Operation. This integral arose in the theoretical analysis of the neutron flux distribution to be expected in the Plutonium Recycle Reactor.

6000 Program - Biology and Medicine

Further discussions were held with personnel of Metabolism Operation concerning the next phase of an extensive radiation antidote study. A design was constructed for an experiment to firm up existing conjectures about the relative merits of several treatment schedules for combating Pu deposition in rats. The design utilizes the information gained from a previous Ru pilot study.

A probability model to simulate strontium-calcium interaction on bone surface was constructed for Biology Operation personnel (unclassified letter to H. A. Kornberg, "Red-Black Ball Probability Model," July 11, 1957).

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STATISTICAL AND MATHEMATICAL ACTIVITIES FOR THE PRODUCT DEPARTMENTS

FUELS PREPARATION DEPARTMENT

Process Control

Further discussions were held regarding methods of reporting the over-all quality status to different levels of management. These centered chiefly around the proper method of calculating the variances in determining the control limits.

Process Experimentation

A test was designed to further evaluate the alsiclad cap with respect to certain reject rates. This test included both solid and I and E slugs, and was designed to minimize the effects of such variables as time and crews.

The study concerned with evaluating the relationship of vendor, slug position within a rod, and rod number within an ingot to several non-destructive test results has been completed (unclassified letter to C. H. Bloomster, July 18, 1957).

Results of statistical analyses performed over a period of several months concerning the fast hydrogen technique for determining the amount of hydrogen in a slug have been summarized (unclassified letter to R. I. Miller, July 20, 1957).

Acceptance Sampling

The review of presently used acceptance sampling plans is continuing. Sampling plans for aluminum components are currently being investigated. This involves (1) estimating the average quality level for each characteristic measured based on extensive past data, (2) comparing these results with the acceptable quality levels as specified by the present plans, and (3) recommending changes in the plans when deemed advisable.

Vendor Relationships

A rough draft was prepared outlining in some detail a plan for rating vendors. The rating is primarily with respect to product quality, although other criteria such as timeliness and cost can also be included. Although pertaining specifically to vendors of aluminum components, the concepts contained in this report can easily be generalized to cover vendors of other products.

Other

Difficulties encountered in the use of the penetration tester for I and E slugs suggested that many rejected slugs actually had tube walls of acceptable thickness. A set of operating characteristic curves for different sampling plans were submitted to personnel concerned with sampling such "reject" slugs to determine their acceptability.

IRRADIATION PROCESSING DEPARTMENT

Rupture Analyses

Data were analyzed to determine whether or not nearness to inactive tubes influenced rupture rates.

DECLASSIFIEDProduction Test Design and Analysis

A final report was issued in connection with the effects of reactor variables on dimensional stability of irradiated slugs. The differences between tubes irradiated at C reactor and at B reactor were found to be significant, which necessitated the establishment of two sets of standards. Revisions will be made as more data from control tubes used in production tests are made available (HW-51190 RD, to W. K. Kratzer, "Dimensional Stability vs. Reactor Variables," July 1, 1957).

Dimensional distortion data from cored slugs irradiated at KE reactor were analyzed to determine the effects of hole sizes ($3/8"$ vs. $1/2"$). These tubes were randomly selected from lot-charged metal prior to discharge (Confidential-undocumented report to W. K. Kratzer, July 1, 1957).

A further analysis concerned with hole sizes of cored slugs was performed on data from Production test IP-30-A. This analysis was performed on those tubes in the test which contained enriched metal (partial charges). Three hole sizes, $3/8"$, $1/2"$ and $5/8"$ were involved, together with solid controls (Confidential undocumented letter to W. K. Kratzer, July 16, 1957).

Adjustments were made in the C-Basin Dimensioner as a result of previous experimentation that had pointed out the existence of a substantial bias. The test was subsequently repeated, the results submitted for analysis, and the precision and accuracy of the various measurements involved (warp, diameter, length) again estimated (unclassified letter to T. L. Deobald, July 11, 1957).

CHEMICAL PROCESSING DEPARTMENTFinal Product Specification

Calculations have been completed in connection with the preparation of the statistical statements pertaining to parts shipped during the 2nd quarter of CY 1957. This quarterly report is being assembled with the cooperation of CPD personnel.

Other

Assistance was given in establishing an acceptance sampling plan for pipettes. The possibility of devising some type of vendor rating system in this area was also investigated.

The distribution of the median observation was considered in connection with a problem dealing with waiting times in filling store orders. A number of median times were available for different sample sizes. The problem was to estimate the over-all median without going back to the original data.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIESActivities for Other Operations

Estimates of the reproducibility of the depleted uranium measurements at specified measurement points in the separations facilities have been made for SS Measurements personnel. Charts were also submitted which gave estimates of the error (absolute and relative) as a function of the number of batches measured.

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Discussions were held with SS Measurements personnel regarding the estimation of the minimum time of circulation in the pipelines where samples are taken. An experiment was designed to estimate the shortest time necessary to obtain a fairly homogeneous mixing.

Bias correction terms are being prepared for use with the revised conversion equations for Pu formation and U-235 consumption. These are being prepared at the request of SS Measurements personnel.

Mathematical assistance was given a member of the Design Engineering Operation in connection with the analysis of heat conduction through the various media from which an underground disposal tank is constructed. Mathematically, the analysis consisted of setting up and obtaining the solution to a set of three simultaneous, ordinary, linear, non-homogeneous differential equations. Exact answers were obtained.

Activities Within HLO

Personnel of Chemical Instrumentation Operation were briefed on proper statistical interpretation of previously constructed regression equations which estimate the functional relationship between specific gravity, uranium and nitric acid in dissolver solution.

A statistical evaluation of the current probability model formulation to explain Pu deposition in HAPD personnel was initiated at the request of Radiation Protection Operation. The model is used to define one phase of plant radiation hazard, to make comparisons among annual hazard levels, and to predict future levels.

Discussions were held with Radiation Protection Operation personnel to assist in defining statistically rigorous specifications to govern separations waste stream sampling.

The first meeting of the newly formed Environmental Monitoring Study Group was held in July. The general problems of coordinating Regional and Biological Monitoring and of evaluating the predictive worth of their respective data were discussed. A priority rating was established for statistical evaluation of all pertinent data. Currently correlations are being run on Biological Monitoring rabbit thyroid data.

Further discussions have been held with personnel in the Chemical Research and Development Operation in connection with a joint report dealing with the effects of reactor variables on isotopic concentration in the cooling basin. These discussions were concerned primarily with the inadequacy of the mathematical model used in the study, the presentation of the results to best illustrate this inadequacy, and recommendations for further work in this area.

OFFSITE VISITS AND VISITORS

L. G. Waters visited the Operations Research and Synthesis Consulting Services, Management Consulting Services, on July 15 for a general discussion on operations

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research. July 16 and 17 were spent with Attitude and Morale Measurements personnel of the Personnel Practices and Community Relations Services for the purpose of discussing HAPO's forthcoming attitude survey and the contemplated community attitude survey.

At the invitation of the University of Idaho, Robert Y. Dean and Wesley L. Nicholson addressed the National Science Foundation sponsored Summer Institute for High School Teachers on July 24 and 25, 1957, respectively.

P. M. Thompson addressed the local Naval Reserve unit on July 9 on the "Potentialities of Research in Management Science."

Carl A. Bennett

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

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RADIATION PROTECTION OPERATION
MONTHLY REPORT - JULY, 1957

A. ORGANIZATION AND PERSONNEL

Organization

A new position, Supervisor - Environmental Sampling, was established in the Regional Monitoring Operation.

<u>Force Summary</u>	<u>6-30-57</u>	<u>7-31-57</u>
Exempt	41	42
Nonexempt	<u>193</u>	<u>188</u>
Total	234	230

B. ACTIVITIES

Radiation Monitoring

Particulate contamination of major construction work locations occurred at the Purex plant on July 4 as a result of a stack emission of radioactive particulates which were deposited within a 1000 foot radius of the stack. Ground contamination was as high as 600 mrad/hour (uncorrected) in sporadic locations. Minor amounts of clothing contamination occurred to construction workers.

Radiation monitoring for Minor Construction included the horizontal rod tip replacement on the 105-C reactor and improvements to the Redox plant canyon ventilation.

Radiation monitoring will only be required on an intermittent basis at the Hot Semi-Works which has been placed on a standby status.

Radiation monitoring was provided for Hanford Laboratories components on a normal basis. Unusually high dose rates to personnel were experienced in Biology Research where hand dose rates of 15 r/hour, while injecting zine-65 into a dairy bull and 25 rads/hour while handling ruthenium-106 hydrosols, were encountered.

Two employees in the Plutonium Metallurgy Operation approached the weekly permissible limit of 0.3 r. An extended work schedule and difficulty in accurately measuring the dose rate resulted in apparent technical overexposures. Individual evaluation of the film badges for the particular gamma energies involved revealed that neither employee exceeded 0.3 r per week.

The annual National Defense Test, Operation Alert-1957, was conducted during the period June 3 through July 19. Radiological Defense functions of Hanford Laboratories were appropriately carried out. Commendation by the local AEC for one member of the Radiation Protection Operation was noteworthy.

A detailed report of Radiation Monitoring is contained in HW-51753.

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DECLASSIFIEDRegional Monitoring

The average daily emission of I^{131} increased by a factor of 4 over June to 1.7 curies. The increased emission was attributed to the dissolving of less than 90-day cooled metal and difficulty with iodine removal equipment at Purex. Iodine deposition in the environs continued to be confused with bomb debris from the current Nevada test series. The average deposition of I^{131} at off-project locations was less than 6×10^{-6} $\mu\text{c/gm}$ of vegetation. Zone sampling was initiated for duplicate analysis by both gamma spectroscopy and wet chemistry. Compositing of samples on a test basis continued.

Isotopic analysis of raw water at the 100-F Area indicated an average of $< 1.3\%$ of the continuous occupational MPC_{GI} . Raw water at the Pasco filter plant showed an average of $< 0.6\%$ of the continuous occupational MPC_{GI} . These analyses include an unaccounted for beta component analysis for which is being pursued to define this fraction and reduce its significance. A mud sample from a gate inspection at McNary Dam showed expected concentration factors in mud over water of 2500 for Zn^{65} , 3000 for Co^{60} and 35 for Cr^{51} .

A detailed report of waste disposal monitoring is contained in HW-51873.

Exposure Evaluation and Records

The year-to-date doses of twenty CPD employees were re-evaluated on an individual basis to permit more accurate measurement of the 17 Kev X-rays and 60 Kev gamma rays encountered in plutonium processing and fabrication. The result was an over-all reduction of 15 percent in the year-to-date dose. A higher-than-desirable number of employees engaged in this work are approaching the 3 r annual working limit. Substantial rotation of personnel will be necessary in this location to keep individual doses less than 3 r in calendar year 1957.

Plans for incorporating a calibration at 16.1 Kev and 58 Kev energies into our routine processing of 200-West badge films were initiated. It is anticipated that film processed in August will be processed with these calibrations.

Three minor cases of plutonium deposition were confirmed in July. The total number of cases of plutonium deposition on record is 205.

An extensive review of bioassay scheduling neared completion. Many employees had their sampling frequency changed to be more responsive to job assignments.

Radiological Development

A method of dose estimation using simultaneous equations was established for interpreting the several energies of X and gamma radiation recorded on personnel film badges exposed to plutonium in 234-5 and 231 buildings. Comparison of this method with the present method of interpretation indicated the dose estimate may be about 15 percent less than the current estimate.

Investigation of methods for converting the record and report processing of the Bioassay Operation to electronic data processing continued. Needs were defined. Several items of film badge data processing, which were previously delayed by lack of funds, were completed.

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The studies of the potential application of ultrasonic energy for skin decontamination were extended to plutonium work. The results were not as favorable as the previous studies with yttrium chloride and, in fact, did not indicate any advantage in using ultrasonic energy. The plutonium contaminant was introduced in the form of a nitrate in nitric acid solution. Several different reagents were used to decontaminate the plutonium. In conjunction with Biology Operation, a joint report is in preparation on this subject.

A possible alternate of checking batteries through the existing meters was investigated further. It is estimated that equipment can be installed for testing the filament battery only for approximately \$14 per instrument. Use of such a battery check in conjunction with checking the calibration points in the area could extend the calibration frequency. Suitable switches for this installation were obtained and steps were taken to install these in approximately half of the TGM instruments.

Calibrations

Routine checks of radium sources revealed a 1/2 gram source to have a slight leak. The source was immediately removed from service and advice sought from the AEC for disposition. In continuation of the program of reducing the supply of radium sources in Hanford Laboratories, three sources were shipped to Los Alamos.

Radiological Consultation

The Quarterly Report of Research Activities in the Fields of Radiological Sciences was assembled for the past quarter and sent to Technical Publications for preparation for issue. Material from the Biophysics, Instrumentation and Radiation Dosimetry studies of the Biology and Medicine Program on the Progress in the Peaceful Uses of Atomic Energy was obtained and assembled for transmission to the Atomic Energy Commission. This material is to be included in the 23rd Semiannual Report to Congress which will have a feature section on the subject of peaceful uses.

Consultations were held with Exposure Records and Radiological Physics on the subject of exposure limitations which should be placed on individuals receiving a major fraction of their exposure from the 17 Kev X-ray of plutonium. The possibility of basing the limitation of this exposure on the skin dose was investigated, and an experimental program of determining the depth dose curve for the soft radiations was initiated.

A review of the rough draft of the National Academy of Sciences study on radioactive waste disposal was made.

Several literature references on the general subject of disposal, control and effects of radioisotopes from Hanford to the Columbia River were compiled in answer to two off-site requests.

DECLASSIFIEDRadiological Disaster Studies

The final draft of the hazards report on the plutonium recycle demonstration reactor was received and the section relating to calculations previously performed on the consequences of a major disaster was reviewed. Comments were forwarded to Advance Engineering.

Maximum Permissible Concentrations Evaluations

A series of calculations based on experimental data concerning the retention of radioactive particulates in the lungs of mice were performed. These calculations used the power law to derive the MPC in air for ruthenium-106. In order to fit completely the range of experimental data from one day to 400 days, two power functions were required. The results of these calculations were forwarded to Biology Research.

Radiological Standards

Requests from the U. S. National Bureau of Standards and the Union of South Africa Bureau of Standards for copies of the second draft for revision of NBS Handbook 42 were filled. Comments on this draft have been received from six of the seventeen national and local authorities to whom copies were sent for comment.

C. EMPLOYEE RELATIONSSafety

There were three medical treatment injuries for a frequency of 0.62.

Security

No security violations occurred.

Suggestions

Radiation Protection personnel submitted five suggestions. Nine suggestions were evaluated. Six suggestions were adopted for a total savings of \$365.

Training

Assistance was provided in drafting short courses at the request of the AEC on radiation protection and waste disposal.

Beneficial Moves

Three beneficial moves occurred during the month including the promotion of R. C. Dozer to Supervisor, Environmental Monitoring and J. F. Evans to Specialist, Radiological Assignments.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HM Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
W. C. Day	July, 1957	AEC Radiological Physics Fellowship Program	Summer School	AR Keene and Staff	No	100, 200 & 300
E. R. Goza, Jr.						
W. D. Holland						
D. E. Jones						
D. C. Lawrence						
B. M. Miller						
V. C. Moore						
W. E. Morgan						
J. G. Parks						
K. J. Schiager						
M. C. Schumacher						
R. K. Stock						
F. Swanberg, Jr.						
D. S. Willhcutt						
G. Victor Beard	7/15-16/57	Chief, Health Protection Branch, Biology & Medicine Division, AEC Washington, D. C.	Discuss new regulations to be forthcoming in the AEC Manual.	AR Keene JW Healy	Yes	3746:300
W. M. Beam	7/31/57	Dow Chemical Company Rocky Flats Plant	Discussed industrial relations on plutonium work restrictions. JW Vanderbeek	AR Keene JW Healy	No	700 Area

VISITS TO OTHER INSTALLATIONS

C. M. Unruh	7/9-8/2/57	AEC Mercury, Nevada	Participate in weapons testing per request of AEC.	J Deal	Yes
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DECLASSIFIEDREGIONAL MONITORING

The general findings are summarized in the following:

<u>Sample Type and Location</u>	<u>Activity Type</u>	<u>Average Activity Density</u> <u>μc/cc</u>	<u>Trend*</u> <u>Factor</u>
<u>Drinking Water and Related Materials</u>			
Benton City Water Co. Well	alpha	1.2×10^{-8}	--
100 Areas	beta	$(0.09 \text{ to } 3.0) \times 10^{-6}$	+2
200 Areas	beta	$(0.3 \text{ to } 1.0) \times 10^{-7}$	--
Pasco, Kennewick, McNary Dam	beta	$(<0.03 \text{ to } 1.8) \times 10^{-6}$	--
Backwash Solids -			
Pasco Filter Plant	beta	$1.2 \times 10^{-1} \mu\text{c/gm}$	--
Backwash Liquids -			
Pasco Filter Plant	beta	1.7×10^{-6}	--
Anthracite, Sand Filter -			
Pasco Filter Plant	beta	$2.3 \times 10^{-4} \mu\text{c/gm}$	+5
<u>Other Waters and Related Materials</u>			
200 West Wells	beta	$<2 \times 10^{-7} \text{ to } 6.7 \times 10^{-3}$	--
200 East Wells	beta	$<2 \times 10^{-7} \text{ to } 6.3 \times 10^{-2}$	--
Wells Near 200 Areas	beta	$<2 \times 10^{-7} \text{ to } 8.0 \times 10^{-7}$	+2
Outlying Wells	beta	$<2 \times 10^{-7}$	--
Columbia River -			
Hanford Ferry	beta	1.6×10^{-5}	+2
Columbia River -			
Below Reactors	beta	1.5×10^{-5}	+2
Columbia River -			
Paterson to McNary	beta	3.8×10^{-7}	--
Columbia River - Mud	beta	$(0.2 \text{ to } 1.7) \times 10^{-4}$	+2
Raw Water - Operating Areas	beta	$(0.05 \text{ to } 5.2) \times 10^{-6}$	--
Reactor Effluent Retention	beta	$6,000 \text{ to } 43,000 \mu\text{c/sec/reactor}$	--
Basins to River		$(1.7 \text{ to } 7.6) \times 10^{-3}$	--
Reactor Effluent Retention	alpha	$<0.04 \mu\text{c/sec/reactor}$	--
Basins to River		$<5 \times 10^{-9}$	--
I-131 in Farm Wastes to River	I-131	1.3×10^{-6}	--
I-131 in Columbia River -			
Hanford	I-131	3.2×10^{-8}	--

* 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.

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<u>Sample Type and Location</u>	<u>Activity Type</u>	<u>Average Activity Density μc/cc</u>	<u>Trend* Factor</u>
<u>Atmospheric Pollution</u>			
Gross Alpha Emitters	alpha	(< 2 to 5) $\times 10^{-15}$	--
Gross Dose Rate - Separations Areas	beta-gamma	0.7 to 7.8 mrad/day	+3
Gross Dose Rate - Residential Areas	beta-gamma	0.5 mrad/day	--
Active Particles - Separations Areas	beta	(1.7 to 6.1) $\times 10^{-13}$	-3
I-131 Separations Areas	I-131	(1.2 to 7.1) $\times 10^{-13}$	-4
I-131 Separations Stacks	I-131	1.7 curies/day	+4
Ruthenium - Separations Stacks	Ru-103-106	< 0.02 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.008 to 0.036 ptle/m ³	-7
Active Particles - Project	--	0.003 to 0.067 ptle/m ³	-5
<u>Vegetation</u>			
Environs of Separations Areas	I-131	(0.6 to 1.3) $\times 10^{-5}$ μc/gm	-38
Residential Areas	I-131	$< 6 \times 10^{-6}$ μc/gm	-12
Eastern Washington and Oregon	I-131	(< 0.6 to 1.3) $\times 10^{-5}$ μc/gm	-9
Non-Volatile Beta Emitters Wash. and Ore.	beta	(0.06 to 5.4) $\times 10^{-4}$ μc/gm	-2
Alpha Emitters - Separations Areas	alpha	(0.4 to 7.8) $\times 10^{-7}$ 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.

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HW-51741 DELRADIATION MONITORING

	<u>Hanford Laboratories</u>	<u>Minor & Major Construction</u>	<u>Others</u>	<u>July</u>	<u>Year to Date</u>
Special Work Permits	2025	459	192	2676	19,174
Routine and Special Surveys	1110	592	261	1963	17,873
Air Samples	2102	106	91	2299	16,011
Skin Contamination	13	10	0	23	147
*Class II Radiation Incidents	0	0	0	0	1
**Class II Radiation Incidents	0	0	0	0	4

EXPOSURE EVALUATION AND RECORDS

<u>Gamma Pencils</u>	<u>Pencils Processed</u>	<u>Paired Readings 100-280 mr</u>	<u>Paired Readings Over 280 mr</u>	<u>Lost Readings</u>
July	154,728	10	10	8
1957 to Date	1,660,426	90	89	65

300-L Area

July	17,810	6	2	1
1957 to Date	41,548	10	4	3

Beta-Gamma Film Badges

	<u>Badges Processed</u>	<u>Readings 100-300 mrad</u>	<u>Readings 300-500 mrad</u>	<u>Readings Over 500 mrad</u>	<u>Lost Readings</u>	<u>Average Dose Per Film Packet</u>
						<u>mr(ad(ow)</u> <u>mr(s)</u>
July	38,351	790	57	7	76	1.30 4.44
1957 to Date	337,348	4,547	191	50	507	1.68 3.43

Slow Neutron Pencils

	<u>Pencils Processed</u>	<u>Paired Readings 4-12 mrem</u>	<u>Paired Readings Over 12 mrem</u>	<u>Lost Readings</u>
July	2,722	64	45	6
1957 to Date	17,166	224	76	13

Fast Neutron Film Badges

	<u>Badges Processed</u>	<u>Readings Above 50 mrem</u>	<u>Lost Readings</u>
July	944	1	2
1957 to Date	6,744	3	10

Bioassay

	<u>July</u>	<u>1957 to Date</u>
Plutonium: Samples Assayed	1158	8296
Results above 2.2×10^{-8} $\mu\text{c/sample}$	36	215
Fission Product: Samples Assayed	1247	9179
Results above 3.1×10^{-5} $\mu\text{c FP/sample}$	2	10
Uranium: Samples Assayed	402	2813

*Radiation Monitoring Operation Customers

**Total Plant

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<u>Uranium Analyses</u>	<u>Following Exposure</u>			<u>Following Period of No Exposure</u>		
	<u>Units of 10^{-9} μc U/cc</u>		<u>Number</u>	<u>Units of 10^{-9} μc U/cc</u>		<u>Number</u>
	<u>Maximum</u>	<u>Average</u>		<u>Maximum</u>	<u>Average</u>	
<u>Sample Description</u>			<u>Samples</u>			<u>Samples</u>
Fuels Preparation	20.81	4.04	39	8.89	3.28	22
Hanford Laboratories	380.1	34.56	15	14.25	3.66	11
Chemical Processing	127.4	8.83	85	51.58	5.99	73
Chemical Processing*	1757.0	42.25	70	15.20	17.15	22
Special Incidents	112.3	10.91	61	2.65	1.58	3
Random	3.15	3.15	1	--	--	--

*Samples taken prior to and after a specific job during work week.

<u>Tritium Analyses</u>	<u>July</u>	<u>1957 to Date</u>
Samples Assayed	0	59

Thyroid Checks

Checks Taken	50	253
Checks Indicating .01 μ c	0	1

Hand Checks

Checks Taken - alpha	60,131	385,403
- beta-gamma	54,886	357,316

CALIBRATIONS

<u>Portable Instrument Calibration</u>	<u>Number of Units Calibrated</u>	
	<u>July</u>	<u>1957 to Date</u>
CP Meter	987	7,365
Juno	334	2,538
GM	1,303	9,797
Others	157	1,238
Total	2,781	20,938

Personnel Meters

Badge Film	2,460	15,834
Pencils	6,867	32,305
Others	158	1,309
Total	9,485	49,448

Miscellaneous Special Services

	425	2,806
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<u>Total Number of Calibrations</u>	12,691	73,192
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ARK:bh

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A. R. Keene
 A. R. Keene, Manager
 RADIATION PROTECTION

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JULY, 1957

General

Safety performance of the Operation was considered satisfactory as indicated by the Minor Injury Frequency Rate (3.68) and the type and severity of the injuries incurred.

The absenteeism rate was up slightly (3.61% for July versus 3.36% for June) and is attributed to the prevalence of a form of influenza.

There were three security violations charged to the Operation. As this number is considered excessive, vigorous corrective action is being taken.

Two unit grievances were filed against the Operation involving the distribution of overtime. Both grievances were settled at the Step I level.

Facilities Engineering Operation

The attached report summarizes the status of HLO project work.

Preliminary scoping work on the Plutonium Fabrication Pilot Plant was reviewed with representatives of Construction Engineering and the using operation.

The preparation of Project Proposals for items which are included in the FY-1958 Plant Acquisition and Construction Budget continued on schedule.

"Third Party Inspection" of the hot water tanks and air receivers was completed in Buildings 306 and 314.

Property associated with the P-11 project is being examined for potential use by other HLO and HAPD components. Disposal of items no longer required will follow the usual channels.

Work involved with placing the Hot Semi-Works Building No. 201-C in a lay-away status has now been completed.

Nine jobs have been submitted during the month to the Work Review Board for status determination. To date no critical work has been held up due to delays in receiving determinations from the Review Board; however, many small jobs are awaiting performance upon decision of the Board.

Effective this month building rentals in HLO will reflect actual cost incurred in the previous month rather than average cost which has been used heretofore. The process utility account has been combined with the landlord account for more equitable distribution of incurred cost. The purpose of these changes is to record combined operating and maintenance cost by individual buildings for the convenience of tenant organizations and to focus attention on potential economies.

Major work in progress by the Design & Drafting operation include the 108-F Building Sampler System; Star Valves used in prototype machinery in 321 Building; IAFS Absortometer Source Holder; ETR Process Cap; ETR Critical Facility; Control & Power Design for the HTF Organic Heat Transfer Study; "As-Built," 321 Building.

One electrical engineer (new hire) and one civil engineer (transferred from IPD) were added to the Facilities Engineering force during the month.

Laboratories Administration

Three new Organizational and Policy Guides were issued. Timely revisions were issued on specific sections to eight existing guides. The review of AEC Manual Chapters which are the prime responsibility of Laboratory Auxiliaries Operation was continued. The pertinent information and procedures requiring conformance are being incorporated into the Organization and Policy Guides.

Contracts

The following contract was approved:

Contract No. CA-167 with George W. Watt - Consulting services on problems relating to research, development, and plant technology.

The following contracts have been closed out:

Contract No. DDR-3, Hanson-Van Winkle-Munning Company - Design and fabrication of a plating rack.

Contract No. SO-13, Aluminum Company of America - Aluminum tubes.

The following listing includes active contracts assigned to Hanford Laboratories Operation:

<u>Contract Number</u>	<u>Contractor</u>	<u>Services Requested</u>	<u>Completion or Termination Date</u>
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Special Agreements

G-65	Phillips Petroleum Company	MTR experimental work	None
SA-16	Future Farmers of America	Care of sheep	11-30-57
SA-17	Swedish Hospital	Obtaining clinical data on use and application of radioactive materials	12-31-57
SA-20	Washington State College	Acquisition of swine	2-28-58

Consultant Agreements

CA-145	George Watt	Consult on research, development & plant technical problems	8-31-57
CA-153	Dr. P. E. Church	Consult on atmospheric physics & meteorology problems	3-31-58
CA-154	Dr. R. E. Zirkle	Biological consulting service	2-28-58
CA-155	Prof. J. L. Powell	Consulting service-physics	3-14-58
CA-159	Dr. M. E. Ensminger	Consult on Animal Husbandry	5-31-58
CA-162	Betz Laboratories, Inc.	Provide engineering services for water treatment methods	8-1-57

<u>Contract Number</u>	<u>Contractor</u>	<u>Services Requested</u>	<u>Completion or Termination Date</u>
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Maintenance and Repair

MRO-1	RCA Service Co. Inc.	Service RCA equipment	11-30-57
MRO-7	North American Philips	Servicing a Philips Electron Microscope	12-8-57

Design, Development and Research

DDR-4	University of California	Research work on Aluminum Alloy Creep	5-31-58
DDR-5	Superior Tube Company	Zircaloy tubes	--
DDR-6	Allegheny Ludlum Steel	Zircaloy tubes	--
DDR-11	Allegheny Ludlum Steel Corp.	Zircaloy 2 tubes	--

Supply

SO-7	Aluminum Company of America	Aluminum tubing	--
SO-11	Speer Carbon Company	Graphite	--

HOO-AEC approved \$25,000 for the Assistance to Hanford Program, Hanford Laboratories Operation, for FY-1958. Contract No. ATH-HLO-1-58-A for \$5,000 was assigned to General Engineering Laboratory under this program for assistance by Dr. H. Poritsky and associates.

The reassignment of vehicles during the month included one sedan, one carryall, and one pickup truck. One panel truck was returned to Transportation and Maintenance Operation from the Hot Semi-Works as it was no longer required within Hanford Laboratories Operation.

Technical Shops Operation

Total productive time for the month was 11,690 hours. The total shop work backlog is 19,676 hours of which 50% is scheduled to be completed by September 1. Overtime worked during the month was .9% (162 hours) of the total available hours.

Distribution of time was as follows:

	<u>Man Hours</u>	<u>% of Total</u>
Fuels Preparation Department	2189	18.8
Irradiation Processing Department	2213	18.9
Chemical Processing Department	1529	13.0
Hanford Laboratories Operation	5647	48.3
Construction Engineering Operation	36	.3
Miscellaneous	76	.7

Customer demands for service remained firm in all components of the operation. There was a noticeable increase in the level of service requested by Hanford Laboratories personnel.

Safety and security performance was considered satisfactory with no major violations.

Absenteeism increased over the previous month from 2.59% to 3.57%.

Two grievances concerning overtime distribution were filed and settled satisfactorily at the Step I level.

Equipment which permits rapid cutting of aluminum and other non-ferrous metals was received and placed in operation. The new process called "Heliarc Cutting" was developed by the Linde Company and employs a constricted arc between a tungsten electrode and the piece to be cut in conjunction with a high velocity gas stream. Preliminary tests indicate the new process may be used advantageously where large volumes of non-ferrous metals require cutting.

Technical Information Operation

In order to effect further operating economies in the Operation action was initiated to assign subscriptions to certain high-use periodicals to the individual departments who will handle their own internal routing. A review of route lists for the remaining periodicals is in progress and requests for additional names to be added to lists will require the approval of a person authorized to sign a Library Procurement Card.

A proposal for a simplified IBM system of document control was prepared and submitted to the Manager of Data Processing - Relations and Utilities Operation for his concurrence.

The AEC Division of Information Services has announced plans to publish monthly reports covering the research and development activities at various Commission sites. The Commission has requested that HAPO submit a monthly summary of HLO research and development activities. Technical Information's Abstracting and Bibliography group will compile this summary. The material submitted by HAPO will be reviewed by the AEC Division of Production prior to distribution by the Division of Information Services.

A revised list of HAPO personnel who are authorized to review documents and approve offsite transmittal was prepared and issued to Files personnel.

At the request of the AEC-HOO the proposed AEC Manual Chapters 3402, "Declassification," and 3403 and Appendix 3403 - 05, "Guide to Unclassified Fields of Research," and Chapter 3202, "Reporting and Dissemination of Information Resulting from AEC Research and Development Activities," were reviewed and comments forwarded to the AEC-HOO.

A performance measurement report was prepared for the first six months of 1957. The indices used and the stated goals are being studied for possible revision in order to achieve reliable measurements of Technical Information work loads and accomplishments.

A comparison was made between the holdings of the G.E. Manager Development Library in Crotonville and the HAPO Plant Library in regard to management development information. Of the 784 titles in the Manager Development Library, the HAPO

library has 260. Information is being developed which will assist the HAPO library in selecting additional volumes on this subject.

The Supervisor of 300 Area Classified Files conducted the first sessions of the HLO Secretarial Training Course on July 9 and 11. The course was well received, and several helpful suggestions were made by students.

A classification review of all Secret photographs controlled by Classified Files was begun during the month. This review was undertaken because there are relatively few photographs at Hanford which must be classified Secret, based on current AEC instructions. Review of the first 75 photographs indicates that approximately 90% can be downgraded to Confidential. This downgrading will permit (1) handling these photographs as Undocumented, (2) removal from Files accountability, and (3) return of the negatives and prints to Photography Operation.

Work Load Statistics

	<u>June</u>	<u>July</u>
Documents routed and discharged	26,332	21,224
Documents issued	10,496	10,470
Documents destroyed	2,452	1,962
Reports abstracted	224	212
Formal R & D reports issued	10	2
Document classification changes	367	556
Books circulated	2,091	2,406
Periodicals circulated	9,854	8,091
Volumes added to the collection	489	325

Radiographic Testing Operation

Customer demands for testing services remained at a high level. Due to a reduced force occasioned by illness and vacations the work load carried by the remainder of the force was abnormally high.

Activities ranged from 16 consultations with engineering personnel regarding potential applications of testing techniques to 805 actual tests performed. Major tests include work on the stainless steel dissolver vessel for Redox being fabricated by Minor Construction forces - examination of a new HA-column TH-2, for Purex - survey of the concrete embedded Redox process lines - examination of experimental reactor process tubing - spot radiography of the welding in the piping of the KAPL-120 loop (100-H reactor) - testing work required in the pressure vessel survey conducted in the 100-KW Area - testing experimental fuel elements for HLO - routine examination of welder qualification coupons and outage tools used by reactor maintenance forces.

The adaptation of standard testing tools and techniques required to accomplish some of these tests challenged the ingenuity and resourcefulness of the operators. For example, in testing the piping of the KAPL-120 loop (100-H reactor) the radiation level encountered was high, which prevented any extensive radiographic work at any one time. Contamination problems and cramped quarters added to the difficulty in

performing this work. A socket weld joint design offered problems because of the variation in metal thickness at each joint. In some locations it was necessary to use lead shielding to protect the film from exposure by the radiation field associated with the piping.

Testing Statistics

<u>Component</u>	<u>No. of Tests</u>	<u>Ft. of Weld or Material</u>	<u>No. of Pieces</u>	<u>Description</u>
A. Chemical Processing Department	194	145	116	Stainless steel process vessels and piping.
B. Construction Engineering Operation	90	97½	17	Stainless steel process vessel and welder coupons.
C. Hanford Laboratories Operation	78	161	40	Zirconium and aluminum tubing. Zirconium and aluminum clad fuel elements.
D. Irradiation Processing Department	443	178 66 sq.ft.	94	Carbon steel pressure vessels. Stainless steel and carbon steel pipe lines and tubing. Outage tools.
Totals	805	581½ 66 sq.ft.	267	

P. J. Lucas
Acting Manager,
LABORATORY AUXILIARIES

JLBoyd:LJL:sf

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HW-51741
JULY 1957

MONTHLY PROJECT REPORT

UNCLASSIFIED

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT DATE	PROJECT PROGRESS IN PER CENT			STARTING DATE	BENEFICIAL USE DATE	PROJECT COMP. DATE	
					SCHED. ACTUAL	SCHED. ACTUAL	CONST. ACTUAL			DESIGN CONST.	DATE CONST.
General AEC-2-23X-56-L-2	Plant Projects - FY 1956	Reactor & Fuels	\$140,000	\$140,000* 4-4-57	100	100	2	5-23-56	As	9-28-56	
CG-664	350° C Flow Loop - 314 Bldg.	REMARKS: Fabrication of the test loop by Construction Operation is scheduled to begin in October 1957. All material and equipment are now on order or have been received. 2" valves are scheduled for delivery in Jan. '58 and no improvement has been made to date in spite of expediting efforts. Scheduled delivery of canned motor pump may be improved from Dec. '57. Field work is scheduled to start in October. *Includes \$350 transferred equipment.									
General AEC-2-23-57-N-2	Plant Projects - FY 1957	Radiation Protection	\$150,000	\$150,000 2-4-57	Not Scd.	0	0	2-18-57	12-31-57**	9-1-57*	
CA-658	Shielded Personnel Monitoring Station (747 Building Addition)	REMARKS: Steel not yet released by Navy. An alternate layout was submitted by the A-E along with several questions. A final layout was prepared and submitted to the A-E with comments and answers to his questions. The layout and comments will serve as criteria for detailed design. *GE preliminary design & scoping only. ** Project proposal date.									
CG-680	Corrosion Testing Facilities - 314 Bldg.	Reactor & Fuels	\$135,000	\$135,000* 5-2-57	100	100	12	10-3-56	2-2-58	1-25-57	3-2-58
		REMARKS: FH Lohse, the fixed price contractor, started field work of installation of corrosion testing equipment in the 314 Bldg. on July 15, 1957. Construction Operations pipefitter strike delayed contractor but negotiations have been completed with the contractor to supply pipefitters. *Total project cost \$166,000 including \$31,000 transferred equipment. **Preparation of construction schedules delayed pending receipt of detailed breakdown of schedule from lump sum contractor. Bids were opened June 4 for fixed price installation of equipment and facilities. FH Lohse was low bidder at \$56,000. Construction Operation began work on June 3, 1957 of dismantling obsolete equipment and refinishing concrete floor. This has been completed. Removal of equipment is dependent upon contractor's installation schedule.									
CA-685	Alterations to Buildings 325 and 326	HLO	\$23,000	\$23,000 10-4-56	100	100	100*	10-1-56	As	11-14-56	
		REMARKS: Final adjustment of the elevator door in the 325 building is complete. Requested changes in the 326 building portion of the project were included in a bid package for other work in the 300 Area. *Except for extras.									

MONTHLY PROJECT REPORT

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JULY 1957

MONTHLY PROJECT REPORT															HW-51741		JULY 1957	
PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				STARTING DATE		BENEFICIAL USE DATE		PROJECT COMP. DATE				
				AMOUNT	DATE	DESIGN SCHED	ACTUAL	CONST. SCHED	ACTUAL	DATE	DESIGN CONST.	DATE						
CA-700	Geological and Hyrdrological Wells	Chemical Research	\$122,000	\$122,000	6-27-57	100	100	52*	11-8-56	10-24-56	Completed	As Wells	Completed	1-15-57 12-10-57				
REMARKS: USGS has completed 8 wells and a total of 3953 feet of hole. The fixed price contractor has completed 8 wells and 2638 feet of holed. He experienced difficulty with faulty casing welds provided by the vendor. This resulted in loss of nearly a months drilling time.																		
*Fixed price contractor only.																		
CA-728	High Level Exposure Facility Addition - 141-H Bldg.	Biological Research	\$26,000	\$26,000	2-11-57	100	100	3	3-11-57	7-16-57	12-11-57			6-20-57 1-11-58*				
REMARKS: Ray Britton Construction Company started work cn 7-16-57. The building foundations are completed and work has started laying the concrete block walls.																		
*Project proposal date.																		
CG-729	Ventilation System Improvements 222-U Bldg.	Chemical Research	\$73,000	\$73,000	3-12-57	100	100	2	4-23-57	7-15-57	6-12-58*			5-28-57 9-15-58*				
REMARKS: Condensate drains and radiator servicing has been completed by the contractors forces Off-site fabrication of ductwork and procurement of equipment by the Contractor have started. No work is anticipated by the Contractor at the site until the last week in August.																		
*Project proposal dates.																		
CG-733	Plutonium Metallurgy Facility Expansion	Research & Fuels	\$295,000	\$295,000	5-10-57	60	80	0	5-14-57	6-10-57	Completed	As	Completed	10-1-57 6-15-58				
REMARKS: Construction Operation has completed the majority of decontamination and demolition work and ceased operations at the request of Project Engineering due to unsettled labor conditions. Detail design is progressing.																		
CG-757	Coolant Radio-Analysis Laboratory Addition - 1706-KE	Chemical Research	\$77,500	None to date	None to date	To be est	To be est	To be est	1*	7*	12*			4* 13*				
REMARKS: Project proposal was sent to AEC on 5-28-57. It is still awaiting authorization. AEC is waiting for another project proposal to be submitted from IPD in order to get the overall picture on project work in the 1706-KE Bldg. and to let one fixed-price contract.																		
*After Authorization.																		

MONTHLY PROJECT REPORT									
HANFORD LABORATORIES OPERATION									
PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			BENEFICIAL USE DATE
				AMOUNT DATE	DATE	DESIGN SCHED. ACTUAL	CONST. SCHED. ACTUAL	DATE	
IR-222	Aquatic Biology Raw Water System 100-KE Area	Biology Research	\$8,900	\$8,900 4-8-57		100	84	1-2-57 4-20-57	8-15-57* 8-15-57*
		REMARKS:							
IR-224	Biology Controlled Activity Water System - 100-F Area	Biology Research	\$19,900	\$19,900 6-27-57	100	100	Not Schd. 7-22-57	As Completed	4-11-57 12-27-57
		REMARKS:							
CG-620	Equipment Not Included in Construction Projects, FY 1956 Vacuum Furnace	Reactor & Fuels	\$120,000	\$120,000 2-7-57	100	100	5-1-56 6-1-57	8-31-57	4-1-57 9-30-57
		REMARKS:							
CG-660	Equipment Not Included in Construction Projects, FY 1957 Modifications and Additions to Metallographic Cell - 327 Bldg.	Reactor & Fuels	\$147,000	\$135,000 3-15-57	100	100	3-27-56 5-14-57	12-31-57	4-1-57 12-31-57
		REMARKS:							
CG-661	Additional Heat Generation Facility - 189-D Bldg.	Reactor & Fuels	\$664,000	\$22,400* 11-13-56	30	34	To be est 12-6-56 To be est 15**	23**	13** 23**
		REMARKS:							

MONTHLY PROJECT REPORT

HM-51741

JULY 1957

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				STARTING DATE	BENEFICIAL USE DATE	PROJECT COMP. DATE
				AMOUNT	DATE	DESIGN SCHED	CONST. SCHED	ACTUAL	ACTUAL			
CG-672	Monochromatic Neutron Beam Facility - 105-KE Bldg.	Physics & Instr.	\$195,000	\$195,000	3-7-57	100	0	0	0	5-21-56	6-1-58	10-1-58
		REMARKS:										5-1-58
		Installation is awaiting delivery of procured items. The spectrometer procurement is on schedule and will be delivered in August 1957. The final purchase requisition for the shielding material has been issued.										
CA-681	Hanford Equipment in the ETR	Reactor & Fuels	\$1,200,000	\$600,000*	2-8-57	100	**	**	**	9-17-56	*	5-29-57
		REMARKS:										8-15-58
		Interim authorization of \$550,000 GE and \$50,000 for AEC for partial procurement and complete design. **GE portion of design and procurement effort 100% complete. Field construction by Phillips Petroleum Co. 0% complete. ***Estimated date only. It is expected a directive for the remaining funds required by GE will be received during August. Information necessary to complete the design revisions has not yet been received from Phillips Petroleum Co.										
CG-682	High Level Cut-Off and Examination Cell - 327 Building	Reactor & Fuels	\$430,000	\$30,500*	2-1-57*	100	0	0	0	7-18-56	Not Estab.	6-26-57
		REMARKS:										Not Estab.
		Project proposal revision 2 transmitted to HOO-AEC on June 27, 1957. This revision asks for total project funds in the amount of \$430,000. The proposal was approved by HOO-AEC, however, issuance of a directive is delayed awaiting availability of funds.										
CA-695	Radio Telemetering Network	Physics & Instr.	\$89,000	\$89,000	1-10-57	100	<1	<1	<1	2-22-57	4-15-58	5-27-57
		REMARKS:										5-15-58
		The only bid received for fabrication and installation of the telemetering equipment was submitted by Motorola Inc. Their bid of \$202,885 was rejected. The bid reflected cost of developing, designing, and fabricating equipment Motorola felt would meet Hanford functional requirements. The government fair cost estimate was \$66,500 and reflects the cost of reproducing the prototype telemetering equipment for which the complete design was included in the bid package. Vendor data for wind										
		REMARKS: (Contd.)										
		chargers and towers was submitted to F. H. Lohse, Construction Contractor. These were approved.										

UNCLASSIFIED		HANFORD LABORATORIES OPERATION										HW-51741 ☒ DEL		JULY 1957	
PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE	BENEFICIAL USE DATE	PROJECT COMP. DATE				
				AMOUNT	DATE	DESIGN SCHED	ACTUAL	CONST.				DESIGN CONST.			
New Construction - FY 1958		Reactor & Fuels	\$3,600,000	None to date	None to date	To be est	To be est	0	0	3 mo.**	*	10 mo.**	*		
CG-744	Metallurgical Development Facility	REMARKS:													
		Project proposal sent to Washington D. C. AEC for approval on 5-28-57. Proposal is for \$60,000 for preliminary design and initiation of detailed design.													
		*To be established after scoping is completed.													
		**Detail design only.													
CG-747	Plutonium Fabrication Pilot Plant	Reactor & Fuels	\$4,000,000	\$100,000	100*	0	0	4-22-57	Partial	5-1-59	10-1-58	8-31-60			
		REMARKS:													
		The project proposal requesting total project funds was forwarded to Washington - AEC for approval. Twenty one scope drawings were issued for comments. The scope is currently being reviewed to reduce the present estimated cost from \$4,410,000 to \$4,000,000.													
		*Preliminary design only.													
		**After authorization.													
CG-731	Critical Mass Laboratory	Physics & Instr.	\$2,000,000	None to date	None to date	To be est	To be est	0	0	None est.	None est.	None est.	None est.		
		REMARKS:													
		A new project proposal is being prepared for submission.													
CA-749	High Level Radiochemistry Cell	Chemical Research	\$800,000	7-10-57	\$15,000	100*	To be est	7-11-57	19 mo.**	10-12-57	18 mo.**				
		REMARKS:													
		A work authority was received from AEC for \$15,000 for preliminary design and a work release authorization was issued on the same date to CEO.													
		*For preliminary design.													
		**After authorization.													
CA-765	Additions to the 314 Building	Physics & Instr.	\$46,000	None to date	None to date	To be est	To be est	0	0	1 mo.*	12 mo.*	5 mo.*	12 mo.*		
		REMARKS:													
		The project proposal was approved by the AEC Board of Review on 7-25-57 and is awaiting availability of funds for issuance of a directive.													
		*After authorization.													

MONTHLY PROJECT REPORT

HW-51741

DEL

JUNE 1957

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				STARTING DATE		BENEFICIAL USE DATE	PROJECT COMP. DATE	
				AMOUNT DATE		DESIGN SCHED ACTUAL	CONST. SCHED ACTUAL			DATE	DESIGN CONST.		DESIGN CONST.	
CA-760	Expansion of the 3745-B Bldg.	Physics & Instr.	\$225,000	None to date	None to date	0	0	To be est.	To be est.	1 mo.*	9 mo.*	16 mo.*	6 mo.*	16 mo.*
		REMARKS:												
		A new Plant and Equipment Analysis Report and project proposal are being prepared with a reduced scope.												
		*After authorization.												
CG-758	Ceramic Fuels Development Press and Furnace Additions	Reactor & Fuels	\$200,000	None to date	None to date	0	0	To be est.	To be est.	1 mo.*	8 mo.*	13 mo.*	6 mo.*	14 mo.*
		REMARKS:												
		Proposal transmitted to AEC on 6-6-57 and approved by the AEC Board of Review on 6-27-57 and sent to Washington D.C. AEC for approval.												
		*After authorization.												
	Additions to the 622 Building	Physics & Instr.	\$80,000	None to date	None to date	0	0	1 mo.*	8 mo.*	13 mo.*	7 1/2 mo.*	14 mo.*		
		REMARKS:												
		Project proposal preparation delayed to allow evaluation of engineering practices in an attempt to reduce design costs on small projects of this nature. The proposal was forwarded to the Manager-HLO for final GE approval.												
		*After authorization.												
	Alterations to the 327 Building	Reactor & Fuels	\$80,000	None to date	None to date	0	0	1 mo.*	5 mo.*	12 mo.*	3 1/2 mo.*	13 mo.*		
		REMARKS:												
		The project proposal has been completed and is being routed for HLO approvals.												
		*After authorization.												
	Addition to the 305-B Building	Physics & Instr.	Not Est.	None to date	None to date	*	*	*	*	*	*	*	*	*
		REMARKS:												
		*A project proposal is being prepared. A scope drawing has been prepared for cost estimating purposes.												

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-51/41 DEL
JULY 1957

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE		BENEFICIAL USE DATE	PROJECT COMP. DATE	
				AMOUNT	DATE	DESIGN SCHED	CONST. ACTUAL	ACTUAL	DATE	CONST.		DATE	DESIGN CONST.
	Badgehouse Alterations for Self Service	Radiation Protection	*	*	*	*	*	*	*	*	*	*	*
		REMARKS: Scoping and cost estimating were initiated for project proposal preparation to provide self service badge racks in all 100 and 200 Area main gatehouses.											
				*Not determined to date.									
	Alterations to the 321 Building	Chemical Research	*	*	*	*	*	*	*	*	*	*	*
		REMARKS: Preliminary discussions were held with the using component to determine their needs.											
				*Not determined to date.									
	In-Reactor Studies Equipment	Reactor & Fuels	*	*	*	*	*	*	*	*	*	*	*
		REMARKS: Project proposal preparation was initiated. Basic requirements and scoping are being reviewed with the using component.											
				*Not determined to date.									
	Vacuum Air Sampling - 108-F Bldg.	Biology Analyses	\$35,000	*	*	*	*	*	1 mo. **	2 1/2 mo. **	*	2 mo. **	6 mo. **
		REMARKS: *A project proposal is being prepared by CEO. Schedules have not yet been established. **After authorization.											
	Supplemental Heating and Lighting Bldgs. 326 and 328	HLO	\$7,300	*	*	*	*	*	3 wks. **	*	*	7 wks. **	*
		REMARKS: * Project proposal requesting design funds has been prepared by CEO and is being routed for signatures. Schedules have not been established. **After authorization.											

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LABORATORY AUXILIARIES MONTHLY REPORT (cont.)

HW-51741 DELVISITS TO HANFORD WORKS

<u>Name</u>	<u>Dates of Visits</u>	<u>Company or Organization Represented & Address</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>	<u>Areas & Buildings Visited</u>
BJ Sevold	7-22-57	Aircraft Nuclear Propulsion Dept., Evendale, Ohio	For information on salary, wage, and library administration, and hot laboratory work.	JL Boyd RE Rostenbach WH Reas DM Robertson RD Tillson HA Paulsen LD Turner WJ Gruber MF Puckett SP Gydesen MG Freidank BJ Borgmier BB Lane	Yes	328, 300 3702, 300 3760, 300
JJ Gervais	7-18, 19, 20, 22, 23, 24, 25-57	The Linde Co., Seattle, Washington	Demonstrate welding process.	LJ Lucas	No	328, 300
FM Pierson	7-25-57	Do-all Northwest Co., Seattle, Washington	Inspect Do-all Saws.	LJ Lucas	No	328, 300
EM Kidd RR Lowery	7-29 & 7-30-57	Union Carbide Nuclear Co., Oak Ridge, Tenn.	Discuss IBM system for document control.	BJ Borgmier MG Freidank AF McConiga	No	3760, 300 713, 700
N. Brand W. Walsh (AEC inspectors)	7-25-57	AEC, Washington, D.C.	Discuss document accountability and control.	BJ Borgmier MG Freidank MF Puckett	No	3760, 300
Chester Macomber Henry Hilson RS Ferguson	7-24 & 7-25-57	U.S. Army Redstone Arsenal, Huntsville, Alabama	Same as above.	AF McConiga H. Tellier	No	3760, 300 713, 700

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VISITS TO OTHER INSTALLATIONS

<u>Name</u>	<u>Dates of Visits</u>	<u>Company Visited and Address</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>
SP Gydesen	7-29 thru 8-9-57	Western Reserve University, Cleveland, Ohio	Attend seminar course.	Dean Shera	No

P. J. Lucas

Acting Manager,
LABORATORY AUXILIARIES

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EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

UNCLASSIFIED

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HW-51741. DEL

General

On June 31, the staff of the Hanford Laboratories Operation totaled 1,171 including 499 exempt and 672 nonexempt employees. Of the total exempt employees, there were 435 with college degrees including 419 technical degrees as follows:

<u>BS</u>	<u>MS</u>	<u>PhD</u>
211	108	100

In addition, there are 40 nonexempt employees with college degrees.

Distribution among the nine level 3 components is included in Table I.

Personnel Development and Communications

Eleven secretaries participated in the Laboratories' first presentation of the four-hour Secretarial - Clerical Training Course during the month. Four employees attended "Data Processing," and 20 completed the six-hour seminar "Applied Statistics." In addition, 20 employees completed the human relations course "Understanding People."

As a part of the annual orientation program for technical graduates and summer students, the Laboratories provided orientation talks and tours of facilities for 85 program participants during the report period.

Twenty-six technical graduates and 12 technician trainees were on rotational training assignments at month's end. These figures may be compared with the 22 and 17 on assignment in the respective categories at the end of June.

Seven employees participated in the Area Tour for Women.

Sixteen technical papers and signed articles were processed for publication during the month.

Personnel Practices

Suggestions -- At the July meeting of the Suggestion Board, 20 suggestions were reviewed and 18 were approved for awards totaling \$155. Five represented tangible annual net savings of \$917.79 and 13 represented intangible savings.

Suggestion 6309, submitted by D. W. Latta prior to the reorganization, was reviewed by the HAPO Legal staff and has been referred by them to W. E. Johnson for any further action he may wish to take.

Twenty-eight suggestions were submitted by HLO employees during July representing an average of 4.2 suggestions per 100 eligible employees.

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Benefit Plans -- Hanford Laboratories participation in the Employee Benefit Plans as of the end of July is listed below:

	<u>June</u>	<u>July</u>
Insurance Plan	99.6%	99.6%
Pension Plan	97.9	97.9
Stock Bonus Plan	59.7	59.4

Selective
Service

-- The military status of HLO employees is shown in the following table:

	Non-Technical	Technical	Non-Technical 1-A	*Critical	Total
<u>Reservists</u>					
Standby	11	26	0	1	38
Ready	18	20	6	2	46
Total	29	46	6	3	84
<u>Non-Veterans</u>	31	37	23	41	132
TOTAL	60	83	29	44	216

*Critical refers to those employees for whom deferments are currently being requested.

Placement and Records

There are only two openings in HLO, one secretarial position and one engineering assistant, for which difficulty is being experienced in obtaining suitable candidates. Negotiations are complete for filling all other open requisitions.

Nonexempt
Transfers -- Three nonexempt HLO employees were transferred to other HAPO components during the month. Three new transfer requests were received during July.

Service
Recognition -- Ten five-year and 11 ten-year service recognition pins were issued during July. For calendar year 1957 to date, there have been 62 five-year pins and 39 ten-year pins issued.

Attendance
Recognition -- Four one-year, three two-year, one four-year and one six-year attendance recognition awards were issued during July.

Personnel status changes of exempt and nonexempt employees and transfer activities are summarized in Tables I, II and III.

Technical Personnel Placement

PhD Recruiting -- Seven PhD candidates visited Richland for interviews during the month. There were five offers extended and three acceptances received. Since September 1, 1956, there have been 62 PhD offers extended, 14 acceptances received, and 14 offers continue open. In addition, four acceptances have been received to offers extended prior to that date, bringing the total HLO PhD acceptances received during the current year to 18.

HAPO PhD statistics are summarized in Table III.

BS/MS	HLO extended one offer which remains open. Since September 1, 1956,
Experienced	28 offers have been extended by HLO and have resulted in 15 accept-
Recruiting --	ances, with three offers remaining open.

Exempt transfer statistics are summarized in Table IV.

Health and Safety

During July, Laboratories personnel worked a total of 190,556 hours with no disabling injuries. Since September 1, 1956, a total of 2,071,729 hours have been completed with no disabling injuries.

There were 41 medical treatment injuries this month with a frequency of 2.15 as compared to 2.04 last month.

Reportable incidents are as follows:

1. An employee was spattered with nitric acid when an etching mixture of nitric acid and ethyl alcohol reacted violently.
2. There were two fire runs: one when a fluorescent light ballast burned out in 328 Building; the other when an oven set to test a masonite sample at 200° F. overheated to 500° F. in 1709-D Building.

To date, HLO has been billed for compensation awards to four of our personnel in the amount of \$49.00. These awards will be reported monthly henceforth.

The 12 security violations in July brought the 1957 HLO total to 64. One of the nine reported in June was retracted.

Medical examination completions this month were only 78% owing to the large percentage of personnel on vacations. Completions for the year to date are 92.5%.

During July, supervision was notified of nine new work restrictions and 20 continued restrictions. One restriction was discontinued.

A practice civil defense exercise, held July 12, required seven minutes for evacuation of 300 Area. Assistance was given two operations in revising building evacuation plans.

Salary and Wage Administration

Seventeen position audits were completed during the month as follows:

Financial	- 3
Laboratory Auxiliaries	- 3
Reactor & Fuels	- 1
Chemical Research & Devel.	- 1
Radiation Protection	- 1
Physics & Instrument R & D	- 7
Operations Research & Synthesis	- 1

The following position changes were made effective during the month:

Positions Deleted - 1
Positions Added - 3
Position Titles Changed - 1

Effective July 1, a new level 5 component, Critical Mass Physics, was added to the Nuclear Physics Research Operation. The appropriate position title, approvals, and transfer of personnel was accomplished concurrent with the same date.

The Quarterly Distribution Report by salary level and zones of Hanford Laboratories for the period ending June 30 was completed and forwarded to Contract Administration, Relations and Utilities.

The organization directory, effective as of July 1, was prepared and distributed to all departments and/or operations of HAPO during the month.

The Point Score Evaluation Plan for use in evaluating semitechnical jobs was completed and forwarded to 65 HLO managers and supervisors during the month. The Specialist, Wage Administration will hold discussions as necessary with appropriate personnel regarding its use.

The major efforts of the Specialist, Wage Administration during the month was spent in developing the attitude survey questionnaire with other managers of HAPO departments and/or operations for use in the forthcoming Fall attitude survey to be conducted at HAPO.

Union Relations

A proposal was originated by the Hanford Laboratories Operation and transmitted to R. E. Donnell for consideration as an offer to the regional monitors in the hope of bringing the negotiations to a conclusion. Donnell resubmitted to Hanford Laboratories a revised proposal which was acceptable to HLO and a meeting was held with the regional monitors on July 29, 1957. A draft of the proposal was given to the Council and discussed at the meeting. As yet, no answer has been given as to acceptance by the radiation monitors and the regional monitors.

In regard to the Wonacott arbitration case, no further meetings have been scheduled to discuss the differences between the Company and the Council in this jurisdictional dispute.

No further action has been taken by HAMTC in connection with the Maki case.

Five grievances were received during the month of July. They are briefly summarized as follows:

A machinist in Technical Shops was aggrieved as to the overtime distribution. This grievance was settled at Step I.

A number of radiation monitors claimed that a laboratory assistant "B" was performing work that belonged to the monitors. A Step II answer has been prepared and will be distributed shortly.

Another grievance was received from a sheetmetal journeyman in Technical Shops regarding overtime distribution. This grievance was answered satisfactorily and settled at the Step I level.

A radiation monitor filed a grievance claiming discrimination against himself and other holders of rover badges who were delayed unnecessarily while clearances were being checked. The Step I answer was satisfactory and the grievance is settled at that level.

An instrument technician in Reactor and Fuels claimed that nonunit personnel were doing work that rightfully belongs to the instrument craft. This grievance was scheduled for Step II discussion by the Council but has not yet been discussed.

The grievances processed by this operation since September 1, 1956 now total 27 and are summarized in Table V.

Manager
Employee Relations

T. G. Marshall/dwu

TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUSI. Employment

<u>Non-Exempt Employment Status</u>	<u>June</u>	<u>July</u>	<u>Non-Exempt Transfer Requests</u>	<u>June</u>	<u>July</u>
Requisitions at end of month	24	17	Transfer Cases		
Cancelled	0	3	Active cases at end of month	50	47
Received during month	14	10	Cancelled	1	3
Filled during month	7	14	New during month	5	3
Candidates considered			Transfers effected	5	3
Total applications	14	1	Planned transfers		
Total transfer request from other at HAP0	4	7	Effective during month	0	3
Total interviewed	2	0			

II. Technical Personnel Placement

Ph.D. Recruiting - (Compiled by R&UO for all HAP0)

	<u>Cases Con-</u> <u>sidered</u>	<u>VISITS TO RICHLAND</u>				<u>OFFERS</u>			<u>On</u> <u>The</u> <u>Roll</u>
		<u>Extended</u>	<u>Visited</u>	<u>To</u> <u>Visit</u>	<u>Open</u> <u>Invite.</u>	<u>*</u> <u>Extended</u>	<u>*</u> <u>Accepted</u>	<u>Open</u>	
Engineering:									
Chemical	66	33	14	2	5	8	2	2	-
Electrical	23	9	2	2	1	1	-	1	-
Mechanical	27	17	8	2	1	6	2	3	-
Metallurgical	41	24	8	2	8	5	2	1	1
Civil	2	-	-	-	-	-	-	-	-
Science:									
Chemistry	241	84	34	7	5	25	3	3	2
Physics	246	111	31	21	17	22	4	6	3
Math-Stat.	48	14	4	-	1	1	1	-	-
Other	46	8	7	-	-	6	4	-	2
DVM	4	-	-	-	-	2	2	-	1
TOTAL	744	300	108	36	38	76	20	16	9

*Offer totals include 11 carry-overs from the 1955-56 season with 4 acceptances not on the roll as of 9/1/56 and 7 open offers at that time.

BS/MS Experienced Recruiting - HLO

	<u>Cases Con-</u> <u>sidered</u>	<u>VISITS TO RICHLAND</u>				<u>OFFERS</u>			<u>On</u> <u>The</u> <u>Roll</u>
		<u>Extended</u>	<u>Visited</u>	<u>To</u> <u>Visit</u>	<u>Open</u> <u>Invite.</u>	<u>*</u> <u>Extended</u>	<u>*</u> <u>Accepted</u>	<u>Open</u>	
Engineering:									
Chemical	16	7	3	-	-	1	-	-	-
Electrical	27	15	8	-	-	4	2	1	2
Mechanical	35	23	15	-	-	5	3	-	3
Industrial	7	4	3	-	-	3	2	-	2
Metallurgical	21	13	7	-	-	6	4	1	4
Ceramic	4	3	3	-	-	4	1	-	1
Other	16	5	2	-	-	-	-	-	-
Science:									
Chemistry	30	6	2	-	-	2	-	1	-
Physics	13	5	3	-	-	2	1	-	1
Math-Stat.	5	3	3	-	-	3	2	-	2
Other	48	2	2	-	-	-	-	-	-
TOTAL	222	86	51	-	-	30	15	3	15

*Offer totals include 2 carry-overs from 1955-56 season not on the roll as of 9/1/56.

TABLE IV. EXEMPT TRANSFER CASES

	<u>July</u>	<u>June</u>	<u>Total</u>
Active cases at <u>beginning</u> of month	16	19	
New cases: Initiated by employee	2	1	
Initiated by management*	1	1	
Cases Reactivated			
	<u>19</u>	<u>21</u>	
Cases Closed: Transfers within HLO			4
within HAPO			2
other G. E.		2	13
Withdrawn	2		19
Terminated		<u>3</u>	<u>11</u>
	<u>17</u>	<u>16</u>	<u>49</u>
Active cases at <u>end</u> of month	17		<u>17</u>
Total cases (Including those initiated prior to and since 9/1/56)			66
Initiated by employee			47
Initiated by management*			<u>19</u>
			<u>66</u>

*Include's ROF's, transfers proposed by employee's management, and requests from other G. E. departments.

TABLE V. Union RelationsGrievances Processed - September 1, 1956 to date

Total processed 27 (includes 2 non-unit grievances)

Step I

Answered satisfactorily*	17
Pending time limit	0

Step II

Pending Step II answer	1
Pending time limit	1
Answered satisfactorily**	8

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

** Step II grievances in which the Council formally applied for arbitration but for which no further action is taken within three months are considered settled at Step II.

FINANCIAL OPERATION MONTHLY REPORT
July 1957

Compiled by Members of the
FINANCIAL OPERATION
HANFORD LABORATORIES OPERATION

Personnel

There were no personnel changes in the Financial Operation during July.

Activities

General Accounting Operation

In response to a request from SS Accountability, HLO custodians of SS Materials were asked to prepare formal procedures covering the control and management of these materials. August 15 is the established due date.

A forecast of diversions of nuclear materials inside production channels covering the second and third quarters of FY 1958 was prepared and submitted to SS Accountability representatives.

In response to a request from Contract Administration, HLO level 3 components were asked to furnish the Manager - General Accounting with information covering special requests for information and services by HOO-AEC. A monthly report will be prepared by the Manager - General Accounting.

A summary of AEC Manual Chapters with which the Company has agreed to comply was received from Contract Administration. Copies were forwarded to Employee Relations and Laboratory Auxiliaries and were distributed within Financial for review and determination that existing procedures assured compliance. Other level 3 managers and the Manager - HLO were provided information copies.

A report of findings in connection with the physical inventory of uninstalled cataloged equipment in the custody of Radiation Protection Operation was issued in July. Thirty pieces of equipment carried on property records at a value of \$21,746 were reported as missing. All missing equipment was transferred into a special code representing unknown custodial equipment. Items charged to this code that cannot be located upon completion of HLO uninstalled cataloged equipment physical inventory will be written off record. Since the issuance of this report, Radiation Monitoring Operation has located equipment valued at \$7,352.

Reconciliation of the physical count of uninstalled cataloged equipment in the custody of Laboratory Auxiliaries Operation and in Biology Operation to property records continues. The reconciliation will be completed and a report of findings issued in August.

All field work in connection with the physical inventory of Hot-Semi-Works was completed and the reconciliation of physical count to property records is in progress. This inventory was taken in preparation for transferring Hot-Semi-Works from operational status to that of "Plant and Equipment Held for Future Use".

Quarterly inventory reports for the quarter ending June 30, 1957, were received from all HLO custodians of Reactor and Other Special Materials and reconciled with Property Accounting Records. All reports were in agreement except an increase of 1.6 grams of platinum in the custody of Radiation Protection Operation due to reporting actual weight which previously had been estimated.

The June balance of Zirconium transferred to HLO from R&U amounted to \$620,276.13, representing material physically located at HAPO and at vendors' plants. The following is a breakdown of the zirconium account as of June 30, 1957:

Inventory material located at Stores	5,486.0 lbs	\$ 67,640.21
Material charged to Cost located at Stores	1,363.4 lbs	-
Billing held in inventory account for fabrication costs and material at vendors' plant	-	552,635.92
	<u>\$6,849.4 lbs</u>	<u>\$620,276.13</u>

Funds available to Hanford Laboratories Operation for charges against the fee during calendar year 1957 have been reallocated. The revised allocation reflects a decrease of \$900 from the amount originally allocated and includes provision for travel and living variation expense.

A proposed allocation of funds available to Hanford Laboratories Operation for attendance at meetings of professional and trade societies during FY 1958 has been developed.

During the month, an AEC auditor has been working with various general ledger accounts.

Cost Accounting Operation

Starting with July 1957 business, a change was incorporated in the method of allocating HAPO general overhead to research and development and production. In FY 1957 an incremental amount of general overhead, predetermined at 7% of direct costs, was allocated to research and development with the remainder allocated to production. The method to be used in actual costing in FY 1958, which also was the method applied in compiling the FY 1958 Revised Budget for research and development and production, is based on allocating to research and development all applicable general overhead costs. This is estimated to be 25% of direct costs.

As a result of HOO-AEC request, cost of each HAPO general overhead function will be traced to production and research and development. Extensive detailed records and additional effort of cost accounting personnel will be required in order to fulfill this request. Previously, general overhead costs were traced to end functions only in the broad categories of general and administrative costs and protection of plant and personnel costs. It will now be required to trace each type of general overhead cost, i.e., patrol, fire, library, classified files, employee relations, financial, radiation monitoring, etc. to the end functions.

As general overhead costs are billed back and forth among the HAPO components, a complicated and time consuming task evolves by the time general overhead costs finally reach the HAPO components responsible for the production processes and research and development programs. HLO Cost Accounting has made the necessary arrangements to fulfill the Commission's request.

General Electric Company at Hanford is operating on the basis of a preliminary financial plan transmitted by HOO-AEC as an interim plan until such time Congress passes the appropriating legislation applicable to the Atomic Energy Commission for FY 1958 and Washington AEC make an allocation to HOO-AEC as a result of the congressional action. A firm financial plan for FY 1958 is not expected until after September 1, 1957.

The FY 1957 Savings and Improvement Report for Hanford Laboratories was prepared by the HLO components during July and submitted to Contract Administration. Thirty items were submitted which represented savings to date of \$171,613 and an annual future savings of \$259,657.

Contacts have been made by the HOO-AEC auditor performing an audit of Hanford Laboratories' Financial Operation concerning accumulation and distribution of operating costs and equipment work in progress.

Depreciation cost related to the buildings and facilities of Hanford Laboratories is now allocated each month to the services performed by Hanford Laboratories. Effective July 1, 1957 depreciation cost applicable to process technology, general overhead and other miscellaneous services performed for the product departments are billed to them. Depreciation costs related to all research and development work performed by Hanford Laboratories will remain in the HLO depreciation account throughout the fiscal year and then transferred to HOO AEC on June 30, 1958.

Personnel Accounting Operation

A cost-of-living allowance amounting to 1.77% was made effective July 29, 1957 to non-exempt employees. This brings the adder factor to 26.31 percent. The increase will be reflected on weekly salary checks dated August 9, 1957 and change to area differential to exempt in their August salary payment. This allowance will result in an increase in the annual going rate of payroll \$52,000.

Employees Compensation Services requested information required to complete the annual survey of professional scientific salaries sponsored by the Los Alamos Scientific Laboratory by August 12, 1957. Reports were complete in draft and final reports will be transmitted to Mr. L. L. Weiss for consolidation by August 7, 1957.

Auditing

The audits of Contracting and Procurement and of General Accounts were completed and reported on as of July 31, 1957. Preparation of an audit schedule for the year ending July 31, 1958 is underway.

Measurements

A report summarizing the information obtained at a Company meeting of Measurements Specialists from laboratory components was prepared and distributed to interested personnel in other HAPO components. Other activities during July were associated with the completion of the interim measurements report covering the period January 1, 1957 to June 30, 1957.

Office Procedures

Consultation was performed with a representative of Operations Research concerning the related problem of paperwork flow in HLO. A definition of all source data, its flow through all organizations, and its eventual summarizing and reporting is being considered for all information originating within HLO. These activities are the first step in a long range study; much remains to be done in this area of paperwork elimination.

Studies were begun of all paperwork procedures of the Personnel Accounting Operation. Office methods concerning payroll preparation, summary and reporting and the EDPM system for weekly and monthly payroll are to be examined to assist that group in improving and streamlining these procedures wherever possible.

Payroll Statistics

<u>Changes during month</u>	<u>Total</u>	<u>Exempt</u>	<u>Non-Exempt</u>
Employees on Payroll at Beginning of Month	1 154	481	673
Additions and Transfers In	30	19	11
Removals and Transfers Out	(14)	(2)	(12)
Transfers from Non-Exempt to Exempt		1	(1)
Employees on Payroll at End of Month	<u>1 170</u>	<u>499</u>	<u>671</u>
<u>Overtime Payments During Month</u>		<u>July</u>	<u>June</u>
Exempt		\$ 6 210	\$ 1 464
Non-Exempt		<u>7 585</u>	<u>9 030</u>
		<u>\$13 795</u>	<u>\$10 494</u>

Gross Payroll Paid During Month

Exempt	\$366 164	\$352 602
Non-Exempt	<u>261 658</u>	<u>277 277</u>
	<u>\$627 822</u>	<u>\$629 879</u>

Participation in Employee Benefit Plans at Month End

	<u>Number Participating</u>	<u>Percent Participating</u>	<u>July</u>	<u>June</u>
Pension Plan	1 073	1 028	97.9%	97.9%
Insurance Plan				
Personal Coverage	1 156	1 142	99.6%	99.6%
Dependent Coverage	707	709		
U.S. Savings Bonds				
Stock Bonus Plan	695	685	59.4%	59.7%
Savings Plan	101	100	8.6%	8.7%

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<u>Insurance Claims Paid</u>	<u>July</u>		<u>June</u>	
	<u>Number</u>	<u>Amount</u>	<u>Number</u>	<u>Amount</u>
Employee				
Life Insurance	-	-	-	-
Weekly Sickness & Accident	9	806	10	581
Comprehensive Medical	29	3 635	25	4 274
Dependent				
Comprehensive Medical	54	5 336	73	10 955
Total	92	\$9 777	108	\$15 810

<u>Good Neighbor Fund</u>	<u>July</u>	<u>June</u>
Number participating	747	750
Percent participating	63.8%	65.0%

Other StatisticsCash Advances and Travel Expenses

	<u>No.</u>	<u>July</u>	<u>No.</u>	<u>June</u>
Accounts Outstanding at beginning		\$ 4 106		\$ 8 173
Charges:				
Cash issued - by checks	27	3 250	62	7 770
- by currency	27	2 884	87	8 242
- air travel orders		5 440		12 132
Other - (Billings from other GE Components, moving expense, etc.)		2 044		
		<u>17 724</u>		<u>36 317</u>
Less:				
Expense vouchers processed				
Travel expense accounts	13	1 895	136	26 943
Other (moving expenses, conference expense, etc.)	7	130	22	451
Refund of advances	53	5 229	68	4 603
Billings to and from HAPO Components - Net		<u>(251)</u>		<u>214</u>
		<u>7 003</u>		<u>32 211</u>
Accounts Outstanding at Close	33	<u>\$10 721</u>	51	<u>\$ 4 106</u>

W. Sale/bk
August 12, 1957

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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.

INVENTORTITLE OF INVENTION OR DISCOVERY

J. D. McCormack

A Digital Printer Employing Temperature Sensitive Paper.

J. C. Sheppard

The Use of n-octylamine for the Solvent Extraction Recovery of Neptunium.

W. C. Roesch and
R. C. McCall

Condenser Ionization Chamber Readers.

F. B. Quinlan and
W. E. RoakeSwage Compacted and Clad UO_2 Fuel Element.

END

**DATE
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