HW-62587

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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

OCTOBER, 1959

NOVEMBER 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

GENERAL ELECTRIC

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HW-62587

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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
OCTOBER, 1959

Compiled by
Operation Managers

November 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRELIMINARY REPORT

This report was prepared only for use within General Electric Company in the course of work under Atomic Energy Commission Contract AT(45-1) - 1350. Any views or opinions expressed in the report are those of the author only.

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE October 31, 1959

	At close of month			At beginning of month			Additions		Separations	
	Exempt	NonExempt	Total	Exempt	NonExempt	Total	Exempt	NonExempt	Exempt	NonExempt
Chemical Research and Development	129	101	230	127	101	228	2	2	0	2
Reactor & Fuels Research & Development	195	172	367	192	159	351	3	14	0	1
Physics & Instrument Research & Development	63	34	97	62	34	96	1	1	0	1
Biology Operation	35	45	80	36	45	81	0	0	1	0
Operation Res. & Syn.	16	4	20	16	4	20	0	0	0	0
Radiation Protection	33	99	132	33	100	133	0	1	0	2
Lab. Auxiliaries	52	191	243	48	193	241	5	3	1	5
Financial	14	13	27	12	13	25	2	1	0	1
Prof. Plant. & R. P.	82	19	101	86	18	104	4	1	8	0
Programming	16	4	20	16	4	20	0	0	0	0
General	1	2	3	1	2	3	0	0	0	0
Totals	636	684	1320	629	673	1302	17*	23	10	12*
Totals excluding internal transfers	636	684	1320	629	673	1302	14	21	10	7

* Including 3 nonexempt employees to exempt roll.

Composite Separation Rate	1.6666
Separation Rate(based on separations leaving G. E.)	.5303
Controllable Separations Rate	.0000

BUDGETS AND COSTS

Costs for October were $1,971,000, a decrease of $38,000 from September. Fiscal year-to-date costs are 34% of the amounts currently authorized to Hanford Laboratories.

Plutonium Recycle Program costs are $2,026,000 (40% of annual authorized funds) for the first four months of the fiscal year. There are some indications based on reviews held with AEC-Washington Division of Reactor Development people, that an upward adjustment of some program funds may be made. If not, a sharp curtailment of expenditures with the attendant slow down of programs for the balance of the fiscal year will be required.

Research and Development costs on the New Production Reactor for the Irradiation Processing Department were reduced in October from the September level, however, a further reduction is required due to fund limitations.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

The over-all PRTR contract is 49.4% complete versus a scheduled 56% based on the official PRTR schedule; PFPP Phase III equipment installation is estimated at 96% complete.

HW-61236, the rough draft of the PRTR Final Safeguards Report, was reviewed by the PRTR Sub-Council of the General Electric Reactor Safeguards Council and the PRTR Startup Council, and discussed with personnel of the AEC Hazards Evaluation Branch. A revised report, incorporating the comments of these groups, will be published in November.

Funds have been authorized for scoping and preliminary design of the PRTR fuel element rupture test facility (Project CAH-867).

Vibratory compaction is being currently employed to make Zircaloy-clad, rod-cluster UO_2 fuel elements for irradiation in the ETR and VBWR.

Evaluation of the first 500 pounds of Spencer Chemical Company arc-fused UO_2 reveals that it exceeds our rigorous specifications for purity and density.

Preliminary data indicate that internal surface cladding defects of the order of 0.002" in depth can be detected in swaged Zircaloy-UO_2 rods with an immersion type ultrasonic tester. Routine ultrasonic testing of swaged rods is under way.

In high temperature, ex-reactor microscopy studies it was found that the addition of small amounts of additives such as Nb_2O_5 or TiO_2 to UO_2 markedly changes the temperature at which crystals form and the shape of the crystals. These results may be pertinent in the design of a fuel element for high temperature operation in which minimization of the relocation of the UO_2 is desired.

The thermal expansion coefficient for PuO_2 was determined as $11.53 \times 10^{-6}/^{o}C$. for the temperature interval 237 to 928 C. This is appreciably lower than the preliminary value of $15.2 \times 10^{-6}/^{o}C$ reported last month. For comparison the expansion of UO_2 was $10.1 \times 10^{-6}/^{o}C$.

A three-foot long, 19-rod Al-Pu cluster has been operated at maximum PRTR conditions for five days in the ETR. This is the largest prototype which can be reactor tested prior to PRTR startup because of size limitations of all existing test loops operating at the necessary temperatures and pressures.

A 7-rod Al-Pu cluster, 12 UO_2 - PuO_2 capsules, and two Al-Pu capsules are under irradiation in the MTR. Two oxide and six Al-Pu capsules are undergoing post-irradiation examination.

Of the Zircaloy cladding tubes received for use in fabricating Zr-Clad Al-Pu rods, 60% are being rejected because of faults revealed by the various inspections.

To avoid "acid-staining" on autoclaved Zircaloy-2 clad UO_2 fuel rods, the maximum allowable transfer time between the etching bath and the aluminum nitrate "stop" bath has been shown to be 30 seconds. Likewise, the zirconium concentration in the HNO_3-HF etching bath must be maintained below 30 grams per liter.

The non-destructive testing of the Zircaloy-2 PRTR process tubes is 95% complete. Eighty-two of the 97 tubes have passed these tests and are considered structurally sound.

In ex-reactor autoclave tests at 300 C, no abnormal hydriding was observed in sections of Zircaloy-2 process tubing which had suffered deformation caused by deliberate rupturing of Zircaloy-clad co-extruded uranium fuel samples located inside the process tubing.

A section of irradiated Zircaloy-2 process tubing recently removed from service in KER Loop 2 does not indicate abnormal hydriding but does show localized areas of small equiaxed recrystallized grains.

Both effective decontamination and adequately low corrosion of carbon steel surfaces in the NPR may be possible if galvanic corrosion of the carbon steel can be eliminated. Variables found to affect the galvanic corrosion rate are: the relative areas of carbon and stainless steel surfaces, solution velocity, and temperature. Bisulfate decontaminating solutions show promise for both the NPR and the existing Hanford reactors.

A small concentration of chlorine significantly reduces the air oxidation of graphite. At 550 C, 0.5% Cl_2 decreased the oxidation rate six-fold.

The ex-reactor initial elongation of a Zircaloy-2 creep specimen tested at 22,000 psi and 290 C was 2.8 percent. A corresponding specimen in-reactor demonstrated little initial elongation and no noticeable creep after having been exposed to 2×10^{17} nvt. The temperature of the in-reactor specimen will be raised in increments of 25 C until creep occurs.

It has been found that the mechanical properties of several structural metals are affected by the rate of exposure to reactor irradiation as well as the total exposure. Lowering the temperature of irradiation reduces the rate effect.

Post-irradiation testing of thorium metal specimens shows that they embrittle severely, to approximately the same degree after exposure to 1.0 a/o burnup as uranium metal after 0.1 a/o burnup.

Post-irradiation tests on irradiated uranium metal show that the thermal conductivity decreases 18-30% on burnouts of 0.02 to 0.03 a/o, and is not recoverable at elevated temperatures.

For uranium metal specimens irradiated to 0.29 a/o burnup, it appears that very little swelling occurs at irradiation temperatures below 500 C.

A detailed metallurgical examination of various pressure bonded, Zircaloy-2 clad, tubular uranium fuel elements has revealed the mechanism of compound formation along the bonding interface.

Hot heading of KER-size tubular fuel has been successfully accomplished. The resulting product appeared satisfactory for subsequent projection welding of end rings. Tooling will soon be available to handle long lengths of tubular elements.

After three weeks of irradiation, one inner tube of a KER-size tube/tube fuel assembly failed. Operation was in pH 4.5 water at 250 and 280 C. Examination revealed extensive pitting attack, presumably resulting from excessive surface temperature caused by a deposited crud layer approximately 0.010" thick. The jacket surface was also contaminated with copper from the extrusion cladding. Similar surface pitting was observed on BMI examination of rod/tube elements which had been exposed to 2000 MWD/T in a KER loop also in low pH water.

Seven, 7-rod cluster elements were discharged from KER-2 after rupture indications in the loop were detected. The exposure was 2500 MWD/T in 250 C, pH 10 water. One of the rods had ruptured resulting in a jacket split about one inch long. There was no indication of film formation, and the black oxide appeared to be intact.

Steady state boiling curves were obtained experimentally for K Reactor I & E fuel geometry at tube powers of 500, 1000, 1500 and 2000 KW employing a test section of K-Reactor length.

2. Chemical Research and Development

A simple method was discovered which causes strontium to precipitate in good yields with rare earth fission product fractions selectively recovered from Purex waste. This is a break-through on strontium fission product recovery.

Selective recovery of cerium by the peroxide-acetate process was confirmed by Purex Plant tests. Laboratory research on this method was completed.

Smooth, trouble free operation was experienced on starting up the pilot-scale fluid-bed waste calciner prototype. Preceding exploratory studies at ANL on simulated Purex waste feeds in their equipment were concluded and the results are being incorporated into the HLO program now underway.

The Radiant Heat Spray Calciner is a competitive process and laboratory tests continue to be encouraging. Both unit operations will be continued until the advantage of one over the other is evident.

Continued testing in pilot-scale NPR dissolver prototypes showed no significant restrictions to the use of either the flooded tray or recirculating vertical barrel concepts.

Early results of seismic geophysical tests conducted by Washington State University experts indicate that seismic methods are capable of discerning most geologic features of the area.

3. Physics and Instrument Research and Development

In dissolving fuels of 3% enrichment, the smallest critical mass will likely occur for the completely dissolved condition and will be less than 170 lbs., according to exponential experiments now in progress. This somewhat unexpected development will not materially affect dissolver batch limits for 3% fuel but will improve estimates for handling fuels of higher enrichments.

During the month nuclear safety advice was furnished to Plutonium Metallurgy Operation, Radiometallurgy Operation, and Chemical Research Operation, and the first HLO Nuclear Safety Bulletin was issued.

Technical planning for the first series of experiments in the Critical Mass Laboratory continued. The results to be expected are being calculated by the IBM-709. Some of the cases calculated correspond to experiments performed in the old P-11 laboratory, thus providing a check on the calculation method.

In the NPR program exponential experiments were conducted on tube-in-tube fuel elements and PCTR measurements were begun on cluster elements of natural uranium. Although natural uranium would not be used in the NPR these measurements provide valuable check points on both calculation methods and experimental techniques.

In a study of the characteristics of the NPR primary loop system, satisfactory methods were developed for simulating the performance of the heat exchanger on the analog computer. This particular component of the system had given difficulty because its behavior was dependent on several parameters in addition to the time variable. Study of the complete system awaits arrival and installation of the new EASE computer.

Among people examined to date at the Shielded Personnel Monitoring Station, a high percentage (95%) contained detectable amounts of Zn^{65} averaging less than 10^{-5} of the permissible body burden. While fallout is indicated as the source of much of this isotope, similar results have not been reported from other sites equipped with similar monitoring facilities.

Orderly progress was made on the many projects in the instrument field, notable among them being investigation of a method for counting neutrons in the presence of a high gamma background, personnel dosimeters which will alarm when a preset exposure is reached and an alpha air monitor of improved sensitivity.

4. Biology

Radioiodine levels in thyroids of jack rabbits were five times greater than those of one year ago. Contamination of aquatic life remained unchanged.

DTPA administered to rats which had received otherwise lethal injections of plutonium was able to prevent the lethal effect.

Cysteine was found to protect against the effects of X-irradiation on the glucose absorbing ability of the intestine.

5. Programming

Analysis of waste stream materials from three out of five uranium ore mills from which samples have been obtained indicated ionium (Th-230) content in total thorium to be from two to four per cent. For efficient preparation and recovery of special heat producing isotopes (U-232 and Th-228) it would be desirable to use thorium feed containing about 10 per cent ionium. The fact that mill waste streams without any process development or changes, provide material of up to four per cent ionium is quite encouraging.

The RBU computer code was given an extended trial run this month. No coding errors have as yet turned up as a result of this run, and the code may be considered complete except for auxiliary service routines being supplied by ourselves. The American-Standard final report on this project is now about ready for distribution. Testing and evaluation of the code will be continued during the next few months.

An exchange seminar program with the University of Washington has been established. On alternate months, Hanford and the University

will send speakers to the other location. At the first seminar (in Seattle), E. D. Clayton will speak on exponential and critical experiments.

TECHNICAL AND OTHER SERVICES

Work was completed on the comparison of four models with respect to their ability to predict in-reactor corrosion.

The central multivariate analysis subroutine of the GCL computer program has been completed and checked.

Computations of a reliability index for the K-plant water system under various alternatives were successfully completed.

A study of the feasibility of complete automation of radiochemical isotopic analysis by multi-channel gamma spectrometers has been initiated.

Work on 14 operations analysis programs continued during the month. In addition, statistical and mathematical assistance on 16 problems was given within HLO and to other departments and operations.

Two new plutonium deposition cases were confirmed. Body deposition in both cases was less than 1% of the maximum permissible body burden (0.04 μc). The total number of deposition cases that have occurred at HAPO is 237 and 170 are currently employed.

There were 23 authorized projects at month's end with total authorized funds of $7,797,600. The total estimated cost of these projects is $9,271,365. (PRTR and PFPP are considered separately.) Three new projects were authorized and two were completed during the month. Three new projects are awaiting AEC approval and three new projects were submitted to AEC during the month. Four proposals for new projects are in preparation.

Total productive time for Technical Shops for the month was 18,531 hours. This includes 17,131 hours performed in the Technical Shops, 808 assigned to Minor Construction, 218 to other project shops, and 374 hours to off-site vendors. The total shop backlog is 26,456 hours of which 50% is required in the current month, with the remainder distributed over a three-month period. Overtime worked during the month was 3.5% (781 hours) of the total available hours.

Radiographic Testing Operation made a total of 5, 872 tests, of which 703 were radiographic (including x-ray and gamma-ray) and 5. 169 were supplementary tests. Out of a total of 2, 585 man-hours, 527 (20 4%) were in connection with radiographic tests, and 2, 058 (79. 6%) were used on supplementary tests.

A major revision of the Standard Distribution Lists for Classified Scientific and Technical Reports (M-3679) will be made. The revision will eliminate 21 of the present 37 categories in M-3679 on the basis that there need no longer be any classified reports issued in these categories. In addition, the scope notes for C-42 (Reactors - Production) are going to be re-written and expanded. A new Category C-65 will be created into which will fall Savannah River and Hanford Research and Development reports which contain production information or information from which production data can be inferred. Under the revised system, all Research and Development reports emanating from Hanford will be either unclassified or, if classified, assigned to Categories C-42 or C-65.

There were a total of 66 open orders to J. A. Jones Company for construction service work at month's end. These open orders amounted to $195, 233. Forty eight orders were closed out during the month amounting to $90, 053, and sixty two new orders were issued amounting to $49, 501.

Design for the chemical processing area of the 306 Building Addition Project CG-744, was completed and transmitted to AEC October 7, 1959 Bid invitations are expected to be issued November 10. The construction period may be exceedingly long due to steel procurement for the pickling tanks.

SUPPORTING FUNCTIONS

The laboratory equipment pool (Building No. 3718) is nearing completion and should be ready for occupancy by November 15 1959 A procedure covering the movement of property into the building is being prepared. One of the PRTR warehouses may also be used for this purpose about January 15, 1960.

Arrangements have been completed for the transfer of accounting responsibility for thirteen presently authorized projects from CE&UO to HLO, effective with November business. Weekly reports covering these projects and newly authorized projects will be published during November.

An audit of maintenance was started during the month. Its main purpose is to assess the adequacy of HLO maintenance levels.

Payments amounting to $2,800 arising out of the Maki arbitration case were made during the month.

As of October 31st, the staff of the Hanford Laboratories totalled 1320 employees, including 636 exempt and 684 nonexempt. There were 546 exempt employees possessing technical degrees including 334 BS, 112 MS and 100 PhD.

The medical treatment frequency for October was 1.52 as compared with 1.97 last month. There were 5 security violations during October, bringing the total for the year to date to 38.

During the month, an injury which occurred on September 29th was reclassified as a disabling injury and occurred when an employee smashed a finger which required amputation on October 12. This represents HLO's second disabling injury since 1956.

BS/MS recruiting for the 1959-60 recruiting year began on October 7. During the month, 7 recruiters visited 10 universities. Early indications are that the demand for engineers is increasing over last year; however, students' response to our interview visits has been excellent. Seven offers were extended to experienced graduates and 6 acceptances were received during the month. Recruiting activity in this area has decreased materially during recent weeks. Two PhD offers were extended and 2 acceptances were received during the month. Two PhD's reported on the roll for HLO. During October HAPO participated in Company PhD recruiting at Texas, Rice, Purdue and Illinois.

Four Technical Graduates were added to the Training Program rolls during October and 8 were placed on permanent assignment. The total force in the Training Program on October 31st was 78.

Classes 11 and 12, PBM-I, totalling 40 Laboratories people were started. Fifteen Engineering Assistants were enrolled in the Applied Creativity course.

H M Parker

Manager
Hanford Laboratories

HM Parker:mlm

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REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Effect of Pre-existing Autoclave Films on the Hydriding of Zircaloy-2. Eight samples of Zircaloy-2 were given various pre-treatments to form different types of surface films. These were then exposed to dry hydrogen gas at 400 mm Hg pressure and 500 C. The hydriding induction times varied from zero minutes (for samples either "vapor blasted" or "etched" but not autoclaved) to about 100 minutes for samples pre-autoclaved 72 hours at 400 C in steam. However, all samples were completely hydrided within three hours exposure to the dry hydrogen gas at 500 C. These results confirm earlier findings that pre-autoclaving offers only temporary protection to hydriding in the absence of sufficient water vapor to maintain the oxide surface film.

In another test, a pre-autoclaved Zircaloy-2 sample was held in high vacuum for two hours at 500 C and then exposed to dry hydrogen. This sample exhibited an induction time of 60 minutes and then hydrided at a rate similar to a control sample which was not heated in vacuum. From this experiment it is concluded that exposure to hydrogen is the factor which leads to the breakdown of the oxide film, and that high temperature alone is not sufficient. If merely time at temperature were the cause of the observed induction times, this second sample should have hydrided instantly upon exposure to hydrogen.

Hydriding of Zircaloy in a Simulated NPR Gas Atmosphere. Samples of Zircaloy-2, Zircaloy-3 and Zircaloy-4 were exposed for 16 days in a simulated NPR gas atmosphere. This gas was simulated by passing helium through water to saturate it with water vapor; then passing the gas over hot graphite at 1100 C, where the reaction $H_2 + C \rightleftharpoons CO + H_2$ occurs. The reaction gas mixture then passed over the Zircaloy samples which were held at 400 C for the 16-day test period.

Three samples of Zircaloy-2 and one each of Zircaloy-3 and Zircaloy-4 were tested with various surface treatments. After the test, hydrogen analyses of the samples showed Zircaloy-2 ranging from 54 to 115 ppm, Zircaloy-3 40 ppm and Zircaloy-4 160 ppm, compared with pre-test values of about 25 ppm.

The final hydrogen values, determined by vacuum fusion, were confirmed by estimates made metallographically. With the exception of the Zircaloy-4 sample, all of the final hydrogen concentrations are about in line with

atomic hydrogen pick-up which could be expected from the corrosion reaction in water vapor at 400 C for 16 days and do not indicate substantial pick-up of molecular hydrogen in addition. The final Zircaloy-4 value is unexpectedly high but is consistent with the hydriding behavior in other tests of this particular batch of Zircaloy-4, which is now believed to be off-standard.

Fuel Element Rupture Studies. A coextruded rod element with a 0.025-inch diameter pinhole defect in the cladding was exposed to water at 170 C, 500 psig for 50 hours. About 350 ml of hydrogen was slowly evolved during the first 15 hours of exposure, then none was evolved during the remaining 35 hours. After 50 hours, there was no visible distortion of the fuel element sample. Apparently the water reacted slowly with the uranium exposed at the defect, evolving a small quantity of hydrogen until the pinhole was plugged with uranium oxide and the reaction ceased.

In another series of tests, large coextruded tube-element samples, with pinhole defects, were confined in lengths of KER-size Zircaloy process tubing and ruptured in water at 300 C in an autoclave. The ruptures involved the corrosion of up to 550 grams of uranium per rupture and in some cases caused considerable distortion of the process tubing. Two of the distorted process tube samples were examined metallographically for zirconium hydride formation in the damaged area, and, significantly, there was no evidence of abnormal hydriding.

Recently there were two ruptures of coextrusion Zircaloy-clad uranium fuel elements in the KER in-reactor test loops. One rupture resulted from the penetration of the inner cladding of a small tube element, and the other was a failed rod element. Both cases presented the opportunity to compare "real" in-reactor ruptures with ex-reactor "autoclave produced" pinhole defect ruptures. The strong similarity between the appearance of the in-reactor and ex-reactor ruptures is believed to be evidence of the significance of these ex-reactor autoclave rupture tests.

Reactor Decontamination. The APACE decontamination process (employing alkaline permanganate solution followed by ammonium citrate-ethylene diamine tetra acetic acid solution) is being tested for possible application in the NPR piping system. Testing has shown the process to be promising except that the acid solution corrodes carbon steel excessively when it is galvanically coupled to stainless steel. Laboratory tests have been started to elucidate the variables in this corrosion process and find a method of controlling it.

Incomplete laboratory results on the stainless-carbon steel couple in the acid solution show that important variables are: (a) the relative area of the cathode (stainless steel), (b) the solution velocity, and (c) the temperature. It is also tentatively believed that oxygen and iron concentrations in the acid may be important. However, galvanic currents only account for less than one-half of the observed corrosion in this series of laboratory tests conducted to date. Chemical inhibitors and cathodic protection are being investigated as possible means of limiting this corrosion.

Autoclaving of KER Elements. Three tube-and-tube elements fabricated by Fuels Development Operation have been autoclaved for two weeks in 360 C water as an additional proof-test, since a similar coextruded fuel tube recently ruptured in-reactor in a KER loop. The autoclaved elements were inspected after 5, 10 and 14 days of exposure and showed little change from their visible appearance after the original autoclave test (three days; 400 C, 1500 psi steam). Copper contamination was clearly visible after the initial autoclave test but showed little change with the additional exposure in 360 C water. Some acid staining did show as grey areas after 10 days of exposure.

Radiometallurgy Laboratory Studies

Visual examination was concluded on the internal tube of a 36-inch long, Zircaloy-2 clad, coextruded 1.47% enriched, tube-in-tube fuel element which ruptured in KER Loop No. 3 after an irradiation of 400 MWD/T. A film build-up estimated approximately 10 mils thick was observed over the entire center tube. The rupture appeared as a pinhole defect which expanded the uranium to partially block the internal diameter. Deep pitting attack of the Zircaloy-2 cladding was observed near the rupture. Metallography will continue after the radiation level is reduced by a factor of 10 (RM-553).

An unrestrained, coextruded uranium sample clad with 30-mil Zircaloy-2 showed increases in diameter from 1% to 7% after 2000 MWD/T exposure in the ETR. Another sample was found to be ruptured at the thermocouple end (RM-275).

Metallographic examination of a small crack in the Zircaloy-2 cladding of a coextruded, natural uranium rod, which was irradiated to 3500 MWD/T in NaK at the MTR showed a penetration of the crack into the uranium for about 0.05 inch (RM-250). Metallographic examination of the Zircaloy-2 cladding from a ruptured 7-rod cluster from PT-IP-214-A showed many holes, seams and inclusions. One hole had penetrated 50% of the can wall, and the can wall thickness was found to be from 47 to 57% of the desired thickness of 0.030. These defects were related to the fabrication process (RM-295).

Metallographic examination of samples from the #4 section of the Zircaloy-2 process tube removed from KER Loop 2 has not revealed any hydride formation but has shown localized areas of small equiaxed, recrystallized Zircaloy-2 grains (RM-502). Visual examination of the swaged and welded end closures of a 7-rod cluster fuel element (PT-IP-246-A) showed them to be in excellent condition after irradiation to 400 MWD/T. The welds that joined the rods to the spacer ring showed some white corrosion product indicating either poor autoclaving or improper fabrication (RM-552). A thorium tensile sample was irradiated to a calculated 1 a/o burnup and was tested at room temperature (RM-213). A sample of uranium which had been irradiated to 3500 MWD/T and annealed at 880 C for 100 hours was polished, etched and replicated for electron microscopy. Numerous cracks and fissures were observed as well as a central crack which extended over 2/3 of the diameter (RM-265).

The results and conclusions from these tests will be reported in connection with the respective development programs of Fuel Design and Physical Metallurgy Operations.

Basic Metallurgy Studies

Radiation Effects in Fissionable Materials. Unirradiated uranium specimens and specimens irradiated to 0.018, 0.031, 0.072, and 0.10 a/o burnup under PT-3NA have been sent to BMI for thermal conductivity measurements and results obtained on the specimens irradiated to 0.018 and 0.031 a/o burnup and on an unirradiated specimen. The thermal conductivity of the irradiated uranium was found to be from 18 to 30 percent lower than the unirradiated uranium depending upon test temperature. The thermal conductivity versus temperature curve for the specimen irradiated to 0.031 a/o burnup was reversible indicating the lack of recovery at elevated temperatures. A consistent relationship between thermal and electrical resistivity was not apparent in the data.

Testing of irradiated thorium, an isotropic cubic metal, should yield data that can be interpreted more simply than that for dimensionally unstable uranium, although both undergo damage from fast and thermal neutrons. Six tensile specimens of thorium have been irradiated in NaK-filled capsules at the MTR to burnups ranging from 0.1 to 1.5 a/o. Specimens irradiated to 0.1, 0.85, and 1.50 a/o burnup were measured for hardness and a specimen irradiated to 0.65 a/o burnup was tested in tension during the month. Irradiation to 0.1 a/o burnup resulted in an increase in Rockwell "A" hardness from approximately 16 to 48, while higher burnups caused only small subsequent hardening. Metallographic examination revealed a well developed network of intergranular cracks in the specimen irradiated to 1.5 a/o. The brittleness of this specimen influenced the hardness values which varied from 34 to 59 R_A. The specimen irradiated to 0.65 a/o burnup had an ultimate strength of 75,200 psi, a 0.2 percent yield strength of 69,100 psi, and a total elongation of 2.1 percent. Comparable values for the unirradiated control specimens are 26,750 psi, 18,300 psi, and 37.8 percent, respectively. These data reveal that irradiation to about 1.0 a/o burnup embrittles thorium to an extent comparable to uranium irradiated to about 0.1 a/o burnup.

Radiation Effects in Structural Materials. A formal report, HW-61287, entitled "An Effect of Neutron Flux Level upon Damage Accumulation," was completed this month. It was shown that at a given temperature there is an effect of flux upon the shape of the neutron exposure curve. This indicates that two irradiations to the same exposure, if carried out at different flux levels, will give different property changes. These differences are decreased by lowering the irradiation temperature. Increasing irradiation temperature has the opposite effect.

Mechanical and Physical Properties of Materials. The creep properties of Zircaloy-2 are considerably improved by small amounts of residual cold work. The extent to which increasing amounts of cold work improve creep properties and the effects of recovery occurring in the test temperature

range are now being determined on specimens cold worked within the range of 15 to 45 percent cold work. Flat creep specimens cold worked to 15, 25, and 45 percent cold work are being tested in vacuum creep units backfilled with a static pure helium atmosphere. Results on the 25 and 45 percent cold worked material at 400 C (752 F) show that third stage creep has yet not occurred in 4500 hours at the stress levels of 13,000 and 18,000 psi. At a stress level of 21,000 psi, the 45 percent material has gone into third stage creep, but the 25 percent material has not. The initial elongations for the 25 percent material is higher than that of the 45 percent material, but in 1500 to 3000 hours the creep rate for the 45 is greater than that of the 25 percent material. Consequently, on the basis of the test results thus far, there is no improvement in creep properties by increasing the cold work to 45 percent.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel material is a direct way of detecting radiation damage in these materials. Thin films of foils offer advantages since handling problems due to radioactivity are minimized. The preparation, irradiation, and subsequent microscopic examination of films and foils is continuing. Irradiation of thin evaporated films of Al supported on 200 mesh copper grids has shown that copper is present in or on the aluminum after irradiation exposures of approximately 1×10^{19} nvt. In order to establish whether the copper results from in-reactor diffusion or from in-reactor evaporation, four capsules each containing an evaporated carbon film supported on a 200 mesh copper grid are being irradiated to various exposure levels. If copper is present on the carbon film, in-reactor evaporation of copper must occur during irradiation.

Particles of uranium dioxide, about one micron in diameter, dispersed on an evaporated film of aluminum, have been irradiated to 8.0×10^{18} nvt (thermal). No evidence of fission fragment trajectories in the aluminum has been observed. The uranium dioxide particle outlines become diffuse with increasing exposure. At an exposure of 1.5×10^{18} nvt, the aluminum film broke away from the uranium dioxide particles, and an irregular deposition of high electron scattering material remained in regions near the original uranium dioxide particles. The matrix aluminum shows considerable heterogeneity in that flakes and globules of high electron scattering material are uniformly dispersed on or in the aluminum; this was not the case prior to irradiation. Electron diffraction patterns of several films irradiated to various exposure levels have been measured; however, all lines have not as yet been identified.

A thin foil of high purity aluminum prepared by rolling and subsequent chemical thinning techniques has been irradiated to an exposure of 3.2×10^{19} nvt and then studied in the electron microscope. When the foil is bombarded by the finely collimated, intense beam of electrons in the microscope, localized thermal stresses cause dislocations to move. Preliminary study of this film has indicated that irradiation does not appear to impair the motion of the observable dislocations. Development of techniques for preparing thin foil specimens of reactor fuel and cladding material has continued.

An article, entitled "An Improved Method of Etching by Ion Bombardment," has been published in the September 1959 issue of Review of Scientific Instruments.

In-Reactor Measurements. A prototype creep capsule is in operation in the KW Reactor. This capsule has been designed to make continuous measurements of the creep deformation of an annealed Zircaloy-2 specimen during irradiation. The capsule was charged with the specimen located near the edge of the graphite reflector. This extreme position was necessitated by high gamma heating in the active lattice of the reactor. At this point the fast flux has been measured to be in the order of 10^{14} nv. The capsule received a thorough operational check before charging into the reactor and was tested in-reactor before loading the specimen. An exposure of 2×10^{17} nvt was given the specimen before the load was applied. The stress on the specimen is 22,000 psi. The test temperature is 550 F (290 C). An identical test is being run out of the reactor to provide a direct comparison with in-reactor behavior. The initial elongation of the ex-reactor specimen was 2.8 percent. The in-reactor specimen did not exhibit nearly as high an initial elongation and no noticeable first stage creep in the next 60 hours. The test temperature will be raised in 25 F increments until creep does occur in-reactor.

As a result of the Capsule Development Meeting held at BMI, various methods for fabricating the hot-junctions on sheathed thermocouples are being evaluated. Of the methods proposed, and those methods currently in use at HAPO, one appears to be intrinsically better than the others. This method involves plugging the open end of the sheath with a tight fitting plug of 308 SCB stainless steel. Holes are drilled in the plug to accommodate the thermocouple wires. The use of the 308 SCB produces a weld with properties more like the original 304 than can be obtained by fusion welding 304 alone. A series of short thermocouple sections were prepared by this method along with samples prepared by other methods currently in use. The closures were made by both experienced and inexperienced welders; the samples have been radiographed, and the junctions will be tested for response and for cyclic life. The cycle life test will be performed by quenching from a 900 C molten salt bath into water; a severe test that closely approximates the conditions that sheathed thermocouples can encounter in scram shutdowns of test reactors.

Metallic Fuel Development

Cluster Fuel Elements. The proposal for the second rupture test to be run in the ETR 3x3 loop has been written and is being issued. The irradiated elements for this test were discharged last month from tube 3674-KE after an exposure of 2200 MWD/T, and have been shipped to the ETR.

Seven, 7-rod cluster elements (one with 30-mil and six with 20-mil jackets) coextruded in Zircaloy-2 have been discharged from KER Loop 2. These elements were scheduled for an exposure of 5000 MWD/T, but were discharged after an estimated exposure of 2500 MWD/T because of rupture indications

in the loop. After they were discharged, the clusters were visually examined in the KE view pit. One peripheral rod of one element was found to have a bump about one inch long by 1/2 inch wide, and perhaps 1/8 inch high on its surface, about half way between the ends of the rod. This bump was split parallel to the axis of the rod. Examination under water did not determine whether this was the 30-mil or one of the 20-mil clad clusters. The loop had been operating at outlet temperatures of 250 C with the water maintained at pH 10 by the addition of LiOH. No evidence of corrosion was seen at the time the fuel elements were discharged, and the visible rod surfaces appeared to be black and free from film.

Tubular Fuel Elements. Zircaloy-2 clad tube-in-tube fuel elements are being evaluated in the KER loop facilities in support of the NPR program. On September 30, 1959, a failure was incurred in Loop 3 after only three weeks irradiation of three enriched elements. Examination of the fuel elements indicated that a "crud" film of 0.010" maximum thickness had deposited on the fuel element surfaces. In areas where this film had broken away, the black autoclave film was missing, and the Zircaloy-2 clad had suffered corrosive attack.

A clad failure had occurred in the inner annulus of the inner tube of the down stream element. The failure was 17.25 inches from one end of the 36-inch long element and had occurred as the result of extensive pitting corrosion. At the point of failure, corrosion of the underlying uranium had resulted in swelling and splitting of the Zircaloy-2 clad. The temperature drop through 0.010 inch film would be excessive, and accelerated corrosion due to "overheating" of the clad is the most probable cause of failure.

Tube and rod fuel elements were run in KER Loop 4 as the initial test of tubular fuel in high temperature coolant. The two elements were shipped to BMI after 2000 MWD/T pH 4.5 coolant. Examination in the BMI hot cell showed that the surface of the rod had incurred pitting corrosion similar to that seen on a recently failed tubular element from KER Loop 3. Diameter measurements of the rod were lower than optical measurements made on the elements at Hanford. The diameters measured at BMI give a corresponding volume increase of about one percent. The tubes appear to be in good condition. No increase in tube bowing occurred.

Three tube-in-tube elements intended for Loop 4 were returned to FDO for reautoclaving. There had been some doubt as to the corrosion resistance of these elements subsequent to the Loop 3 tube-in-tube failure. These elements were then reautoclaved for ten days. They still have a corrosion resistant black film.

Immersion in 37 percent HCl at room temperature was utilized as a defect test of the Zircaloy-2 cladding of NPR size tube and tube fuel element components. Observation of hydrogen bubbles liberated by the chemical reaction of HCl on uranium revealed four out of the sixteen tubular components tested had cladding penetration. The defects revealed by this method were a line of pinholes along the inner surface of a two-foot

long outer tube and small tears of the inner surface of a one-foot and a three-foot outer tube and a three-foot inner tube. The components tested are to be assembled into elements for IPD's charge-discharge testing and for display elements.

A series of tests are being developed for application to Zircaloy-2 clad fuel elements to insure their satisfactory performance in the reactor. First priority has been given the following:

Removal of the copper extrusion-lubricant layer from the Zircaloy surface by acid etching and mechanical abrasion frequently leaves small spots of copper deposit on the Zircaloy surface, as well as copper diffused into the outermost layers of the Zircaloy. Visual observation often fails to identify such copper content. Copper on the surface may be released using electrolytic techniques. Benzoin oxime, an organic reagent specific for copper, is then used. With use of a more corrosive electrolyte, diffused copper may be readily detected.

Another aspect of the copper content problem is the question of whether small specks of copper deposited on the Zircaloy surface are really detrimental. To help answer this question, the ionization potential between Zircaloy and copper in tap water was measured at temperatures from 25 to 100 C. Zircaloy was found to be $\sim$0.4 V negative with respect to copper at all temperatures within the range mentioned. The implications are that small copper deposits will tend to accelerate the corrosion of surrounding Zircaloy in hot water causing pits.

The Vectorscope developed for measuring wall and sweater coat thickness on aluminum clad slugs appears to be adaptable to Zircaloy OD cladding. A probe to be used with this device for measuring the ID wall thickness of the Zircaloy has just been fabricated and is now being calibrated. Present indications are that it will be satisfactory for this purpose.

The ultrasonic bond test as used to test aluminum slugs appears to apply equally well to Zircaloy clad fuel. A test tank to accommodate ten-foot long tubes or rods is being fabricated, and a crystal probe head to check the ID jacket is being designed. If successful, this device will non-destructively check both interior and exterior jackets for satisfactory bond.

Wall defects in cladding material are relatively easy to spot by visual observation of the outer jacket, particularly if a channel allows the pickle acid to reach the uranium core, causing evolutions of gas which bubble or froth at the leaky place. Similarly, complete channels through the inside wall are betrayed by gas evolution into the pickle solution. To aid in detecting tears, folds, and seams in the internal cladding, the standard "Dy-chek" dye penetrant test is applied. Scanning the wall with a borescope reveals large open cracks directly, and narrow, deep cracks, folds, etc., by the tell-tale red dye spot. Preliminary trials show promise for an "electric eye" scanning system in which a photocell is attached to the eye piece of the borescope. As the large

open tears, or red spots of "Dy-chek" positive areas pass the scanning lens, they cause a drop in the photocell output. This change actuates an indicator needle or alarm.

Component Fabrication. The salt bath heat treatment of Zircaloy clad fuel elements is being investigated to define the conditions of treatment to produce optimum fuel element properties. Three-inch long sections of both KER outer and inner tubes have been treated in a range of quench conditions, range of beta temperatures, and a range of beta holding times. Examination has been made of the uranium-Zircaloy bond structure and thickness and uranium grain size. X-ray examination of as-extruded and the heat treated specimens is partially complete.

Approximately 150 feet of 0.095 inch diameter Zircaloy-2 wire was electroplated using an alkaline pyrophosphate type copper bath. The sole purpose for the copper was to provide lubrication for the two-step drawing operation to reduce the diameter to 0.075 inch. A clad thickness of a half of mil was found to be adequate. The wire is to be used for the outer wrap of the PRTR cluster fuel assembly.

Closure and Joining. Acid machining of uranium from Zircaloy-2 clad rod stock to facilitate welded end plug closure was successfully accomplished by rolling of rods submerged horizontally in 37 percent HCl. Previously successful acid machining has resulted only when the material had been submerged vertically with the end to be machined in the down position. The success of horizontal machining is significant in simplification of the process for production purposes.

Short lengths of KER size (1.050 inch OD x 0.500 inch ID) Zircaloy-2 clad uranium coextruded tube have been successfully hot headed. The hot heading operation is a preliminary step in one type of tube closure consisting of extruding the uranium core from the end of the tube while forcing the Zircaloy-2 cladding over the end of the tube toward the center of the tube wall. The cladding which formed over the end of the KER tubes appears uniform and sufficiently thick to permit projection welding a ring cap to the ends of the tube for the final closure. The tubes were prepared for heading by chemical plating copper to the tube surface, then coating with a thin graphite lubricant to prevent the Zircaloy-2 from seizing to the tube container and mandrel. The tubes were preheated to 620 C and inserted in a preheated container and extruded at a 6 to 1 ratio. Attempts will soon be made to hot head 20-inch long KER tubes. This tooling will have the advantage that any length of tube can be hot headed with a minimum of tooling change.

Allied Fuel Studies. The development of macrocracks in irradiated uranium due to internal strains caused by the anisotropic thermal expansion of uranium crystals has been experimentally demonstrated. The initial draft of a document describing the rapid quenching of irradiated uranium disks which produces the macrocracks is completed. Photomicrographs comparing the cracks produced in-reactor and ex-reactor are included in this document in order to show the similarity of the fractures.

The ability of Zircaloy-2 to mechanically serve its function as a fuel jacket or pressure vessel depends on, in addition to its creep strength, its notch sensitivity and resistance to brittle propagation of cracks. The pre-irradiation testing phase of the in-reactor burst test program revealed a high resistance to crack propagation in Zircaloy-2 extruded jacket material providing it was stressed below its ultimate strength. Burst capsules were stressed with internal nitrogen pressure at various temperatures and times sufficiently to cause creep, but not to cause failure. A crack was then started at test temperature and pressure by forcing a knife edged tool into the jacket wall. In all cases, there was no ductile or brittle propagation of the jacket puncture. A spot on one capsule was embrittled by locally alloying the Zircaloy-2 with silver. When this spot fractured under pressure loading, the crack terminated at the boundary of the 1/8 inch diameter spot of alloy. Provisions were made for conducting similar measurements of resistance to crack propagation on this type of capsule after it is irradiated under controlled stress and temperature condition.

Reactor swelling experiments of Zircaloy clad uranium fuel rods with selected uranium temperatures, cladding thickness, and exposure are being conducted. Radiometallurgy examination of GEH-3-58, one of the above rods, which operated at an average central uranium temperature of 580 C to an exposure of 2100 MWD/T reveals maximum and average diameter increases of 6.4 percent and 3.8 percent, respectively. This average diameter increase, together with a 0.5 percent increase in fuel rod length, gives a volume increase of 8.3 percent. Temperature records reveal that the center of the uranium cycled 40 times through the alpha-beta transformation and three times through the beta-gamma transformation. The maximum recorded temperature was 815 C. Examination has begun on GEH-3-59 which operated to an exposure of 2100 MWD/T at an estimated average central uranium temperature of 825 C. With reactor excursions the maximum temperature is estimated to have been 950 C. A circumferential crack in the cladding at the cross-sectional interface of the end cap and uranium has separated one of the end caps from the fuel rod. A separation of the cladding and uranium at the U-Zr bond has occurred for approximately one-half inch along the rod. The exposed uranium is severely corroded. No severe diameter change can be observed elsewhere on the rod.

Four of nine capsule assemblies fabricated to extend the coverage of temperature, exposure, and cladding restraint have been charged in the MTR. Measured temperatures were 15-20 percent below design because the capsules were not charged in the requested flux. Nineteen aluminum capsules designed to permit irradiation of 0.020 and 0.030" clad uranium rods at selected central uranium and cladding surface temperatures have reached approximately one-third the goal exposure of 1500 MWD/T in D Reactor. Thermocouples in two of the three capsule trains have failed. Temperatures measured with the one remaining good thermocouple are 25 percent below the desired 600 C. Calculations of temperatures in the other two capsule trains indicate they are also below goal temperatures but closer to design conditions.

Metallurgical Development. A detailed metallurgical examination of various pressure bonded Zircaloy-2 clad uranium tubular fuel elements has been completed. This investigation has revealed the mechanism of compound formation along the bonding interface. Since samples were held at 845 C for four hours at 10,000 psi, the diffusion zone was much thicker than a normal coextruded bond. Reaction appeared to begin by uranium diffusing across the interface, forming an epsilon phase with the zirconium. With longer times at temperature the epsilon phase was consumed forming the higher uranium concentration phase of epsilon phase plus delta. Diffusion simultaneously progressed into the uranium forming a delta phase followed by a eutectoid formation of alpha plus delta phase. Slow cooling of the sample allowed the delta phase to form instead of the metastable gamma retained by quenching from the higher temperatures. A cast bonded interface, not subjected to pressure bonding showed a majority of the epsilon and the alpha plus delta phases. Pressure bonding of the cast bonded sample caused an increase in epsilon plus delta, delta and a three-fold increase in the alpha plus delta phases which extended far into the uranium. Microhardness values obtained on the epsilon and epsilon plus delta phases indicated that the combined phases had approximately the same hardness as the uranium (240 DPH). Hardness of the combined delta and alpha plus delta phases was considerably higher than either the uranium or Zircaloy.

Design Analyses and Computations. Large thermal expansion incompatibilities should exist between the fuel material and end caps. If the end caps are bonded to the fuel material, suppression of the thermal incompatibilities could cause stress conditions in the end cap bond area which are more severe than those encountered in the cladding bond areas. Theoretical solutions are being sought which can be used to estimate the effect of end cap thickness on these stresses. The theoretical elastic problem is the finite cylinder which prescribed end conditions. No exact solutions for this problem have been found, but estimates of how rapidly stresses decay can be made. Thus, an estimate can be made on a limit of end cap thickness which must be obtained before any appreciable alteration in stresses can be expected. This estimate can be made for both tube and rod end caps.

2. REACTOR PROGRAM

Coolant Systems Development

Decontamination of Present Reactors. From the results obtained to date, it appears that a bisulfate solution is satisfactory for through-reactor decontamination of the present Hanford production reactors. Laboratory tests have shown negligible corrosion on stainless steel, carbon steel, C-64 aluminum, X8001 aluminum, and Zircaloy-2. So far, three proprietary bisulfate decontaminants have been tested: Wyandotte 75, Wyandotte 1112, and Turco 55-8A.

Decontamination of NPR. Shakedown runs have been completed employing ELMO-12 decontamination test loop, and six tests were completed in this new unit during the past month. After the first test, to determine decontamination factors and corrosion data, a reappraisal of the testing program indicated that more data could be obtained in a shorter time if the loop were operated to obtain corrosion data only.

The bearings in the Chempump were attacked by hydrogen peroxide during the first test. The bearings were unprotected and developed rather severe thrust wear. The pump was replaced by the ORA-1 T-Model pump with protected bearings. The 0-25 gpm rotameter was removed and a 0-40 gpm rotameter was installed. This change was made to permit higher measured velocities during the tests. The coupon holder was also redesigned for the same reason. When the loop is operated at maximum flow with the new coupon holders, a linear velocity of about 6.25 feet per second can be obtained.

Tests have been carried out in the laboratory, in ELMO-12, and in the Irradiated Slug Rupture Prototype Loop to determine the relative importance of experimental variables on corrosion during decontamination. For a given procedure, the most important variables appear to be galvanic coupling, flow velocity, and temperature. In previous tests large discrepancies in the corrosion rate on carbon steel occurred between laboratory results and those obtained in the pilot plants. In many cases the corrosion rates obtained in the IRP Loop, for example, were over ten times as great as those obtained in the laboratory under supposedly similar conditions.

In the laboratory test completed during the past month, it was found that corrosion increased with increasing temperature but not enough to explain the high penetration found in the IRP Loop. However, it was demonstrated that galvanic corrosion did occur and could cause the high penetrations. In the ELMO-12 Loop the corrosion rate varied directly with flow velocity. Although the data obtained so far are only qualitative, equipment changes are being made to permit a quantitative evaluation.

Probably the most important variable is the galvanic coupling. Several runs have been made in the IRP Loop using carbon steel coupons in carbon steel holders and carbon steel coupons in stainless steel holders. The decontamination procedure used included the following steps:

a. Peroxide-bicarbonate
b. Alkaline permanganate
c. Sodium bisulfate.

In the run using carbon steel coupons in stainless steel holders (galvanic coupling), the corrosion of carbon steel was high (0.6 mil) as in all previous pilot plant runs. However, repeating the experiment using carbon steel holders (to minimize galvanic coupling) resulted in much lower carbon steel corrosion (0.07-0.11 mil), more nearly comparable to the rates obtained in the laboratory. The practical implication is that in the NPR, excessive corrosion may occur at locations where galvanic couples

exist (flanges, welds, etc.), unless some measures are developed to protect these spots during decontamination.

The decontamination factors obtained with the three-step bisulfate process were uniformly high (approximately 100) in the absence of galvanic coupling. Where galvanic coupling occurred, however, the heavy corrosion product on the carbon steel appeared to trap part of the contamination, resulting in lower decontamination factors for the carbon steel, namely, D.F.'s of approximately 20.

The APACE procedure appears to give slightly higher corrosion rates than bisulfate for carbon steel, but more efficient decontamination of stainless steel. One procedure (CODS) developed by Bettis for decontaminating stainless steel was tried in the REP Loop. The decontamination factors were low, ranging from two to seven, and the corrosion of carbon steel was excessive (0.7 mil).

Rupture Testing of NPR Fuel Elements. An ETR cluster element was tested in ELMO-4 for a second hour in 300 C water. Considerable swelling and consequent Zircaloy-2 tearing, enough to separate the rod, had occurred. The rod lost 43 grams during the second hour for a total loss of 48 grams. A KER size outer tube in a tube-in-tube element with an initial pinhole defect on the outside had swollen enough on the inside surface to prevent removal of the inner tube after three to four hours exposure to 300 C.

The ELMO-4 Loop was moved from 105-H to the 1706 KE Building. It is expected that the loop will be installed and ready to operate by the end of the second quarter of fiscal year 1960.

Secondary Systems for NPR. A new stress-corrosion heat exchanger has been put into operation to test stainless steel in oxygen-bearing demineralized water. The first test will be primarily to determine the necessity of treating the secondary coolant of the NPR. The test conditions are such as to provide boiling and concentration of this cooling water at 300 F to induce possible stress-cracking conditions on an internal tube operating at 550 F. Results of the tests are expected to be useful in establishing treatment procedures requiring water in this system.

Component Testing. New nozzle cap plug designs using removable threaded O-ring flanges (to permit leaking O-rings on thermocouple trains to be removed without discharging the trains) were subjected to 894 additional thermal cycles between 300 and 550 F during the month. This makes a total of 2096 cycles completed with no leakage observed on either the single or double diamond shaped nickel during thermal cycling. A small amount of leakage has been noted on both seals when the temperature and pressure are removed. However, the gaskets reseal when pressure is re-applied. A bell-ring gasket design will also be tested to determine whether the leakage upon pressure release can be eliminated.

A "Graylok" jumper connection has been thermal cycled 894 times between 250 and 550 F at 1850 psi with no observed leakage. This joint is being tested for use on several out of reactor corrosion test loops. If acceptable, this joint may also replace the Marmon-Conoseal joint previously tested for NPR jumper connections. The use of the Graylok joints in the NPR would permit savings of about $250,000 over the use of Marmon-Conoseal joints at the present supplied prices. Considerable savings could also be made if this type of joint were used in place of pipe flanges since the Graylok supplied cost is about one-third to one-half as much as flanges with the same pressure ratings.

Structural Materials Development

NPR Zircaloy Process Tubes. Chase Brass & Copper Company has activated a new facility for stripping the copper jackets from the NPR tube extrusions. The first 25 extrusions have been stripped and are now undergoing stretch straightening and surface conditioning preparatory to the welding operation. An additional 62 extrusions have been made. Based upon cursory examinations thus far, the extrusions appear to be of excellent quality. Work is proceeding on the installation of new equipment which will be employed in completing these NPR process tubes. It is currently estimated that the first drawing operation will be undertaken during the week of November 16.

No NPR process tube work is being accomplished at the Allegheny Ludlum Steel Company because of the steel strike. However, the nine extrusions produced before the strike have been welded into three tube blanks by the Budd Company. Since radiography showed a flaw in one of the six welds, this weld has been cut out and rewelded. The welds will be ready for GE inspection at the end of October.

Harvey Aluminum has been forced by lack of drawbench capacity to anneal their NPR tubes before the last two draws (of a total of four). Two of their first three extrusions are complete through the annealing stage. One of these two has been given the final two draws and is awaiting stripping of the lubricant. This tube is now more than 60 feet long, too long to fit in the chemical stripping tank. They are cutting short lengths from each end and stripping and examining these to decide which end of the tube should receive the major cropping. The second tube has not received the fourth and final draw. A scratch produced in the third draw must be evaluated to determine the degree of conditioning necessary. These two tubes are expected to be ready for GE inspection the week of November 2. Sufficient sponge to make 20 to 30 more tubes is due to arrive at the vendor's plant by the end of October.

Nonmetallic Materials Development

MTR High Temperature Graphite Irradiations. The GEH-19-3 experiment continues to operate in the L-48 position with samples at 675 C, 750 C, and two in excess of 825 C. Heater #3 has lost circuit continuity, and two thermocouples show anomalous behavior, but since relatively high temperatures are developed by gamma heating most of the objectives of

the experiment will be attained in spite of these component failures. The experiment gained a substantial exposure during Cycle 128 because new MTR fuel elements allowed the reactor to operate throughout the cycle without refueling, for a total of 663 MWD.

Refined temperature data for the GEH-19-1 experiment indicate that at 900 C, CO (needle coke) and CSF graphite contracted the same amount for the exposure received. GEH-19-2 is being disassembled, and data should be available sometime in November. Since this is the first experiment in which the graphite samples were encapsulated to minimize scuffing damage, it is expected that the contraction data will be more reliable than from previous tests.

Samples from hot capsules GEH-14- 111 through 114 were remeasured after irradiation to determine the dimensional changes under radiation. The capsules in these experiments were helium filled, thereby holding the temperature of the samples during irradiation in the intermediate range (200 to 450 C). Nearly all samples exhibited growth during the experiment which is consistent with previous experiments. The samples of GL-10 graphite expanded more than the samples of other types of graphite. If the correlation is true which indicates that graphites with high expansion rates on irradiation at low temperatures show low contraction rates on irradiation at high temperature, then GL-10 is one of the mo · contraction-resistant graphites of those tested to date for the NPR. GL-10 is made from proprietary Great Lakes Carbon Company coke, whereas GL-11 and VC contain Continental cokes.

GETR High Temperature Irradiations. The two graphite irradiation experiments in the GETR, H-1 and H-2, have received little exposure since the end of Cycle 5 on September 29. Due to problems with other experiments, the startup for Cycle 6 was delayed two weeks. Consequently, the irradiation received during this cycle will be only about 1/2 of that received during Cycle 5. The thermocouples in H-1 operated satisfactorily during all of Cycle 5, but those in H-2 began to drift downwards the last few days of the cycle.

Results from a three-group calculation of flux and spectra in the E-5 and E-7 GETR positions are being checked in view of certain inconsistencies in the derived spectra. On the basis of MTR data from the GEH-19 and GEH-9 experiments, the ratio of resonance to fast flux in the GETR appears extremely low. The GETR ratios, if correct, take the E-5 and E-7 exposures out of the region of past experience and greatly increase the problem of convertibility to equivalent HAPO exposure.

Hanford Cold Test Hole Irradiations. Graphite samples (CSF) irradiated at 30 C were recently discharged from a Hanford cold test hole with accumulated exposures up to 11,062 MWD/AT. Even after this long exposure, samples of CSF graphite continue to show expansion in the transverse direction at a rate 0.26%/1000 MWD/AT. A decrease in the expansion rate was observed at an exposure of about 5000 MWD/AT; however, the rate is apparently constant from 5000 to 11,000 MWD/AT. Similar changes in the

contraction rates of parallel samples have occurred. The contraction rate between 5000 and 11,000 MWD/AT is 0.08%/1000 MWD/AT. Maximum total length changes observed were 5.43% expansion and 1.29% contraction.

Low Exposure Graphite Irradiations. Property measurements have been received on the low-temperature, short-term exposure of high density graphites in the Snout II facility in KE Reactor. The graphite types were: (a) Type ATJ, an extremely fine-grained material with density about 1.75, (b) Type S-4 material with a graphite-black base and a density about 1.8, (c) Impregnated ATJ, density about 1.85, ATJ-82, (d) Impregnated S-4, density about 1.90, S-4-82, (e) Type S-1, similar to S-4 except for all-flour mix.

Flexural and compressional strength tests showed increases of 60% for the flexural strength and 40% for the compressional strength after an exposure of 27.7 MWD/AT. There was no significant difference among the grades in the effect of radiation damage although the initial values of flexural strength varied from 4050 psi for S-1 to 7313 psi for ATJ-82.

The thermal conductivity results also showed no significant differences of effect of the radiation damage on the thermal conductivity for the various grades although the initial values varied from 0.84 to 1.3 watt/cm K. Likewise, the porosimetry results do not show any large effects due to radiation, although there was a tendency for the peak below one micron to shift to decreasing pore radius in ATJ-82 graphite.

Compressive Strengths of NPR Candidate Graphite. Ultimate compressive strengths have been determined for the graphites being tested as NPR candidates. The graphites produced from needle cokes (considered to be prime NPR candidates because it is expected that they will be the most dimensionally stable under high temperature irradiation) have shown compressive strengths as much as 37 percent lower than GBF type graphites used previously in some Hanford reactors. A minimum strength of 3460 psi was observed. However, the samples available for strength testing were fabricated with somewhat larger particle sizes than it is expected will be specified for the NPR, and hence the effects of particle size on strength will be determined as samples become available.

Samples cut from the edge of a bar did not show appreciably different ultimate strengths than those cut from the center. Normally, samples for strength determinations in the direction transverse to the extrusion axis of a graphite bar are taken across or immediately adjacent to the center of the bar. In the NPR, tube blocks and cooled filler blocks are being utilized as support members placing the load on graphite nearer the outside surface of the bar where the degree of orientation is known to be higher than at the center. In graphites with smaller particle size mixes this difference in degree of orientation is greater, and, consequently, the effect on compressive strength will be further investigated.

Thermal Hydraulics Studies

K I&E Boiling Curves. Steady state boiling curves were obtained experimentally for K Reactor I&E geometry at tube powers of 500, 1000, 1500, and 2000 KW. These represent the first boiling curves obtained with a test section of prototypical K Reactor length (28.5-ft long heated section) and the first boiling curves obtained under a present Hanford reactor geometry at tube powers above 1250 KW. All the curves except the one at 2000 KW were extended to flows at which boiling burnout started.

When normalized for comparison purposes, these boiling curves differed but little from those previously obtained with a short (23.5-ft long) test section at comparable tube powers. Critical flow in the rear fittings caused a high degree of pressurization at tube powers above 1000 KW.

Reverse Flow Studies, Full Length K I&E Geometry. If a front connector should fail, the only coolant available to remove the post-scram heat generation is that provided by the reverse flow of hot water forced back through the tube by the low rear header pressures. In order to gain further insight into the possibility of inadequate cooling under these conditions, experimental steady state reverse flow runs were made using a full length K I&E test section which provided discharge through the front fittings to atmosphere. Experimental runs were made with rear header water temperatures from 20 to 100 C, flows from 1/4 to 4 gpm, tube powers of 25 to 500 KW, and were continued well into the film boiling region. These data will be used in planning and interpreting the results of transient heat transfer experiments investigating the consequences of the loss of a front hydraulic connector.

Miscellaneous. One experimental run was made in the high pressure heat transfer apparatus with a heater rod specially designed to investigate L/D effects on boiling burnout. The heat flux in the last two feet of the test section was 30 percent greater than that for the rest of the rod. If the supposition that length or L/D has no effect on boiling burnout, then the heating history of the coolant prior to its entering the burnout region does not affect the burnout heat flux and a test section with a stepped heat generation should exhibit the same burnout heat flux as one with a constant lengthwise heat generation. The experimental results from the one run indicated no L/D effect. With a mass flow rate of 1.37×10^6 lb/hr-ft^2 and a steam quality of 29 percent by weight, a burnout heat flux of 0.331×10^6 BTU/hr-ft^2 was obtained. This may be compared with a burnout heat flux of 0.353×10^6 BTU/hr-ft^2 obtained under very nearly identical conditions with a test section with a constant lengthwise heat generation.

Preliminary calculations have been completed and the IBM 709 computer input has been prepared to calculate fuel element temperature deviations arising from bond defects.

Equipment Projects. Vendor representatives have made further adjustments to the silicon rectifying equipment (Project CG-661) which was installed in 189-D to provide additional heat generating capacity in the heat transfer laboratory. Their conclusion was that a 1.2-second response time for a power change to 14 percent of an initial power of 2700 KW was the best the equipment could do. This may be compared with the one second the design specifications require for such a power reduction. The effect of this slightly long response time on thermal hydraulics heat transfer experimental programs is being evaluated.

The power output from the silicon rectifying equipment has a greater AC ripple than was expected. Project representatives are investigating means of minimizing the ripple or, as an alternate, reducing the effect this ripple has been found to have on thermocouple behavior.

It appears that delays in the delivery of some equipment items may delay the start of construction on the first phase, the steady state phase, of Project CGH-834. This project will modify the High Pressure Heat Transfer Apparatus for higher flow and heat generating capacities and will allow transient type experiments to be performed at high pressures.

Previous tests have shown that for the O reactor geometry during pre-charging operations, no coolant would flow past the fuel elements when both front and rear nozzle caps were removed. This raises the question whether steam would be formed in the tube, and, if it were, would the steam generation be sufficiently vigorous to eject fuel elements out the front nozzle. Approximate calculations were made which show that if the post-scram heating were 15 KW, steam formation would start after about 70 seconds and would not be violent enough to eject fuel elements.

Shielding Studies

Neutron and Gamma Attenuation. The as-cured perforated ferrophosphorus concrete test slabs were removed from the shield facility at DR and placed in the oven for baking at 320 C. The gamma leakage through 48 inches of perforated ferrophosphorus concrete increased by a factor of ten compared to a solid shield of ferrophosphorus concrete tested under the same conditions. The foils from the as-cured test are being counted. The iron-serpentine concrete (265 lb/ft^3) was placed in the shielding facility for irradiation, after being baked at 100 C. A sample of serpentine sand was irradiated in a gamma field of 5×10^6 r/hr for 90 hours. This dose had no apparent effect on the ability of the serpentine to retain its water of crystallization.

Counting of foils from the second loading of the NPR boron steel thermal shield test assembly is under way. During the next available reactor shutdown period, the third loading will be removed, and the fourth and final loading will be charged.

Shielding Instruments. The aluminum shell ion chambers, designed for shielding measurements, have been successfully calibrated for dose rates

from 8.0 to 80,000 R/hr. A transistor preamplifier has been built for use with the neutron dosimeter, and an initial installation is now in use at the DR Reactor shielding facility.

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. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. A study has been initiated on the time-temperature relationships for homogeneous solid solution formation in the system UO_2-PuO_2. Single phase formation at elevated temperature may be viewed as a diffusion of UO_2 into PuO_2 particles to form a PuO_2-rich solid solution, and a simultaneously occurring diffusion of PuO_2 into a UO_2 matrix to form a UO_2-rich solid solution. With increased times and temperatures, the concentration gradients of this series of solid solutions should decrease until the equilibrium concentration and structure is obtained. One technique of actually following the transition to the single phase is by x-ray diffraction. An x-ray spectrometer trace, obtained with CuK α radiation, on a UO_2-60 w/o PuO_2 physical mixture, resulted in two closely spaced sets of planes for each Bragg reflection. To follow the structural changes, pellets of this composition were held for one hour at temperatures in the interval 1100-1500 C. The resulting diffraction patterns showed a slight broadening and angular shift toward one another, of each UO_2 and PuO_2(h k l) The merging of the reflections increased with temperature and after one hour at 1500 C, a single, but broad peak was seen for each plane from (111) through (311), indicating nearly complete formation of the solid solution. The interplane spacings calculated from the patterns and plotted versus temperature showed for the (111) plane, a near linear decrease for UO_2 and an increase for PuO_2. The two curves intersected at 1500 C. The interplane spacing at this point was 3.157 Å compared to the theoretical "d" of 3.136 Å, and indicates that complete homogeneity does not quite exist. Diffraction data from samples which were held eight hours at temperature are now being obtained.

The thermal expansion coefficient for PuO_2 reported last month has been corrected through a recalibration of the dilatometer for the 110 C/hr heating rate employed. The corrected expansion, then, is 11.53×10^{-6} in/in/°C for the temperature interval 237 to 928 C. The coefficient of

expansion of uranium dioxide, of 94 percent of theoretical density, has been determined as 10.11 x 10^{-6} in/in/°C in the interval 93-759 C. This agrees closely with accepted values. A redetermination of both compounds will be made during the next month utilizing slower heating rates.

Fuel Evaluation. The three-foot long, 19-rod prototype Al-Pu alloy cluster has completed five operating days at full power and temperature in the ETR 6x9 loop. It operated at a maximum power of about 13 kw/ft of rod and core temperatures in excess of 400 C, which is the maximum expected in the PRTR. The coolant temperature across the element increased 39 F in agreement with calculated values. Al-Pu 3-rod cluster experiments have been fabricated and are being assembled into the loop basket assembly prior to shipment. One element is swage sized onto a graphite lubricated core and the other was fabricated by simply slipping a loose fitting core into the clad tube. Fabrication on two additional prototype 7-rod clusters for irradiation testing in the ETR 3x3 loop has commenced. One will contain pellets of UO_2-PuO_2 fuel material, and the other will contain Al-Pu cores for in-reactor thermal cycling tests. The 7-rod, Al-1.8 w/o Pu alloy, PRTR prototype cluster is undergoing continued irradiation in KER Loop 1.

A total of 24 UO_2-PuO_2 capsule irradiations are in progress; two were discharged with an exposure of 4.4 x 10^{20} nvt and are being examined, 12 are under irradiation, and 10 are scheduled for early charging to the MTR. Testing of 16 Al-Pu and Al-Si-Pu capsules containing plutonium concentrations up to 20 w/o Pu is under way. Six are being examined, eight were discharged during the month, and two are still under irradiation.

Fabrication Studies. Five Al-Pu alloys have good corrosion resistance in 350 C static water for 24 hours. Three alloys contain two to three and one-half percent nickel, the fourth contains 11 percent silicon, and the fifth contains one percent nickel and one percent silicon. Since both nickel and silicon are in some degree objectionable, the latter alloy with lower nickel and silicon was selected to replace the straight Al-1.8 w/o Pu alloy as the PRP spike fuel material. However, in fabricating the alloy for the PRP loading non-uniform corrosion results were obtained which have led to an adjustment of the alloy composition, closer control over casting conditions, and an exploration of the casting variables. The composition of the controlled elements in the alloy is 1.2-1.4 w/o Ni, 0.9-1.1 w/o Si, and 1.8 w/o Pu. At this composition, extruded rods from the first two or three billets cast from a melt have good corrosion resistance after 24 hours exposure to static demineralized water at 350 C, while rods from the remainder of six billets have poor corrosion resistance. Spectrochemical analysis detected no composition difference between the first and the last billet, but metallography showed differences in structure between extruded rod from the first and last billets of a melt. The rod from the first billet had a smaller grain size and a smaller and more uniformly distributed second phase. The rod from the last billet had a grain size twice as large as the first, and the second phase was more coarse with large agglomerations in some areas of the sample. Since the first billets are cast into warm (~ 100 C) molds,

and the last billets are cast into hot (200-300 C) molds, the differences in cooling rate may explain the differences in alloy structure. In subsequent melts, casting temperatures, mold temperature, and slight composition variations have been investigated in order to determine the proper conditions for obtaining good corrosion resistance from the entire melt.

The possibility that extrusion temperature might have an effect on the corrosion resistance of the Al base 2 w/o Pu, 1 w/o Si, 1 w/o Ni core alloy was briefly investigated. Rods were extruded at 450, 500, 550 C, and corrosion tested. No variation in corrosion properties due to this temperature variation was observed.

Extrusions of -100 and -200 mesh Al powder have been made to a nominal 0.500 diameter and approximate 100-inch lengths. The powders were cold compacted to pellets 0.75-inch thick and one-inch diameter. A number of these pellets were placed in the 2.6 diameter extrusion container and hot pressed at 23 tsi for one minute. Pressing and extrusion temperatures were 550 C. Approximate theoretical densities and extremely fine surfaces have been obtained by this method.

Approximately one hundred and fifty rods were swaged to study the effects of swaging on can and cores. Changes in can length and diameter were measured. The changes in diametral and end clearances between can and core were also determined. If accurate can and core measurements are available, it appears that it is possible to control the average diametral clearance to plus or minus 3/4 mil and the end gap to plus or minus 1/16 inch. The over-all rod length can be controlled to plus or minus 1/8 inch. The outside can diameter may be held to plus or minus 1/2 mil if the tube has regular dimensions before swaging.

A sample lot of Zircaloy-2 tubing, purchased for jacketing material for the PRTR, 19-rod, Al-Pu alloy fuel element clusters, is being extensively investigated. Corrosion tests were conducted, and it is reported that all specimens met specifications.

Metallographic samples are currently being examined and cursory inspection of twenty tube specimens indicated that two tubes out of three have cracks or defects on the inner surface which are over 0.003 inch in depth. Arrangements have been made and necessary fixtures are being prepared in order to ultrasonically measure tube wall thickness and locate and measure tube wall defects. In addition, standards are being fabricated to aid in setting up a nondestructive testing device to measure the core-clad gap on Zircaloy-clad, Al-Pu alloy fuel rods.

A metallographic examination has been conducted to determine the cause of failure of the thermally cycled stainless steel clad rods. These three-foot long, Al rods were clad with 0.008 inch 304 stainless steel tubing which showed severe cracking after 27 cycles. The examination showed that the cracking was due to stress corrosion which may have been accentuated by the fact that no end clearance was provided for longitudinal differential thermal expansion between the cores and cans. Additional specimens are being prepared with end clearance for thermal

expansion and precautions will be taken to assure that the chloride content of the autoclave water is low.

Fuel Evaluation. The fuel fabrication effort is currently directed toward the fabrication of the first ten clusters for the PRTR loading. Due to equipment availability, the fabrication is being performed in both the 231Z and 308 Buildings.

Machined tubing is being dimensionally inspected, eddy current tested for defects, and ultrasonically inspected for wall thickness. A steam cleaning technique for tubes has been developed which works very well. A total of about 60 percent of the as-received tubes is being rejected as a result of various inspections.

Alloy core materials which are more resistant to attack by high temperature water than Al-Pu are being prepared. It has been decided that the cores will be an alloy which contains Al-1.3 w/o Ni-1 w/o Si- and 1.8 w/o Pu. The corrosion resistance of this material appears to be very good in 350 C water. Enough cores of Al-1.8 w/o Pu have been prepared for seven or eight clusters; however, this material has been set aside and the corrosion resistant alloy will be used. Corrosion resistant cores for one cluster have been prepared.

Forty-nine dummy rods and 28 Al-Pu rods have been processed through the swage sizing operation. The cores were all coated with dag and the OD of the tubes was reduced two to three mils. These elements had adequate end clearance, and the over-all length was controlled to ± 1/8 inch on an eight-foot length. A dummy cluster will be assembled for thermal cycling tests. The autoclaves in 308 will have to be put into operation before the Al-Pu cluster can be completed. The sand-blasting, etching, wire wrapping, and leak checking facilities are in operation in the Pilot Plant.

Plutonium Elements for PCTR Tests. In anticipation of receiving 1.2 kg of high burnup Pu (20% Pu-240), preparations have been made to fabricate a PCTR loading from this material. Semi-portable shielding has been designed on the basis of calculated activities. Several pieces of equipment have been designed and built to minimize close contact with the metal. It is planned to effect most of the operations at a minimum distance of ten inches. Using 30-mil leaded hood gloves, this distance should reduce the hard gamma dose rate to around 20 mr/hr. The specific activity of the material will be monitored as a function of time. This will allow an evaluation of the activity build-up from Pu daughters.

The additional fifty, 24-inch, critical mass elements have been completed and delivered to the critical mass studies group. These elements are extruded Al-Pu alloy rods clad in Zircaloy.

UO_2 Fuel Development

Fuel Elements. Faster welding of the circumferential closure of fuel rods has been achieved by using a micrometer-adjustable, welding torch holder in the vacuum purged welding chamber. The torch is positioned for the first weld and maintained in welding position for all twenty welds, with each fuel rod being pulled successively into position under the torch. The welding sequence of positioning the fuel rods and making the welds requires approximately twenty minutes for the twenty fuel rods.

The design of the PRTR fuel element end caps has been modified to provide a continuous one degree taper on the portion of the end cap that is inserted in the fuel rod. Improved welds are obtained with these because welding current control is not as critical, and excellent penetration is obtained. Rewelds are expected to be reduced to less than 0.25 percent as a result of these improvements.

Radiographic inspection of 336 fuel rods disclosed insufficient weld penetration in 15 welds. It is anticipated that the rejects will be salvaged by rewelding. Steps have been taken to improve the welding yield. Five of the unsatisfactory welds were made on the same end of the fuel rod of one day's welding, indicating the occurrence of a variation in the welding cycle. The welding cycle and component preparation steps are being carefully reviewed.

Ten complete sets of fuel element hangers were welded, and subassemblies for the next ten sets were fabricated. The desired black oxide autoclave finish has been obtained as a result of improved etching and autoclaving procedures. Persistent rinsing and brushing is required to remove all the etching solution from the many crevice areas.

Two methods of increasing the UO_2 density in PRTR fuel rods before swaging were evaluated: (1) vibrating the loaded tubes on the high-frequency vibrator, and (2) adding UO_2 in the form of fine particles (-200 mesh). Each method increased the initial UO_2 density, but the addition of fine particles has the following advantages: (1) a more uniform, possibly higher UO_2 density in the swaged rod, (2) use of some of the previously rejected UO_2 powder ("fines"), and (3) faster operation. All of the PRTR fuel rods are now being loaded with UO_2 powder consisting of the following particle size ranges: 91 w/o of (-20 +100) mesh and 9 w/o of (-200) mesh.

The first 500 pounds of a 6000-pound order of arc-fused UO_2 purchased from the Spencer Chemical Company was received. Preliminary evaluation indicates that the material meets our rigid specifications for purity and density; if so, this amounts to a significant breakthrough in the preparation of fuel element core material. The UO_2 will be fabricated into both swaged and vibrationally compacted PRTR fuel rods.

Sufficient UO_2 for 27 PRTR fuel elements was sintered and crushed to 20-100 mesh size. The availability of Mallinckrodt "micronized" UO_2

powder and uninterrupted usage of both the 300-ton Kux press and the Pacific Scientific sintering furnace made it possible to produce as much of this material this month as in the preceding four months. If arc-fused UO_2 of the desired quality continues to be available, it will be used essentially exclusively for future PRTR fuel elements.

Fabrication Development. Three fuel assemblies of the 19-rod geometry are being fabricated by vibrational compaction. Size fractions used for these assemblies are -6 +20, -30 +60, and -200.

Vibrational compaction is being used to assemble a 7-rod cluster, three feet long for irradiation in the ETR. The fuel element is composed of fused UO_2, vibrated into Zircaloy-2 tubes 0.57" OD. A 9-rod fuel element, three feet long, is being fabricated by vibrational compaction for irradiation in the VBWR. The cores consist of three particle size fractions, the coarse and medium fractions containing 2.26 percent enriched, sintered UO_2. The fines will consist of a mixture of 2.26 and 10 percent enriched sintered oxide to make an average enrichment of 3 w/o.

Coupling devices for the vibrator have been fabricated which permit vibration of single PRTR tubes, with or without end caps welded in place. A table is being fabricated which will allow vibrational compaction of one to 19 PRTR rods with one end cap in each for ultimate capability studies of the two kilowatt vibration system.

Equations predicting the maximum attainable density by vibrational compaction, using three discrete powder size fractions, have been derived. These equations are based on the theoretical model which assumes infinite diameter ratios between successively smaller particle sizes and are useful primarily for prediction of the relative amounts of each size fraction to be used to attain maximum density. The compacted density of each individual size fraction to be used in a three-component system constitutes sufficient data to solve these equations for maximum theoretical density and the composition at which it occurs.

Preliminary data indicate that internal surface cladding defects in swaged UO_2 fuel rods can be detected with an immersion-type ultrasonic tester. "Standard" internal surface defects, 0.002 inch and 0.004 inch deep, in a UO_2 filled Zircaloy-2 tube were readily detected. Routine ultrasonic testing of swaged PRTR fuel rods is under way.

Ultrasonic testing of the first batch of Zircaloy-2 tubes fabricated per specifications in HW-61112, Rev. 1, is complete. The following results were obtained:

Total tubes received	59
Tubes rejected at defect depth of 0.002 inch	12
Tubes rejected at defect depth of 0.004 inch	3

All ultrasonically detected defects sectioned and examined to date are short cracks or tears. Other defects which were not detected

ultrasonically were noted during visual inspection of the internal surfaces of several tube sections. These defects appear to be surface inclusions of Fe-Cu and are less than 0.002" deep.

Fuel Evaluation. Three different types of sintered UO_2 fuel cores were fabricated for chemical processing studies by Chemical Engineering Development Operation. Approximately 300 pounds each of three-inch diameter by one-inch thick tablets, half-inch diameter by one-inch long pellets, and irregularly shaped, crushed UO_2, were prepared.

Dramatic differences in the irradiation behavior of fuel rods containing a helium atmosphere and fuel rods sealed in a vacuum have been detected. The fuel assembly was irradiated in the MTR for forty-five days at a maximum heat flux of 325,000 BTU/hr-ft^2. The four rods of the assembly contained arc-fused UO_2, vibrationally compacted to 77 percent of the theoretical density. Three rods were welded in helium, and the fourth rod was welded in a vacuum. The UO_2 in the rods containing helium remained unsintered, with little apparent physical change during irradiation. The UO_2 in the rod without a helium atmosphere formed a central void with columnar grains and grain growth occurring across approximately one-third of the fuel diameter. This clear-cut difference demonstrated the importance of a highly conductive continuous phase (in this instance, the helium) in increasing the effective thermal conductivity of UO_2 fuel elements. Consideration will be given to filling the PRTR fuel rods with helium before swaging to insure a continuous helium phase. Examination of the irradiated fuel assembly is being continued.

A fuel element composed of four swaged Zircaloy-clad UO_2 rods is being irradiated at 300,000 to 350,000 BTU/hr-ft^2 in the MTR. The Zircaloy-2 clad element will be irradiated to 3000 MWD/T.

Swaged UO_2 capsules have attained an estimated maximum exposure of 11,000 MWD/T during irradiation in MTR and ETR. No failures of these capsules or any other swaged fuel elements have occurred.

Basic Studies. Differences were observed between the high temperature crystal growth characteristics of UO_2 and UO_2 containing 0.4 w/o Nb_2O_5 and 0.7 w/o TiO_2: (1) the crystals formed from pure UO_2 at approximately 2700 C grew at rates up to three times as fast as in UO_2 containing the additives, (2) the additives in the UO_2 change the pattern of crystal growth, forming crystals without "clean" crystal shapes and faces. These results may be significant in developing UO_2 fuel elements which will operate at high core temperatures without excessive relocation of the UO_2 or release of fission gases.

Facilities. The order was placed for the Magnetic Force Resistance Butt Welder. This machine will produce end closures on fuel rods in 1/60 of a second weld time, and closures on Zircaloy-2 cladding can be completed without inert atmosphere protection.

The semi-automatic 50-ton press was modified by a device which permits automatic pressing of UO_2 pieces.

Corrosion Studies

Zircaloy Etching, Allowable Transfer Time Between Baths. It is known that excessively long transfer times between the etch bath and the stop bath will cause acid staining on the Zircaloy-2 surfaces during autoclaving. In an attempt to determine the allowable maximum transfer time between the pickling bath and the stop bath, controlled tests were conducted using eight-foot long PRTR UO_2 core fuel rods. The following pickling procedure was used:

1. Standard HNO_3-HF etch (28 to 34 C).
2. Varying transfer times from 5 to 120 seconds.
3. Aluminum nitrate stop bath.
4. Hot (50 C) tap water rinse.
5. Deionized water rinse.

The fuel rods were then autoclave-tested for 72 hours in 400 C steam at 1500 psi, using a cold wet startup procedure.

After autoclaving, inspection of sixteen fuel rods showed general white staining on the rods with transfer times greater than 30 seconds. The results clearly indicated that the maximum allowable transfer time for the PRTR fuel elements is less than 30 seconds when the etch bath temperature is between 28 and 34 C.

Allowable Zirconium Concentration In the Etch Bath. Several controlled tests were conducted to determine the effect of zirconium concentration in the etch bath on the acid-staining of PRTR UO_2 core fuel rods. The standard etch procedure was employed, with transfer times of 15 seconds or less between the etch bath and the stop bath. A sample of the etch solution was then taken and analyzed for zirconium. The rods were then autoclaved for 72 hours in 400 C steam at 1500 psi, using a cold wet startup procedure. The results indicate that zirconium concentrations equal to or greater than approximately 30 grams per liter will cause acid staining on the PRTR fuel rods even though the allowable transfer time between the etch bath and the stop bath is not exceeded.

High-Purity Aluminum Alloys. Aluminum alloys fabricated using a high purity (99.995%) aluminum base material continue to show extremely good corrosion results in 360 C refreshed water autoclave tests. Alloys of this type from ANL, Alcoa, and HAPO are in test, and all show corrosion penetrations proceeding by a favorable logarithmic rate or lower. Excellent distribution of the second phase material seems to be obtained with ease in these alloys. The alloy composition of 1.5% nickel and 1.5% iron has shown the lowest corrosion to date.

Corrosion in Low pH Water. Corrosion data at pH 4.5 (adjusted with H_3PO_4) and 300 C have been evaluated. The corrosion of X-8001 aluminum was found to be independent of velocity from 23 to 35 fps on all coupons except those immediately upstream. These upstream coupons were found to exhibit some impingement effects reflected in a higher corrosion penetration. At 1725 hours, normal penetration was about 0.24 mil; upstream coupons at 23 fps showed no impingement effects, upstream coupons at 28 fps had average penetrations of 0.49 mil. In addition, higher corrosion was noticed on replacement samples at 28 and 35 fps. Following the initial higher rate corrosion period, the normal corrosion rate of X-8001 at 300 C, in pH 4.5 H_3PO_4 was found to be 0.06 mil/month from 23 to 35 fps. This agrees with a rate of 0.06 mil/month previously obtained from 23 fps data. Pre-exposure of coupons in the autoclave for 157 and 318 hours had no effect on lowering dynamic corrosion rates in the pH 4.5 test. A second test was started studying X-8001 corrosion in pH 4.5 HNO_3. Sensitized and non-sensitized Type 304 stainless steel is also being tested. Velocities from 21 to 64 fps are being investigated. Visual examination of X-8001 coupons discharged after 312 hours suggests less inhibition in the HNO_3 system compared with the H_3PO_4 system. The corrosion product appears less protective than previous pH 4.5 studies using H_3PO_4. The 64 fps coupons appear in good condition except for severe edge attack on the coupon immediately upstream. The test is scheduled for another 10 weeks of exposure.

PRTR Plant Corrosion Study. Analysis of the various PRTR water systems has revealed several potential corrosion problems. Several desirable locations were specified for insertion of corrosion monitoring probes. Locations of the more likely potential corrosion problems are:

1. Crevices between the shroud tubes and the calandria. Potential pitting of the aluminum might occur in oxygenated D_2O and deoxygenation of the D_2O is suggested to prevent corrosion.

2. Shim rod bearings. Since the shim rods may not be moved very often, slight corrosion could "freeze" the bearings. Deoxygenation would help prevent this, and frequent "exercise" of the bearings would also be desirable.

3. Decontamination of the system. "Dead" spots in the system should be avoided, and provision should be made for draining of the solutions and adequate flushing (rinsing) of the entire system being decontaminated.

Structural Materials Development

PRTR Zircaloy Process Tubes. The ultrasonic, fluorescent dye penetrant and radiographic testing and inspection of the PRTR process tubes prior to pickling and autoclaving are 95 percent complete. Eighty-two of the 97 tubes have passed these tests and are considered to be of sound structural integrity. Pits have been found in four tubes and a seam in

a fifth tube. The seriousness of these indications has not been established. Examination of the remaining 10 tubes will be completed by the end of October.

Eighty-two tubes have been pickled and autoclaved. Staining is being encountered to a minor extent on the outer surface and in varying degrees on the inner surface. Staining on the inside surface may be severe enough in approximately 10 to 20 of the tubes to mask, if present, indications of corrosion-prone metal. Reprocessing of these 10 to 20 tubes would entail removal of the oxide film by vapor blasting, re-pickling, and re-autoclaving.

Approximately 50 percent of the tubes have bowed out of specifications during autoclaving, and present plans are to press-straighten them by a procedure similar to that which was used by the fabricator.

Radiometallurgy Laboratory Studies

Metallographic examination of a sample from a Zircaloy-2 clad, sintered UO_2, four-rod cluster showed a uniform grain size. A replica was obtained for electron microscopy studies (RM-270). Metallographic procedures have been established for the alloys of Al-Pu and Al-Si-Pu (RM-652). The results and conclusions from this work will be reported in connection with the respective development programs of Ceramic Fuels, Plutonium Metallurgy and Physical Metallurgy Operations.

Thermal Hydraulic Studies

Sub-Cooled Burnout Experiments Associated with the PRTR. Seven additional burnout points were obtained under simulated Mark II conditions. These were obtained with flow between two heated surfaces with a normal 0.150-inch annulus.

Two of these were with concentric placement of the inner surface within the outer. The data obtained are consistent with burnout points obtained in the past and the reproducibility lends confidence to the experimental approach. The burnout heat fluxes were about 1.5×10^6 and 0.845×10^6 BTU/hr-ft^2 for conditions of 5 F subcooling at 2.2×10^6 lb/hr-ft^2 flow and 20 percent by weight quality and 1.1×10^6 lb/hr-ft^2 flow, respectively. These two sets of conditions represent cases of a power surge at normal flow and a flow reduction at normal power in the Mark II fuel element.

The other five points were made with the inner surface having a 50 percent eccentricity with respect to the outer. The data check reasonably with previous data obtained with a similar test section. In particular, a 50 percent eccentricity of the inner and outer surfaces results in about a 40 percent decrease in burnout heat flux.

Some unexpected results were found in these eccentric studies, however. With a mass flow rate of 1.1×10^6 lb/hr-ft^2, burnout heat fluxes of 0.85×10^6 and 0.8×10^5 BTU/hr-ft^2 were obtained for conditions of

10 percent quality and 5 F subcooling, respectively. Also, at 2.2 x 10^6 lb/hr-ft^2 mass flow rate, burnout heat fluxes of 0.91 x 10^6 and 0.90 x 10^6 BTU/hr-ft^2 were obtained for conditions of 3.6 percent quality and 5 F subcooling, respectively. This is contrary to what would intuitively be expected and to accepted methods of calculation which indicate that decreasing quality and/or increasing subcooling should increase the burnout heat flux. Further experimental work is necessary and is planned to rectify these apparently anomalous results.

Miscellaneous. Repair of the PRTR Mark I full-scale model has been completed and that of the PRTR Mark II is 90 percent complete.

The pressure drop around the PRTR primary coolant loop was re-evaluated, incorporating experimental data now available. The calculations show that about 50 psi pressure head will have to be dissipated in an inlet orifice.

PRTR Project Management and Design

Over-all PRTR Contract. The over-all PRTR contract is 49.4% complete versus a scheduled 56% based on the official PRTR schedule.

Phase III PRTR Contract. The Phase III PRTR contract is approximately 32% complete with a completion date of April 7, 1960. The contractor has requested an additional 60 days extension in his contract time due to the late delivery of Commission furnished materials. A piece-by-piece evaluation of how equipment delivery has affected the contractor's schedule is being made. Preliminary evaluation indicates that the additional time is not warranted.

The contractor continues erection of the biological shield inner and outer liners and forms for the fuel examination facility heavy aggregate concrete shield. The heavy aggregate concrete subcontractor has set up his plant at the site and pumped test cylinders. It appears that aggregate placing and heavy aggregate concrete grouting will be started the second week in November

A number of the process components have been installed, including the steam generator (HX-1), the primary pumps, the injection pumps, the helium system heat exchangers (HX-6 and 7), the pressurizer, and a number of the instrument panels.

Phase II-A PRTR Contract. The Phase II-A PRTR contract is estimated to be 98% complete versus a scheduled 100%. Contractor completion date was October 5, 1959. The contractor is currently in default and subject to $300 per day liquidated damages. Excavation work on the river is complete. The principal work remaining is finish grading and placement of rip rap around the pump structure. During backfill operations a hole approximately six feet in diameter developed at a point 70 feet south of the pump house. The hole is approximately 18 feet deep with six to seven feet of water in the bottom. The elevation of the water is approximately 1/2 inch higher than the Columbia water surface elevation indicating a slight flow toward

PRTR Stack Addition. The contractor has excavated for the stack and performed the soil bearing tests, which were satisfactory. The contractor has submitted detailed plans and calculations for approval.

Service Building Extension. The design of the service building extension is estimated to be 80% complete versus a scheduled 100%. All scheduled drawings have been received for comment and are currently being revised.

Design Testing

PR-1 Discharge Operation Mockup. Assembly of the fueling vehicle is complete. Operational checks of the various components were begun, and approximately 75 percent of the components were ready for acceptance testing.

PR-10 - Primary Loop Mockup. The primary process pump has operated approximately 1200 hours during the present test run. The high pressure mechanical seal leakage started fluctuating after 1100 hours with rates as high as one gallon per hour for short durations.

High speed recordings were obtained of pump flows and speeds while starting and stopping the primary process pump at full and one-third speeds. The prototype process pump's high pressure mechanical seal failed on October 20, 1959, after 906 hours of operation with leakage rates generally between 0.01 and 0.1 gallon per hour. Uneven wearing of the stationary carbon face (0.036" difference) indicated cocking of the cover insert which holds this face. Improper pressurizing procedure during the last pump startup probably caused the condition. The seat of the insert was chamfered on the outer diameter to prevent reoccurrence. Operation was resumed on October 23, 1959, and leakage rates are 0.05 to 0.1 gallon per hour after 100 hours.

PR-13 - Injection Pump Test. The final report on the PRTR injection pumps, HW-62407, was issued on October 16, 1959. The two pumps were delivered to the Phase III contractor on September 30, 1959. Plunger packing tests will continue using the replacement pump which is identical to the reactor injection pumps with the exception of plunger diameter of 13/16-inch instead of 1-3/8 inch. Q-P self-adjusting asbestos chevron packing failed to seat properly in either pump. New packings from Raybestos Manhatton, and Durametallic have been ordered for testing.

PR-40 - Shim Control Mockup. Modification was started on the second prototype assembly to make it conform to the vendor proposals. Notice to proceed was given to the vendor on October 12, 1959, for the 24 reactor assemblies. All prints except the assembly and parts list were reviewed at the vendor's plant. The aluminum extrusions and bearings have been forwarded to the vendor.

PR-52 - Process Tube Thermal Cycling and Pressure Testing. The process tube was operated 520 hours during the month with leakage rates from the high pressure closures lower than during previous runs. The fuel element was removed for examination by Fuels Development personnel and was re-installed for continued testing after being found in excellent condition.

Pressure drop data were obtained at temperatures of 475 F and 500 F and various flows. Results at 500 F and 130 gpm are:

Inlet piping (minus valve)	6.6 psi
Process tube (with fuel element)	2.9 "
Orifice	17.5 "
Outlet piping	7.5 "

An autoclaved and pickled Zr-2 process tube is being secured to replace the present tube which will be examined for corrosion and other defects.

The hold-down devices incorporating flat leaf-type springs with waves to absorb the differential thermal expansion have proved satisfactory. These springs have held successfully for a 160-cycle period with approximately 2000 pounds on each hold-down providing a good gas seal. Springs of 4130 steel and Starrett ground stock have been used. A spring of Inconel "X" has been fabricated and will be tested after heat treatment.

The one-sixth reactor outlet face mockup was rebuilt in accordance with the latest modifications and changes.

A heavy wall jumper (0.134" thickness) and heavier pipe (1-1/2" Schedule 40) have been installed on the flex tester. There was no evidence of leakage problems at full pressure and temperature.

Special Tools. Testing of the nozzle-to-jumper wrench for hex nuts was resumed after reassembly of the outlet face mockup. Work on the wrench for geared nuts was discontinued.

The fuel element extractor bid package has been completed and an estimate of $17,000 made for fabrication. No action will be taken immediately.

PR-64 - Gas Sampling Technique. Preliminary testing indicated satisfactory separation of helium from the water but insufficient gas pressure to provide flow through a rotameter. New gas separator designs are being fabricated for testing. Preliminary investigation has begun to determine if the mechanical portion of the Rupture Monitor System can be fabricated on-site at a cost near the original estimate.

PR-70 - Helium Compressor Test. The Hofer high pressure compressor has been operated about 250 hours during the month with continued check valve and oil compensating pump difficulties. The valve rebuilt with Inconel had poor wear resistance and was removed after 100 hours of operation. Valves of heat treated tool steel are now being fabricated. A purchase requisition has been issued and bid requests sent to several manufacturers for valves to meet our service requirements. Oil pumps from Hofer were received during the month and proved to be unsatisfactory. Their design differed only in the use of a hard insert sleeve in an attempt to improve wear resistance. The search for an improved injection pump design has not as yet been successful. The Corblin low pressure compressor operated for more than 500 hours during the month. Two check valve failures and three diaphragm failures

resulted from broken valve particles and the third pair from apparent metal fatigue after 830 hours. This pair of diaphragms consisted of plant fabricated 304-L SS sheet and vendor provided 316 SS sheet. Examination of these diaphragms did not reveal any significant differences in the condition of the metals. Check valve failures were 416 stainless steel (250 hours) and carbon steel (350 hours); however, one 416 stainless steel disc is still operating after over 1100 hours. X-ray and dye penetrant testing previous to operation had not revealed any flaws in the 416 SS disc that failed. Testing and evaluation of materials will continue.

The Mine Safety Appliance Company has proposed an infrared analyzer unit for detecting oil in the helium gas streams at a cost of $6000. The Model 200 Analyzer, whose cost includes solenoid valves, recorder, regulators and test cylinders, appears to be the best solution now available for oil detection.

PR-80 - Air Cooling Duct Test. Design of the small capacity duct is 90 percent complete, and fabrication has started.

PRTR In-Reactor Gas Loop. Design of the in-reactor section of the gas loop is 80 percent complete. Prints for comment were issued. All Hastelloy "X", Inconel, and Inconel "702" for the section is on order with delivery scheduled in eight to twelve weeks. A new O-ring gasket in the nozzle was tested at 1800 psi but failed on pressure cycling. The requisition for an outlet connector was revised and given one week time extension. No bids were received on the requisition for a pressure compensating bellows chamber. This requisition has been rewritten to include any pressure compensated device to absorb thermal expansion in the piping system. The testing furnace has been modified with calrod elements and has successfully maintained 1500 F.

Super-Alloy Testing. Tests have been continued to determine best welding and heat treating techniques for Hastelloy "X", Inconel and Inconel "702". Good age hardening was found to be introduced by furnace cooling following the solution treatment. One piece of Inconel "702" tubing has been installed and tested for 216 hours at 5000 psi and 1150 F.

Leak Detection. Calibration of the water vapor leak detection unit at room temperature was completed. Work has begun to find the effect of air temperature and room humidity on the calibration curve.

Boiler Tube Sheet Mockup. Full pressure operation of the two test boilers began on October 6, 1959.

Silicone Foam Testing. Plans have been initiated to build and pressure test four assemblies filled with silicone foam prototypical of electrical and instrument duct penetrations of the PRTR containment vessel.

Process Instrumentation. The acceleration time from standstill to 1/3 full speed (i.e., to the low operating speed) on one of the PRTR primary pumps operating in the 314 Building coolant loop was determined to be 2.4 ± 0.02 seconds. Full line voltage was used to accelerate the motor and pump with

the loop at about 1040 psig and a water temperature of 480 F.

The deceleration of this same pump and the flow decay characteristics of the loop were measured after loss of electrical power to the pump motor under the typical operating conditions noted above. The recorded coolant flow and pump deceleration characteristics are as follows:

Time (in seconds after power removed)	RPM (in percent of full speed which was 1800 RPM)	Flow (in percent of full flow which was 4200 gpm at 480 F)
0	100	100
1	92	92
2	84-1/2	82
5	65-1/2	64
10	47	44
15	35	35
20	27	27
30	16	19
40	8	11
50	3	7
60	1-1/2	0

Data were simultaneously recorded on a high speed multichannel recorder. Differential pressure transducers at two points in the loop provided flow characteristics. A hand tachometer modified to drive an amplifier provided motor and pump speeds.

Two models of the second prototype thermistor temperature probe for the Fuel Examination Facility have been built, and both have been evacuated to approximately one micron. In order to evaluate sensitivity and stability, one model uses 100,000 ohm (at room temperature) thermistors while the other uses 2000 ohm thermistors.

Automatic Controller. Inspection and acceptance testing of the reactor control and reactor radiation monitoring system was found to perform adequately during the functional tests. Additional functional testing of some of the more critical automatic control components is scheduled after the equipment is received on site.

Design Analysis

Physics Analysis. Formulation of equations from which xenon tables may be generated for the PRTR is nearly complete. General expressions for poisoning in regions of uniform fuel have been established. Because of the small core size much effort is being devoted to proper weighting of the local poisoning. It is planned to utilize the IBM-709 to generate the tables.

Further work in support of loop design has been carried out. A study of the heat generation and reactivity worth of a proposed rupture loop design was completed. It was determined that the required maximum specific power could be obtained from an NPR fuel element enriched from 1.5 to 2%, depending on local flux values in PRTR.

An evaluation of the high pressure steam loop with respect to program objectives has been completed utilizing more recent design data. A report covering this work is in preparation.

Physics assistance is continuing in cooperation with the CRMF design effort. Details of the MTR-RMF design and methods of obtaining experimental results were discussed with Phillips employees at the MTR site.

An IBM-709 program is being written in FORTRAN to predict control rod worths in a reflected reactor. Hand calculations for the PRTR rods have been completed, and it is hoped that the method employed may be verified by obtaining solutions for rods of known worth in other reactors.

PRTR Shielding. Cadmium will be used for thermal neutron shielding of the large penetrations of the PRTR bottom primary shield. Several methods of obtaining a metal-to-metal bond of cadmium to aluminum were tested in Minor Construction shops. All tests demonstrated that joining temperatures would have to be too closely controlled for practical shop use. Therefore, mechanical methods will be used to attach the 1/8-inch cadmium liners to the aluminum cylinders.

Steam Loop Transient Analysis. A transient analysis on the proposed PRTR steam loop is being performed on the IBM-709 computer in an effort to determine whether standard flow control units can be utilized in maintaining 900 F outlet temperature and a temperature difference across the loop of 240 F during all periods of PRTR operation. The problem has been programmed in FORTRAN.

Gas Loop Transient Analysis. Transient temperature profiles for the CO_2 gas-cooled loop were calculated for shutdown and startup conditions at 15,000 lb/hr CO_2 flow rates. These results indicate that the process equipment (HX-1, HX-2, and electric heater) provided for the loop will be able to maintain the temperature increase or decrease rate of the ex-reactor piping at the exit of the test section at 900 F/hr over a major portion of the transients.

Assuming a reactor scram from a loop operating level of 500 kw fuel element power and 1500 F CO_2 temperature, the calculations show that a decay rate of 900 F/hr can be maintained after the temperature in the ex-reactor piping has dropped to about 1100 F. The maximum temperature decay rate, occurring about 30 seconds after scram, was estimated to be 13,300 F/hr or 222 F/min. Startup transient calculations with reactor power increasing at a rate of 20 MW/min indicated lower rates of temperature change than for the scram case.

Rupture Monitor. Bids on design and fabrication of the mechanical and electronic portions of the PRTR rupture monitor system were received during the month. The mechanical system bids ranged from two to four times the fair cost estimate of $30,000, and will probably be rejected. The design portion of the mechanical system will be performed on-site to permit better definition of the requirements of the system. Most of the bids on the electronic portion were very close to the fair cost estimate. Selection testing of the photomultiplier tubes to be used in the rupture monitor system was begun. A number of the scintillation crystals received for the test were rejected because of an inadequate hermetic seal.

Reactor and Process Piping. Detailed design of a standpipe attachment to the pressurizer was completed, and procurement action was initiated during the month to obtain the necessary Inconel pipe and fittings. The purpose of the standpipe is to permit attachment of multiple level control and alarm devices and to permit more variation of locations than would be possible by use of existing nozzles on the pressurizer vessel.

Detailed design of a back-up light water injection system was started to provide additional reactor safety.

Several sections of the Primary Piping Stress Analysis Contract DDR-79 were revised at the request of Electric Boat Division of General Dynamics Corporation to clarify intent and contractural obligations of both parties. Modifications included:

1. Provision for stoppage of work by the seller in the event expenses exceed the named amounts and until the contract is modified.

2. Provision for the seller to retain copies of notes, drawings, and data furnished or developed by the seller in the course of work under the contract.

3. Type C patent agreement.

4. Provision for the seller to make and retain copies of documents and drawings, other than those prepared by third parties, which are furnished by the buyer.

The outlet nozzle vendor has been unsuccessful in repairing the nozzles, and in the course of repair has distorted them to the extent that they cannot be reclaimed. The elbows and probably the caps will be reused, but new material is being procured for the tube and lower flange. The manufacturing procedure will be revised to reduce distortion problems and make sufficient allowance for final machining. Delivery in late December is anticipated.

A design has been prepared for incorporating pressure reducing orifices in the inlet jumper flanges. The existing flanges will be modified to hold the removable orifices.

Fuel Handler. The fuel handler is assembled, and some acceptance tests were conducted during the month. Minor adjustments and modifications were required for proper functioning of the discharge hoist, tension indicator, variable speed drives, and certain other motions. Alteration of the skirt drive will be required to reduce vibration in one direction of travel. Revision of the bridge position indicator drive will be required to reduce friction in gearing and shafts.

Fuel Element Examination Facility. The Mosler Safe Company has experienced difficulties with cracking of one of the top shielding blocks. The cracking occurred at a thin section adjacent to the loading port hole. The block will be recast as a solid piece, and the holes bored out rather than attempting to cast the blocks with the holes in place. Additional detail drawings which were submitted were approved.

The control console bids were opened. The low bid of approximately $3000 was submitted by Panellit. The fair cost estimate was $7500.

Load-Out Cask. A low bid of $37,980 for the load-out cask was submitted by Industrial Process Engineering. The fair cost estimate was $35,000.

PRTR Gas Loop (Project CAH-822). Approval data have been returned to Struthers-Wells on essentially all of the B Cell equipment. An addendum to the order was issued during the month extending the main loop piping to the inside of the lower support wall and the upper shielding wall. Estimates for this work have not been received.

Preliminary drawings of the in-reactor design have been circulated for comment and are now in process of revision. Long lead materials for the in-reactor section are now on order with the exception of the top and bottom connectors. Requisitions have been submitted for these latter items.

High Pressure Loop (Project CAH-841). The design criteria for the high pressure loop have been circulated for approval.

PRP Critical Facility (Project CAH-842). The preparation of the design criteria for the PRP Critical Facility has continued throughout the report period. Five of eight sections have been written and reviewed, and five of the twenty-three scope drawings have been completed.

The building which will house the Critical Facility has been scoped and will be given to CEO for inclusion in the Maintenance and Mock-Up Building Addition. The building consists of a shielded 10 by 12 foot cell, 35 feet deep surrounded by about 300 square feet of operating area located just south of the PRTR Load-Out Facility.

Fuel Element Rupture Test Facility (Project CAH-867). Funds have been authorized for scoping and preliminary design of a fuel element rupture test facility for the PRTR. Tentatively, the loop will be of the "open" type in which low temperature water is pumped through a regenerative heat exchanger, a cooler, and finally, a pressure control valve. From the

pressure control valve the effluent will flow through a cleanup system to a storage tank. This arrangement is advantageous in that:

1. System operating temperatures and pressures can be readily controlled.

2. A rapid cool-down of the loop can be effected after a fuel rupture occurs.

3. Circulating pumps can be of conventional centrifugal boiler feed pump design.

4. Conversion from a recirculation to single pass operation can be accomplished during reactor operation.

Safeguards Analyses. The rough draft of the PRTR Final Safeguards Report, HW-61236, was reviewed by the PRTR Subcouncil of the GE Reactor Safeguards Council and by the PRTR Startup Council. This report was also discussed with personnel of the AEC Hazards Evaluation Branch in Washington, D. C. Re-analyses and changes in the report have been made to incorporate the comments of these groups. The report will be published early in November.

A proposed list of process specifications for PRTR has been issued for comment.

Rough draft copies of the preliminary hazards report for the PRTR High Pressure Loop were distributed for comment. Comments received were incorporated, and the report, HW-62111, was submitted to Technical Publications.

PRTR Startup Accident Analysis. Power and fuel temperature transients were calculated, using an analogue computer, for a PRTR startup accident further compounded by the charging of an excessive number of Pu-Al fuel elements. The accident investigated was one in which period trips fail to scram the reactor, power level trips are set for the operating range rather than the startup range, moderator level is raised at the maximum possible rate, and shim rods are either removed prior to startup or are removed at the maximum possible rate simultaneously with moderator insertion.

For the Pu-Al loading it was pessimistically assumed that the maximum number of such fuel elements which will be on hand at any time was charged into the reactor. In order to put such a loading in the reactor it would be necessary to use discharged fuel elements from the storage basin and to obtain all fuel elements in the PFPP. Thus, the loading assumed for the calculations is more extreme than any which could result from accidental mischarging.

With such a loading the reactor would become critical when the moderator level was below the flux chambers used in the power level trip circuit. Consequently, the chamber readings would not be representative of the

true power level. In making the calculations it was assumed that the power indicated by the flux chambers would be one-half the true reactor power.

The calculations indicated that the consequences of startup accidents with this type of loading (75 Pu-Al elements) would be less severe than for similar accidents with a normal loading (up to 43 Pu-Al elements).

Plutonium Fabrication Pilot Plant

Phase III Construction. Completion of equipment installation under the Phase III contract is estimated at 96%, compared with 100% scheduled.

Work on the oxide line proceeded slowly throughout the month because of nondelivery of the sintering furnaces until nearly month's end. The service representative of Clearing Machine Company was on site correcting minor errors in the electrical system of the hydraulic press.

Room 113, containing the vapor degrease system, the ultrasonic decontamination system and three utility hoods was accepted from the construction contractor with minor exceptions, including an alarm pressure gauge, an electrical brake in the fuel element hoist and minor items of patching of paint.

The preparation hoods of the oxide line have been pressure tested, and the Kux lever-action pellet press has received a preliminary test.

Procurement. The sintering furnaces were received, partially complete, on October 26 and 27. Portions not shipped include refractory inserts for the hydrogen burners, cross-push drives, and atmosphere control panels. The furnaces themselves are well constructed but were not completed in accordance with the contract. Incomplete items include the shell cooling water system, the electrical power wiring, and the small hoods enclosing the push mechanisms. Other incomplete items may be disclosed as installation work proceeds. Completion of this work by the Phase III contractor will entail the loss of about three weeks' time over previous estimates.

One of the scope engineers visited the engineering offices of Loma Machine Mfg. Company to discuss and approve the rolling mill design drawings. This was done in an effort to assist the vendor to get back on schedule. The vendor has been notified that he is expected to meet the contract shipping date of February 10, 1960.

Project Schedule and Finances. A project proposal revision requesting an increase in authorized funds to cover the book value of transferred capital property was completed and approved during the month.

Plans for the installation of the transferred equipment by J. A. Jones Company, the CPFF service contractor, are being detailed. All of the Group 5 equipment to be purchased was on requisition at month's end except a requisition for a group of hoods. Bids received are to be held and compared with estimates, and items purchased will be those which can be obtained and installed within project funds. Design drawings of the second floor arrangement are being prepared.

PRTR Operations

This month the major effort was devoted to the Engineering Assistant training course and to the preparation of Design Tests. In addition, a listing of proposed PRTR Process Specifications was reviewed and comments were issued. A program is in progress to standardize the reactor system nomenclature used in the PRTR Design Tests, Operating Procedures, and Process Specifications. This study will be completed in November.

At the first meeting of the Physics Sub-Council of the PRTR Start-up Council, held October 26, PRTRO accepted responsibility for the preparation of a number of test write-ups and for laying out the format for the test proposals.

The Phase III contractor periodically operates the service building equipment installed by the Phase II contractor to assure the equipment remains operable. PRTRO personnel observe the operation of the equipment to note any problems encountered. One of the most significant problems observed this month is that the diesels which power the emergency generator and the deep well pump are difficult to start.

Design liaison continued; the Maintenance & Mockup Building extension drawings and specifications were studied and comments issued, the safety, containment and rupture monitor systems drawings were reviewed, and the design of the in-reactor test section for the gas loop was reviewed.

Preparation of HW-61900-RD, PRTR Design Tests, continued during the month. All comments have been received and incorporated into the text. Twenty-two of the 45 tests have been issued. The first eight tests were reviewed by the Start-Up Council. The remainder will be issued early in November.

The accelerated training course for PRTR Technicians was completed early in the month. The Engineering Assistant training program began October 5. This 11-week course is being conducted by the PRTR engineers. It was designed to familiarize the Engineering Assistants with all PRTR systems and experimental facilities.

PRTR operating data sheets were reviewed, and minor revisions were incorporated. Detailed discussions were held with Technical Data Processing Operation personnel for the purpose of arranging for machine programming PRTR operating data for storage and reporting.

A series of bi-monthly meetings was started with HLO Analytical Laboratories Operation personnel to resolve the final details of the PRTR sample program. Included on the agenda are the establishment of laboratory facilities in the 309 Building, procurement of necessary equipment, and training of PRTRO personnel in laboratory techniques.

2. BASIC SWELLING STUDIES

Irradiation Program

Assembly has been completed on a modified capsule containing four natural uranium spheres (0.7 percent U-235) to be used for the basic swelling studies program and currently is being bench tested in a flowing water system. The tests are designed to ascertain that the components are of the highest integrity and will withstand reactor conditions. Concurrent with this proof test, data are being obtained concerning heater efficiency, thermocouple response, and thermal gradients. To date, the modified design has shown greatly improved operating characteristics. It is the intent of this capsule design to maintain a constant temperature in the uranium specimens regardless of reactor excursions or shutdown. Post-irradiation studies will then be made to determine whether or not swelling occurs if the specimen temperature is held constant during its in-reactor history. Information for the preparation of the production test of the capsule has been compiled. It is planned to charge a minimum of two capsules, each containing four uranium spheres as soon as the production test is approved. In addition to the capsule already being bench tested, work on the assembly of two additional capsules is continuing.

Mechanisms and Theory

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. Swelling in two specimens, one with a burnup of 0.41 a/o and the other with a burnup of 0.29 a/o, irradiated at temperatures below 550 C is being studied as a function of post-irradiation annealing treatment. A portion of the specimen with a burnup of 0.41 a/o has been annealed for 100 hours at a temperature of 880 C and replicated for electron microscopy. The density for this specimen after annealing was 16.79, which is higher than the values obtained after annealing at lower temperatures. This density value does not correlate very well with previous data, but probably arises as a consequence of cracks in the specimen. A statistical analysis of the pore density and void fractions has been completed on a specimen that was replicated in the same area after mechanically polishing, after cathodically vacuum etching for 20 minutes, and again after etching for 90 minutes. Almost no porosity was observed in the as-polished condition, but after etching numerous spherical pores were observed. Interestingly enough, the distribution of pore sizes was found to be identical after the 20 and 90-minute etches even though the pore density had increased from 9.9 to 12.6 pores per cubic micron and the void fraction from 0.046 to 0.079 with the longer etching time. These results indicate that the surface of the specimen was severely disturbed during polishing and that these ill effects were not completely removed by etching for 20 minutes. In order to improve the statistics the same specimen was repolished and etched for 10, 20, 40, and 80 minutes. Replication after each step has been completed, and electron microscopy will be initiated shortly. The prime objective of this investigation is to determine: (1) effect of etching on pore sizes; (2) effect of heat treatment on segregation at boundaries; (3) reproducibility in pore size

distributions in various regions on the specimen heterogeneity; (4) extent of possible pore distortions in the center and the peripheral regions of the specimen, and (5) reproducibility of replications.

Relationships have been derived and are used in interpreting micrographs of uranium with a burnup of 0.29 a/o in the as-irradiated state and after a 100-hour anneal at 880 C. The following conclusions can be derived: (1) it would appear that very little swelling (increase in void fraction) occurs in this specimen during irradiation at temperatures below 500 C; (2) there is no significant difference in either pore size or distribution for irradiation temperatures of 500 C or 300 C; (3) post-irradiation annealing at 880 C causes a slight decrease in the number of observable pores per unit volume in those regions of the uranium which were irradiated at low temperatures, approximately 300 C, and causes an increase in the number of pores in regions in which irradiation temperatures were highest, approximately 500 C. The validity of these conclusions will be checked by statistical analysis of data on similar specimens annealed at lower temperatures.

A knowledge of the mobilities of rare gas fission products in uranium is important in understanding the mechanisms of pore formation. Xenon is being introduced into a uranium surface under various conditions of electrical glow discharge. The amount introduced, the mode of deposition, and the depth to which it diffuses into the uranium matrix is being studied. A note, HW-62153, entitled "Range of Inert Gas Particles with Energies from 10 ev to 30 Mev," was issued this month. It was pointed out that at low voltages in the 10-25 ev range (sputtering region) the energy is insufficient to cause inert gas particles to be driven into a metal target. Inert gas deposition by "sputtering" then must be interpreted in light of some mechanism other than ion penetration. The voltages used with an ion gun (30-50 Kev) will cause penetration of inert gas into uranium but not deep enough to avoid surface effects.

A 3/16" ID x 2" long uranium cylinder, which was outgassed for one day at 620 C, was subjected to sputtering of the inner surface at 4 ma/cm^2 in one mm Hg pressure of xenon for three days at 640 C, and an additional three days at 160 C. The cylinder was sputtered at the higher temperature in an attempt to diffuse xenon into the uranium volume, and at the lower temperature to insure that enough gas would be retained on the uranium surface to facilitate studies of the surface layers formed during sputtering. Spherical porosity and some cracking was observed in the redeposited surface layer but none could be found in the general matrix below this layer. Thicknesses of 0.0017 to 0.0023 inch were removed by electropolishing from the inner surfaces of sections of the cylinder. Vacuum fusion analysis showed that no xenon was contained in the uranium after the surfaces were removed. This means that xenon penetrated into the volume metal less than 0.0007 inch beyond the redeposited surface layer volume metal interface, since the surface layer was approximately 0.001 inch thick.

X-ray studies of the surface of a uranium disk, sputtered at 17 ma/cm^2 in 2 mm Hg pressure of xenon for four days at 620 C, have shown, in addition to uranium, the presence of alpha and beta phase UH_3, and UO_2 with an expanded lattice. The expanded UO_2 lattice may be explained either on the basis of oxygen depletion or on the basis of tensile stresses. The appearance of the hydride phases correlates well with the gas analysis data and lends credence to the belief that hydrogen is being introduced into the uranium glow discharge. An all metal bakeable vacuum system is presently being fabricated for "sputtering" studies in an effort to eliminate the sources of contamination. The new system will be capable of attaining higher vacuums than the existing glass system.

It was previously pointed out that a considerable fraction of the xenon and krypton produced in uranium during irradiation results from the decay of other fission products. In view of this fact, it was emphasized that the diffusion of the parent atoms could result in formation of a second phase which could act to precipitate xenon and krypton pores "in situ" as the second phase decays. Calculations necessary to the elaboration of this concept are being carried out.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

Graphite CO_2 Reaction. A series of solid cylinders of CSF graphite (two inches long by 0.42 inch diameter) were oxidized in CO_2 flowing at 1.5 ft^3/hr. All had major axes parallel to the extrusion axis of the original bar. They were oxidized at temperatures in the range of 650 to 825 C.

The equipment and experimental conditions were the same as previously utilized for experiments with graphite hollow cylinders and spheres. These new data remove the discrepancy previously observed between oxidation rates of samples with various surface-to-volume ratios. The data indicate that oxidation proceeds homogeneously throughout the sample in the above temperature and sample size range. An activation energy of 43 k cal/mole has been observed for the reaction.

There has been considerable disagreement in the literature on the activation energy of this reaction. Most likely the differences are due to failure to differentiate between surface or homogeneous reactions or the combination of both. An extensive literature search is being conducted to arrive at the actual cause of the apparent discrepancies.

Air Oxidation Studies. Preliminary experiments indicate that a relatively small concentration of chlorine gas in an air stream serves as an effective oxidation inhibitor for graphite. The following experiments were run at 550 C and 2.0 cfh air on virgin graphite.

% Cl in Air Stream	Rate of Oxidation g/g hr	% Reduction
0	4.71×10^{-3}	--
0.25	2.57×10^{-3}	45.4
0.50	7.57×10^{-4}	85.1(e.g., 6-fold reduction)

This work will be continued to evaluate the potential effectiveness of chlorine as an oxidation inhibitor for graphite under in-reactor conditions.

Microwave Studies. Three graphite samples were placed in CO streams in which microwave glow discharges were established. With 112.5 watts r.f. power a blue-grey glow was observed at pressures from 150 to 300 μHg. By controlling ambient temperature it was found that a heavy deposit of amorphous carbon formed at temperatures below about 520 C. No deposit was formed above this temperature and deposits formed at lower temperatures were removed at or above this ambient temperature. In addition to the heavy soot-like deposit, a ring of brown material which appears to be carbon-suboxide was found around the soot. A slate-grey material which was also found deposited on cooler portions of the sample has not yet been identified.

In conjunction with the work on Cl_2 inhibition, a preliminary experiment with a Cl_2 discharge gave rise to heavy deposits of sooty material on both the sample and the reaction tube at low temperatures (below 100 C) and very low pressures (less than 50 μHg). Wall effects were so great that the glow could not then be maintained for more than about thirty seconds. Analysis of the chlorine is being made to determine presence of air, CO_2, or O_2.

Permeability Studies. A new permeability cell has been built and will be used in conjunction with the other types of cells previously tested

Hawker-Siddeley graphite was run with two different types of surface sealers, "Glyptal", and a plastic with the grade name "Scotch Cast". Both proved very effective in preventing side flow. An average admittance factor (F_o) was found to be in the range of 10^{-3} cm^2/sec (He). Although this is not as impermeable as some of the new "impermeable" graphite materials, it represents considerable improvement over normal reactor graphite.

Loop Materials

Selected nickel-base alloys will be evaluated for use as structural materials for the in-reactor portion of the gas-cooled loop. Among the data of interest are the effects of elevated temperature irradiations in anticipated loop environments on mechanical properties. Irradiations will be conducted in a gas-cooled graphite channel in C Reactor. Irradiation capsules to contain specimens for the atmosphere-

reactivity and tensile-property investigations were designed. Specimen materials were fabricated into machining blanks, and machining was started. The specialized high-temperature tensile testing apparatus was assembled and calibrated with low carbon steel standards.

D. RADIATION EFFECTS ON METALS - 5000 PROGRAM

Radiation damage recovery is being studied for a number of structural metals. These include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Tensile properties, electrical resistance, DPH hardness, and x-ray diffraction spectra are being measured to determine recovery kinetics.

Irradiated and control specimens of molybdenum were annealed for 60 minutes at 125 and 150 C, and similar specimens of zirconium were annealed at 150 and 175 C during the month. Measurements of DPH hardness and electrical resistance were made after each anneal. Significant changes in electrical resistance due to either anneal was not observed for the unirradiated and 1.5×10^{20} nvt specimens of molybdenum or zirconium. However, significant changes occurred for both materials irradiated to approximately 4.5×10^{18} nvt. These changes for molybdenum annealed at 125 and 150 C were 1.07 and 2.80 percent, respectively, and for zirconium annealed at 150 and 175 C, 0.44 and 0.66 percent, respectively. The reproducibility of the data is better than ± 0.1 percent. A significant change in DPH hardness was observed only for zirconium irradiated to 1.5×10^{20} nvt. The hardness change resulting from a 125 C anneal was from 110 to 104 DPH. A reduction in hardness preceding a reduction in electrical resistance conflicts with the bulk of data reported in the field.

Lattice parameter measurements were made from the (210), (220), and (310) reflections for iron irradiated to 4.6×10^{18} nvt, and from the (220), (311), and (222) reflections for copper irradiated to 9×10^{18} nvt. The lattice parameter values were consistent among the reflections for both materials indicating that the changes in lattice dimensions due to irradiation are isotropic. These changes were negative for copper and positive for iron for the neutron exposures represented.

E. CUSTOMER WORK

Radiometallurgical Examinations

Nickel Plated Elements from PT-IP-207-A (RM-306). Three more internally and externally cooled Hanford production fuel elements, which were irradiated to approximately 400 MWD/T as part of IP-207-A, were shipped to the Radiometallurgy Laboratory this month. The slugs were selected for additional control pieces for detection of entrapped hydrogen gas under the plating of nickel plated fuel elements from IP-207-A. Gas samples collected from two control and four plated elements were submitted to Analytical Operation for mass spectrometer analyses. Results from the control samples showed that one set of sample collection bulbs had leaked, and more control pieces were requested. Results from a portion of the nickel plated slugs have been obtained, but

sufficient data are not available at this time to make an evaluation of the tests.

Direct Cast Fuel Cores (RM-318). Sections from two elements have been cathodically etched using a new technique which produces an etch across the entire specimen. Examinations of the etched sections show that the badly distorted pieces contain a greater number of large grains and that they are unevenly distributed.

A small corrosion pit found in the can wall of element #7 was sectioned and examined. The pit resembled a can wall inclusion with a halo around the hole. It was found that the pit had penetrated 40% of the residual can wall, but no clues were evident as to the cause of the corrosion pit.

Self-Supported Fuel Elements (RM-400). Transverse and longitudinal can wall profiles through the supports of two elements have been examined, but no grooving or deterioration of the can wall has been found. Likewise, metallographic examinations of the spot welds have shown no evidence of corrosion.

PT-IP-190-A Ruptured Doe Elements (RM-402). Two elements have been received, and preliminary investigation has been started. Both elements have several rupture areas, all at the base of a support. The large blisters were apparently caused by the accumulation of corrosion products under the outer can wall surface.

High Level Examination and Cut-Off Cell (Project CG-682). Operation of the new High Level Examination and Cut-Off Cell was initiated on October 8, when the inner tube from an irradiated three-foot long KER tube-in-tube fuel element was introduced into the cell. This fuel element had received an exposure of approximately 400 MWD/T and had been discharged on October 1, 1959. A radiation reading of 20 mr/hr was obtained through the foot square, 18-inch thick lead glass viewing window with the element 12 inches from the inside window surface.

Metallography Laboratories

A study has been initiated to elucidate the effects of annealing time and temperature on the AlSi braze layer of normal production fuel elements. The study involves annealing of specimens over a temperature range from 250 C to 550 C for periods of less than one hour to 100 days. During annealing, the silicon crystals in the AlSi braze slowly agglomerate and become spheroidized. The braze layer of the fuel elements is subject to such annealing during exposure in the Hanford reactors. Since a record is kept of the time of exposure of the fuel elements in the reactor, it is expected that the results of this study may be employed by the Radiometallurgy Laboratory in examining irradiated elements to estimate the temperature to which the braze layer was subjected during the reactor exposure period.

Samples will be annealed over the full range of times and temperatures. Evaluation of the results is expected to produce an energy of activation formula which will enable the degree of spheroidization from any annealing

exposure within a wide range of time and temperature to be predicted with a fair degree of accuracy. The program for the study has been outlined, and the equipment is currently being assembled. Initial evaluation of the first results is expected to require approximately two month.

Samples Process During the Month.

Total samples processed: 632

Photographs

Micrographs	344
Macrographs	64
	408

J. W. Woodfield

For Manager, Reactor and Fuels
Research and Development

FW Alabugh:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
WE Cawley	10/14-16	NRTS, Idaho Falls, Ida.	Discuss in-reactor test loops, critical facilities & reactivity measuring facilities.	E Fast W Byron F Petree EE Burdick D Ronsik	Yes
RE Dunn	10/11-15	Minneapolis-Honeywell, Philadelphia, Pa.	Perform acceptance tests on reactor automatic controller.	EB Dahlin	No
DE Rasmussen	10/19-21	GE-APED, San Jose, Calif.	Inspect & approve drawings for PRTR shim control assemblies.	Mr. Hobson Mr. Ripley	No
WK Winegardner	10/1	Willamette Iron & Steel, Portland, Ore.	Fabrication of PRTR fueling vehicle.	F Dever	No
HK Nelson	10/5-7	Minneapolis-Honeywell, Philadelphia, Pa.	Inspect equipment being furnished for PRTR.	EB Dahlin	No
JF Fletcher DP Schively	10/7-8	Struthers-Wells, Warren, Pa.	Discuss PRTR gas loop.	JP Fanaritis	No
JF Fletcher	10/9 10/26-28	ORNL, Oak Ridge, Tenn. Gas Bearing Symposium, Washington, D.C.	" " " " Attend symposium & discuss gas loop blower problems with British vendor's representative.	J Zasler A Frost, Bristol Siddeley, Ltd.	No No No
GL O'Neill JJ Regimbal	10/15-16	Phillips Pet. Co., Idaho Falls, Ida.	Discuss PRP critical facility.	E Gast	Yes
JC Fox	10/19	Cherry-Burrell, Cedar Rapids, Ia.	Inspect PRTR outlet nozzles.	R Snorf	No
NG Wittenbrock	9/30	US-AEC, Germantown, Md.	Discuss PRTR safeguards analyses.	Beck	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Accesss to Restricted Data
FH Shadel	10/18-21	Western Piping & Eng., San Francisco, Calif.	Inspect & observe acceptance test on PRTR River Pumps.	--	No
		Byron Jackson Co., Los Angeles, Calif.		AL Bunke	No
JM Batch	10/18-22	Purdue University, Lafayette, Ind.	Recruiting.	--	No
LG Merker	10/13-18	Loma Machine Mfg. Co., New York, N.Y.	Approve design details for hoodable rolling mill.	AI Nussbaum	No
EG Peterson	10/8	US Corps of Eng., Northern Div.(Pacific) Lab., Troutdale, Ore.	Observe fabrication of shield specimens.	OE Borge	No
DC Kaulitz	10/1-2	Simens-Schuckertwerke, Nuremburg, Germany	Discuss fuel element fabrication & equipment for fuel fabrication.	Dr. Finkelnburg	No
	10/2-7	Saclay, Paris, France		Dr. Pierre-Delattre	No
	10/8-9	Harwell Res. Estab., London, England		Dr. Gahlib	No
	10/10-13	Imperial Chemical, Ltd., Birmingham, England		--	No
RG Wheeler	10/1-2	ORNL, Oak Ridge, Tenn.	Attend High Temperature Thermometry Seminar.	DR Cuneo	Yes
GT Geering	10/5-6	BMI, Columbus, O.	Observe radiometallurgy examination of tubular fuel elements.	JE Gates	Yes
	10/28-30	WAPD, Pittsburgh, Pa.	Discuss loop irradiation, effect of pressure on swelling, capsule tests.	RH Fillnow	Yes
		BMI, Columbus, O.	Observe examination of Hanford fuel elements in BMI hot cell.	JE Gates	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JL Bates	10/6-8	Int'l. High Temperature Symposium, Stanford Res., Monterey, Calif.	Attendance only.	--	No
	10/9	Giannini Plasmadyne Corp., Santa Ana, Calif.	Discuss & view operation, uses & methods concerning the Plasmatron.	J Rasener	No
EA Evans	10/7-9	US-AEC, Washington, D.C.	Discuss fundamental studies of UO_2.	MJ Whitman	Yes
WL Wyman	10/8	Air Reduction Pacific Co., Seattle, Wn.	Inspect welding equipment.	L Hayward	No
JE Minor JC Tobin	10/12-13	GE-APED, Vallecitos, San Jose, Calif.	Attend APED technical symposium.	MJ Sanderson	No
JJ Hauth	10/15-17	American Ceramic Society, Seattle, Wn.	Present paper.	--	No
JE Minor	10/21-22	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Discuss HAPO irradiation programs & observe experiments in ETR.	R Neidner, GE DT Neill, PP Co.	Yes
RD Leggett	10/27	Westinghouse Res. Labs.,	Discuss glow discharge.	WJ Lange	No
	10/28	WAPD, Pittsburgh, Pa.	Discuss swelling program.	MW Burkhard	Yes
	10/29	KAPL, Schenectady, N.Y.	"	WV Johnson	Yes
	10/30	GERL, Schenectady, N.Y.	Discuss glow discharge.	CW Tucker	No
JW Weber	10/29-30	KAPL, Schenectady	Discuss fuel irradiations results & fuel capsule irradiation techniques.	CE Weber	Yes
	10/29	WAPD, Pittsburgh, Pa.		RH Fillnow	Yes
SH Bush RS Kemper	10/28-30	NMI, Concord, Mass	Discuss heat treating & extrusion.	P Loewenstein	Yes
	10/30	National Res. Corp., Boston, Mass.	Discuss Project GA-744	O Reese	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DR Green	10/29-30	GERL, Schenectady	Discuss xenon krypton diffusion.	CW Tucker	No
JW Riches HP Oakes	9/28 9/28-30	Wolverine Tube, Detroit, Mich.	Consult on fabrication of Zr.	EA Wright	No
JW Riches	9/29	Mallory Sharon, Niles, O.	"	SN Randall	No
	9/30	Chase Brass, Waterbury, Conn.	"	DK Crampton	No
JW Riches HP Oakes	10/1	Superior Tube Co., Norristown, Pa.	"	HW Cooper	No
	10/2	Bridgeport Brass Co., Bridgeport, Conn.	"	GW Cleveland	No
RC Aungst	10/13	Chase Brass Co., Waterbury, Conn.	"	DK Crampton	No
	10/14	Superior Tube Co., Norristown, Pa.	"	HW Cooper	No
RC Aungst HP Oakes	10/15	Harvey Aluminum, Torrance, Calif.	"	W Rotsell	No
HP Oakes	10/14	Wah Chang Corp. Albany, Ore.	"	DS Fairgrieve	No
RL Knecht	10/23	Harvey Aluminum, Torrance, Calif.	"	W Rotsell	No
RC Giberson	10/1-2	ORNL, Oak Ridge, Tenn.	Attend meeting on high temp. irrad. measurement.	WR Grimes	Yes
DR deHalas	10/8-13	ORNL-AEC, Oak Ridge, Tenn.	Discuss EGCR graphite.	WK Larkin	Yes
		Vallecitos Atomic Lab., Pleasanton, Calif.	Present paper at technical symposium.	MJ Sanderson	No
PJ Pankaskie RB Richman	10/12-16	National ASTM Meeting, San Francisco, Calif.	Attend. Present paper.	WL Lamar	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RB Richman	10/12-16	GE-APED, San Jose, Calif.	Discuss results & operation of heat transfer corrosion tests.	M Siegler C Gaul	No
RL Dillon	10/14-16	Brussels, Belgium	AEC-Euratom Meeting, present paper.	--	No
	10/19-20	Saclay, France	Inspect corrosion facilities & confer with personnel.	Dr. H. Coriou	No
	10/21-22	Harwell, England		Dr. JN Wanklyn	No
	10/26-	Joint Estab. for Nuc. Energy Res., Norway		Dr. K Videm	No
R Harrington	10/4-9	Goodrich Chemical Co., Cleveland, O.	Discuss new materials developments.	WJ McCarthy	No
		DuPont, Akron, O.		LI Mayo	No
		Goodyear, Dayton, O.		GE Meyers	No
		Precision, Rubber, N.Y.		H Gillette	No
		Union Carbide, Wilmington, Del.		HW Johnson	No
		DuPont, Wilmington, Del.		JR Perkins	No
JL Jackson	10/12-16	GERL, Schenectady	Conference on pyrolytic carbon.	ER Stover	No
		National Carbon Co., Cleveland, O.	Inspect facilities.	JT Meers	No
		Minn. Mining & Mfg., Minneapolis, Minn.	Inspect coating equipment.	HG Sowman	No
LD Perrigo	10/14-15	Phillips Pet. Co., Idaho Falls, Ida.	Explain decontamination procedure for 3x3 loop, ETR	J Johnson C Neill	Yes
JA Ayres	10/17-24	AEC, Chicago Oper. Office, Chicago, Ill.	Discuss program for development of Al as fuel element cladding.	CW Pursel	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JB Burnham TD Chikalla	9/30-10/2	APED, San Jose, Calif. Vallecitos Atomic Lab., Pleasanton, Calif.	Discuss ceramic facilities & behavior of ceramic fuels under irradiation.	EW O'Rorke B Weidenbaum	No
ED McClanahan	9/14-16	Lawrence Radiation Lab., Livermore, Calif.	Discuss fabrication problem.	WJ Ramsey	Yes
JH Rector	10/2-11	Cincinnati Milling Machine Co., Cincinnati, O.	Discuss changes for 180 lathe.	--	No
		National Twist Drill Co., Detroit, Mich.	View newest machine tools & machining methods.	C Oxford	No
		American Society of Tool Engineers, St. Louis, Mo.	Attend meeting.	--	No
		Monarch Machine Tool Co., Cincinnati. O.	Discuss tapping studies.	S Beers	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Date	Areas & Bldgs. Visited
JF Allison	10/14	Autoclave Engineers, Erie, Pa.	Inspect helium compressors.	LD Gustafson	No	300, 314
DL Snellman	10/14	Norfin Co., Seattle, Wn.	"	LD Gustafson	No	300, 314
FH Trones	10/22-23	Byron Jackson Pump Co., Seattle, Wn.	Engineering consultation.	PA Scott	No	300, 314
C Vail	10/5-6	Minneapolis-Honeywell, Richland, Wn.	Adjust temperature controller.	BS Kosut	No	300, 326
EC Goodwin RC Hallam	10/12	CGE, Peterborough, Ontario, Canada	Discuss UO_2 fuel fabrication technology	JJ Cadwell EA Evans	No	300; 326-325
JD Rodgers	10/19-23	Philips Electronics, San Francisco, Calif	Routine servicing of electron microscope.	TK Bierlein	No	300, 326

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
CN Spalaris SR Vandenberg	10/13	GE-APED, San Jose, Calif.	Discuss UO_2 fuel fabrication technology Discuss Pu-Al program	JJ Cadwell EA Evans OJ Wick ID Thomas	No No	300; 326, 325 308
MR Eastly C Leiser	10/19	Vallecitos Atomic Lab., Pleasanton, Calif.	"	"	"	"
LV Jones	10/22	Mound Laboratory, Miamisburg, O.	Discuss special Pu operations.	RW Stewart OJ Wick	No	200-W, 2704Z, 231Z, 300, 308
H Lambertus WM Leaders NA Greenlee	10/19	Spencer Chemical Co., Kansas City, Mo.	Discuss UO_2 fuels.	JJ Cadwell EA Evans	No	300; 326, 325
A Stewart	10/20	National Lead Co., Albany, N. Y.	Discuss fuel element technology.	JJ Cadwell	No	300, 326
J Neely JK Davidson ER Wagner C Preskitt	10/20	Allis Chalmers, Washington, D.C. ORNL, Oak Ridge, Tenn.	Discuss EGCR project.	DR deHalas RE Nightingale HH Yoshikawa	Yes	300; 326, 328
FW Hunton	10/21	Kaiser Engineers, Oakland, Calif.	"	"	Yes	300, 326
J Whealdon	10/15	Air Supply Co. Div., Bellevue, Wn.	Discuss O-rings & wire	R Harrington	No	300, 326
G McFarland RE Naegele	9/29	Dow Corning Corp., Seattle, Wn. Midland, Mich.	Discuss silicone products.	R Harrington	"	300, 326
J Weissenfluh	10/22	Babcock & Wilcox Lynchburg, Va.	Discuss Al corrosion & crud formation in reactors	DR Dickinson LD Perrigo	Yes	100-K, 1704
K Newman	10/14-16	Turco Products, Inc., Wilmington, Calif.	Discuss decontamination.	JA Ayres	Yes	100-K, 1706-KE, 242-B
JF Stolz ME Noe	10/19	Atomics International, Canoga Park, Calif.	Consult on fuel element handling	LD Turner KM Hammill	No	300, 327, 325

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

OCTOBER 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Neutron Temperature Study

Cadmium ratios of Lu_2O_3 foils using various thicknesses of cadmium were measured on a foil rotator in the center of the TTR core. These results are summarized in Table I and are compared to the cadmium ratios of indium, gold, and copper which were measured in the same position.

TABLE I

Cadmium Ratios of Lutetium

Foil	Foil Thickness (Mg/Cm^2)	Cd Thickness (inches)	Ratio
Lu^{176}	0.170	0.025	68.3
Lu^{176}	0.170	0.036	68.6
Lu^{176}	0.178	0.040	69.0
Lu^{176}	0.184	0.050	70.4
Lu^{176}	0.186	0.065	
Lu^{175}	6.36	0.025	1.47
Lu^{175}	6.36	0.036	1.44
Lu^{175}	6.66	0.040	1.45
In	7.04	0.040	2.59
Au	47.1	0.040	3.52
Cu	225	0.040	19.6

Foils were also irradiated in a beam of monoenergetic neutrons with either an energy of 4.79, 5.24, or 14.1 ev. The activity resulting from these irradiations is that of Lu^{176M}.

A "Letter to the Editor" has been submitted to the journal of Nuclear Science and Engineering. The letter describes the results of experiments obtained with lutetium through September, 1959.

Westcott g parameters have been calculated for Lu^{176} at six values of the neutron temperature. The shape of the curve defined by the calculated parameters agrees very well with that defined by experimental values.

Lu_2O_3 foils with a wide range of thicknesses have been prepared and irradiated. However, the results are not available at this time.

Neutron Temperature Coefficients

Programming of the nuclear data tape code is completed. Debugging of this program has been started.

A subroutine to calculate exponential integrals has been written and tested. The two formulas used, however, do not give sufficient accuracy for arguments of the order of 10. A continued fraction form of the exponential integral is being programmed to check its accuracy in this range.

Thermal Neutron Spectrum Near a Temperature Discontinuity

Evaluations have begun of the analytic solutions to the temperature discontinuity problem in a heavy gas moderator in slab and cylindrical geometry. The digital computer program SYZYGY is being used in these calculations. A short program is being written to facilitate comparison between these exact solutions and the multimaxwellian group and effective temperature approximations.

Multimaxwellian Group Analysis

FIT-1, the cross-section fitting program which was described briefly last month, has been compiled. Three debug runs were made, with little success.

A test case of ZOOM, a multigroup program received from UCRL, was unsuccessful. In this test case, the input, which was also received from UCRL, was rejected by the program. The reason for this rejection has not been found.

Neutron Rethermalization Experiments

The technique of fabricating Lu_2O_3-Al_2O_3 ceramic foils was established early this month. Ten sample foils produced uniform counting rates (without weight normalization) to approximately 0.6%, of which 0.3% was statistical. Approximately 80 foils have been prepared for use as neutron thermometers. The foils which have been irradiated exhibit a radioactive contaminant with approximately a 2.50-hour half life which yields a 1% background activity for normal irradiation times. This activity can be corrected for and does not affect the usefulness of these detectors.

The graphite for neutron rethermalization experiments in cylindrical geometry has been fabricated.

Instrumentation and Systems Studies

The report on the reactor speed-of-control analog computer analyses is near completion and will be issued soon in co-authorship with IPD personnel. A secondary report recording the analog computer program for this study also is being prepared.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Exponential Pile Measurements of Large Diameter Fuel Elements

Buckling measurements have been made this month for several fuel elements at several lattice spacings. The preliminary buckling values and other pertinent information are given in Table I:

TABLE I

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios Al/U	H_2O/U	C/U
2.5 x 1.6 IœE	14 9/16 wet	-124	.373	1.291	70.44
2.5 x 2.0 with 1.66 x 1.1	8 3/8 wet	-68	.493	1.102	21.12
2.5 x 2.0 with 1.66 x 1.1	7 3/16 wet	-129	.493	1.102	14.85

The buckling values quoted in Table I are based on an estimated side-extrapolation length of 1.66 inches. Final bucklings will be reported after analysis of horizontal-traverse data.

To determine how the measured side-extrapolation length might vary with front-rear position two horizontal traverses were taken, one on the exponential pile center line, the other one foot to the rear of center. The results of these traverses are given in Table II:

TABLE II

Fuel Element	Lattice Spacing	λ (side-side) (inches)	Position
2.5 x 1.6 with 1.17	14 9/16 wet	1.50 ± 0.2	Center line (front-rear)
2.5 x 1.6 with 1.17	14 9/16 wet	1.47 ± 0.2	One foot rear of center

The results seem to verify the separability of the fluxes for a small assembly.

Horizontal traverses have been taken with and without a cadmium cover on the counter. The results are given in Table III.

TABLE III

λ (side-side) (inches)	Position	Counter Data
1.5 ± 0.2	Pile center	Bare
1.3 ± 0.2	Pile center	Cadmium covered
1.5 ± 0.2	Pile center	Bare - cadmium covered

These measurements were made in an exponential pile loaded with 2.5 x 1.6 I α E fuel elements at a lattice spacing of 14 9/16-inches. The counter was placed at a position close to the radius of the equivalent cylindrical cell. Within the uncertainties quoted in Table III the extrapolation lengths are the same. The magnitude of the extrapolation lengths is not necessarily correct since the shutter method was not used. The differences are valid since the effect of the cadmium shutter method is to raise all λ's by a few tenths of an inch.

PCTR Measurements of Lattice Parameter of Large Diameter Fuel Elements

Shopwork on the tubing for the 2.5 x 2.0, 1.66 x 1.12 tube-in-tube experiment in the PCTR has been completed.

The preparation of the foils for the p measurement is being delayed by the lack of suitable depleted uranium foil. Previous attempts to roll depleted uranium have failed; however, the present attempt has reached 0.013-inch and is still progressing.

PCTR Measurements of k_∞ and f for Selected Cluster Elements

The experimental work in the PCTR has been completed with clusters of natural-uranium rods of 0.925-inch diameter. Based on exponential measurements, the k_∞ of the water-cooled clusters at a 7-inch lattice spacing was estimated to be about 0.9. Inasmuch as no previous measurements have been made in the PCTR of lattices with multiplication constants considerably less than unity, two distinct approaches were made in this experiment.

The first approach, corresponding to usual methods, involved the measurement of the quantity of poison to be eliminated (or the equivalent absorptions) from the lattice in order to increase its multiplication to unity. The shortcoming of this approach is the uncertainty associated with spectral mismatches that develop in an extrapolation of experimental data.

The second approach was to determine the quantity of enriched uranium-aluminum alloy required to increase the multiplication of the cell to unity. Derivation of the k_∞ of the unenriched cell now involves interpreting changes in η and ε as well as thermal utilization. The results of the two techniques will be compared with each other. Further information will be gained by comparison with exponential measurements and the previously reported results of the measurements with the uniformly enriched cluster.

Several determinations of the adjoint mismatch were made as the spectral match was being measured. These measurements showed that the adjoint match is not necessarily as good as the spectral match, depending on the configuration chosen for the driving fuel. Also, with judicious choice of driving fuel location, it is possible to match both the spectrum and the adjoint flux to 1 or 2%.

Absorbing Rod in a Maxwellian Flux

The digital computer program ARMIE, to calculate the effect of an absorbing rod on the neutron thermal flux, effective temperature, and neutron density in a non-absorbing moderator, has been operated successfully. This program is based on the assumption that the reciprocal of the rod blackness varies linearly with neutron energy. Analysis shows that variation of reciprocal blackness with the square root of the energy is more accurate; however, use of such an assumption would significantly increase the mathematical complexity of the problem. As an alternative to using this more accurate and complex square root assumption, a search has been made for reasonable criteria to use in making the linear approximation to the square root dependence. Three criteria for this linear approximation are being examined: a) Tangency to the $1/\beta$ versus energy curve at the energy of the peak of the asymptotic maxwellian distribution in the moderator, b) a minimal least squares error with a maxwellian weighting function, and c) a minimal least squares error with a maxwellian $x(1/v)$ weighting function. Cases to test these criteria are now being run.

Improvements in p and ϵ Measurements

The measurement of ϵ requires a calibration of the fission-product decay rates for natural and depleted uranium. The dual fission chamber constructed for this purpose is being studied to analyze the data taken when this chamber and associated fission foils were irradiated. During the irradiation the count rate in both sides of the chamber increased due to a slow loss in pressure. The counting rate and spectrum are now being measured as a function of pressure to establish a better basis for analysis and avoid the necessity for another irradiation.

The 2" x 5" crystal has arrived and been tested. The resolution is about 8% for cesium gammas which exceeds specifications. However, the response across the face is not constant: ± 1% over the central inch while specifications called for ± 1/2% over the central 2-inches. It appears that the vendor uses collimated gammas when testing for flat response, while our applications refer to an isotropic source. Modifications to the resistor string to optimize collection from the photocathode will be attempted, followed by selection of suitable absorbers if necessary to achieve more uniform response.

Exponential Pile Measurements for N-Reactor

As a result of pressure venting problems, the graphite stack for N-Reactor has been completely redesigned. Since fabrication of graphite for an exponential assembly was in progress, a re-evaluation of the exponential program was necessary. All the graphite had already been extruded in 5" bars, but not machined, and the vendor was requested to wait for our evaluation before proceeding. It appears that the 5" bars will be useable in the new configuration with some additional machining and juggling of the physical arrangement. As soon as prints can

be prepared, the vendor will be asked to quote an additional machining cost for two alternates, and the final decision will be made when the costs are received.

Instrumentation and Systems Studies

Development-design work and some fabrication is progressing on three proposed prototype monitoring instruments for the NPR 105-N Building (IPD Design Test 1071). Development work is essentially complete on the three-decade, scintillation, logarithmic system beta-gamma area monitor and fabrication was started. Design work is almost completed on the linear, four-decade, scintillation beta-gamma area monitor comprising four detector heads and one central station. Design was started, after discussions were completed and approach agreed to, on the chart-recording, air-pulling, logarithmic beta-gamma scintillation air monitor. The air monitor will be wheel-mounted for ease of location change and will incorporate facility for an incorporated air-pulling device or for use with the building air system.

A request was received from IPD to undertake full-scale prototype development of the dual fast-scan - slow-scan rupture detection system. (Reference: Letter, "NPR Rupture Detection," A. B. Greninger to H. M. Parker, dated October 26, 1959.) The accompanying authorization to incur costs up to $40,000 for this work will permit acceleration of the limited development that had been initiated with previously programmed funding. The objective of the accelerated program is to develop a demonstration prototype system within approximately seven months.

First scoping of the mechanical design was completed by CE&UO and detailed designing is underway. Progress has been made on development of the detector-electronic system. The laboratory device to simulate the mechanically interrupted gamma-ray signal for the monitor is being assembled. A transistorized difference amplifier is being developed for use with the simulator.

A meeting was held this month with members of IPD, Reactor Design and Reactor Physics, to discuss NPR analog computer work required for the next three or four months. Three general programs were outlined.

1. Further work on reactor frequency response.

2. Detailed simulation of the dynamics of the heat exchanger.

3. Closed loop analysis of the NPR Primary Loop. This will include all work done for the reactor and heat exchanger to date.

The analog computer study of the NPR heat exchangers has been completed. About one-third of the runs were made on the Digital Differential Analyzer (DDA). The remainder of the runs were completed on the Goodyear computer (GEDA). The results were very satisfactory. One of the purposes of this study was to develop a satisfactory circuit for use in the complete closed-loop NPR simulation which would eliminate the difficulties encountered in prior work on this program. In the earlier work, the equations for the heat exchanger contained some non-time-dependent variables. To obtain satisfactory results, it was necessary to modify the equations to include time dependence of all variables.

The NPR pump coastdown characteristics have been reevaluated on the analog computer. The results were satisfactory.

Analysis of reactor kinetic equations continued. It has been found that the approximate solution given in the unclassified literature for the case where reactivity is varied sinusoidally is incorrect. The correct solution, as determined from the digital differential analyser, is unstable; it is oscillatory with exponentially increasing amplitude. This has been verified analytically. The form of the solution as an infinite series has been found and the first few terms evaluated. From these it appears the instability occurs for all values of reactivity amplitude and frequency.

Mechanism of Graphite Damage

A report was received on the lattice spacing change in the KC type graphite whose irradiation and length change measurement was reported last month. For an irradiation with electrons which gave 0.13% microscopic length change the lattice spacing change was 0.18%. This gives a value of 1.4 for the ratio of lattice spacing change to length change. This is markedly different from the results obtained when neutrons are used for the irradiation. For the neutron case the ratio of lattice spacing change to microscopic length change is about an order of magnitude larger than for electron irradiation. This indicates that a different mechanism is operating for the two different types of radiation.

STUDIES RELATED TO THE SEPARATIONS PLANTS

Plutonium Critical Mass Facility

The construction phase of the laboratory buildings is proceeding on schedule. The control and office building is complete externally and interior finishing is about half done. The floor of the reactor room is complete; during the latter part of the month the cement was poured for a portion of the reactor room walls. Some service equipment arrived during the month but has not yet been installed.

The design drawings of the in-hood reactor components are being prepared, together with specifications, for submission to bid by local shops or outside fabricators.

Pertaining to nuclear safety in operation, a mock-up of the safety rod support magnet and accelerating mechanism has been fabricated to verify the suitability of the proposed design. The mock-up will be tested to determine the magnet holding and release characteristics and current requirements for the magnet.

Criticality of Plutonium Solutions and Precipitates

Theoretical calculations are being undertaken with the 709 Computer to reproduce the P-11 experiments on Pu systems; these calculations will then be extended to include the presently proposed experiments for the Plutonium Critical Mass Facility and in this sense will serve as a guide in the selection and planning of the most useful experiments.

As a first step, the 709 Computer C_3 Program has been compiled. The C_3 Program performs an 18 energy group infinite medium spectrum calculation, then provides as output, (1) a k_{eff} for bare cylinders; the cylinder dimensions are given as input; and (2) three lethargy group parameters for use in the F_3 code.

Nuclear Safety Specifications

Plutonium Metallurgy Operation - Pouring Crucible Design

The dimensions of two cylindrical pouring crucibles for use in plutonium casting operations were evaluated for nuclear safety. The larger of these crucibles is 2" I.D. x 8 1/2" high and is to be used to pour charges of up to 6.6 Kg of plutonium; the other is 3" I.D. and is for smaller charges. The evaluation showed that the 2" I.D. crucible is geometrically safe at full water reflection, even if charged to capacity (8.5 Kg of plutonium). The specified charge is 6.6 Kg (maximum). The stipulation is made, however, that the loaded crucible must be at least 24" away from all other plutonium.

The 3" I.D. crucible is not safe by geometry and could be critical at a height of 2.5" (about 6 Kg of plutonium). Consequently, a mass limit of 2.5 Kg is imposed on this crucible, which provides a degree of safety for inadvertent double batching.

The effect of small changes in crucible diameter on the critical height and critical mass can be seen in the following table:

Diameter	Critical Height	Critical Mass
2.0"	∞	∞
2.1"	10"	11 Kg
2.25"	5.7"	7.5 Kg
2.5"	3.7"	$\sim$ 6 Kg
3.0"	2.5"	$\sim$ 6 Kg

This analysis is based on a minimum critical mass of 5.8 Kg and an extrapolation length of 2.5 cm (water reflected sphere); which appears reasonably accurate but slightly conservative when compared to UCRL data.

Plutonium Metallurgy Operation - Metal Storage

An evaluation was made to determine the effect of polyethylene moderation on the nuclear safety of a plutonium metal storage array. The array in question is two dimensional and contains unit masses of up to 3.0 Kg of plutonium on 24" centers; each mass is wrapped in several thicknesses of 15 mil polyethylene. It was concluded from this study that this particular array is safe, regardless of the amount of polyethylene around the plutonium components, provided there is only one unit mass at each storage location.

Radiometallurgy Operation - Storage Basin Specification

The nuclear safety of the Radiometallurgy Operation in 327 Building was reviewed and tentative critical mass control specifications established for the two fuel element storage basins. One of these basins contains water and the other is dry. The specification permits the storage of 120 Kg (max.) of uranium at an enrichment of 1.6% U-235 (max.) in each basin. The uranium rods may be of any diameter and in any array (i.e., no restrictions on rod diameter or spacing between rods). It is also permissible to store Pu-Al alloy in each basin. In this case, the amount of plutonium in the basin is not to exceed 250 g, and the Pu-Al fuel elements must be in a designated location at least two feet from the uranium array.

The amount of fissile material permitted in the operating cells at any one time is well below the minimum critical mass.

Chemical Research Operation - Enriched Uranium Dissolver Design

The scope design of a dissolver vessel for processing enriched uranium metal and uranium oxide fuel assemblies was reviewed to determine geometrically safe dimensions. The design calls for a square vessel about 8" on a side and about 8 feet long. The dimensional requirements of this design are based primarily on processing the Yankee fuel assembly, which has the following specifications:

Fuel:	UO_2
Enrichment:	3.4% U-235 initially 2.6% U-235 + 0.4% Pu-239 finally
Dimensions:	7.62" x 7.62" x 94" long
Components:	306 rods of 0.34" dia.
Fuel Weight:	319 Kg UO_2 per assembly
Cladding:	348 SS

The nuclear safety analysis shows the following:

1. At the U-235 enrichments under consideration (5% max.), the uranium rod system is more reactive than the homogeneous solution system (the maximum safe cylinder diameter is smaller for the heterogeneous case) and uranium metal is more reactive than uranium oxide, therefore, nuclear safety must be based on a system of uranium metal rods.

2. Critically safe dimensions have been established for systems of uranium metal rods based on theoretical correlations to data from experiments with enrichments of 3% and lower. These dimensions are as follows:

% U-235	D_s (Safe Cylinder Diameter)	a_s (Safe Square of side "a")
2.0	10.2"	9.1"
2.5	9.2"	8.1"
3.0	8.6"	7.6"
3.4	8.3"	7.3"
4.0	7.9"	6.9"
5.0	7.7"	6.8"

3. For a square dissolver vessel, 8" on a side, it is estimated that the limitations on enrichment would be as follows:

   2.6% (max.) for uranium metal rods

   4.3% (max.) for UO_2 rods

   This preliminary information will help in resolving the basic design of the dissolver vessel. More accurate data will be available as soon as the correlation of experimental data at 3% enrichment and the calculations at 5% enrichment are completed.

Criticality Studies in Support of Processing Power Reactor Fuels

Experiments with Heterogeneous Systems

Critical mass studies were continued in support of processing power reactor fuels with experimental work proceeding on both heterogeneous and homogeneous systems.

The first critical approach and exponential experiments were conducted with the small, 0.175-inch diameter rods of 3.063 percent enrichment. A hexagonal pattern was used for the lattices which were totally water reflected. The uranium rods were 23.5-inches in length; these rods were encased in 0.025-inch wall Lucite tubes for insertion in the lattice frameworks.

The results of these critical approach and exponential experiments are summarized in the following tables.

Critical Mass and Buckling
For 3.063 Percent U-235, 0.175-Inch Diameter Rods

Critical Approach Measurements

Lattice Spacing (inches)	H_2O/U (Volume Ratio)	Critical No. of 23.5-inch Rods (cylindrical geometry)	Critical Mass (cylindrical geometry)	Calculated Critical Mass* (spherical geometry)	Critical, or Material, Buckling* (10^{-6} cm^{-2})
0.45	6.29	628.3	242.5 lbs. U	184.3 lbs. U	14,330
0.50	8.00	569.4	219.9 lbs. U	171.1 lbs. U	13,382
0.55	9.89	554.2	213.9 lbs. U	171.9 lbs. U	12,106
0.60	11.96	572.5	221.0 lbs. U	184.5 lbs. U	10,661

Exponential Measurements

Lattice Spacing (inches)	H_2O/U (Volume Ratio)	Buckling* (10^{-6} cm^{-2})	Calculated Critical Mass for 23.5-inch Rods* (cylindrical geometry)	Calculated Critical Mass* (spherical geometry)
0.45	6.29	14,347	242.0 lbs. U	183.8 lbs. U
0.50	8.00	13,345	220.8 lbs. U	171.9 lbs. U
0.55	9.89	12,030	216.1 lbs. U	174.0 lbs. U
0.60	11.96	10,600	223.1 lbs. U	186.5 lbs. U

* The extrapolation length was taken to be 6.5 cm for these calculations.

In the critical approach experiments the lattices were loaded to within about 96 percent of the critical mass as estimated from the multiplication curves. The critical number of rods are given for a clean lattice (critical approach extrapolation corrected for the effect of the safety rod guide tubes and the source stringer).

The critical mass in spherical geometry was calculated from the buckling using the same value of extrapolation length as was used to calculate the buckling from the measured critical mass in cylindrical geometry, or from the exponential measurements.

The predicted critical mass from the exponential experiment is seen to be in good agreement with the measured critical mass from the critical approach measurement. The buckling values are known with less precision because of the uncertainty in the extrapolation length (λ); a single value of 6.5 cm was used in these preliminary calculations.

The expression which gives the buckling from the exponential measurement may be equated to that which gives the buckling from the critical approach measurement so as to yield values for both the extrapolation length (λ), and the buckling (B^2). The following values were obtained from this procedure.

Extrapolation Length and Buckling

Lattice Spacing (Inches)	λ	Buckling (10^{-6} cm^{-2})
0.45	6.54 cm	14,280
0.50	6.40 cm	13,500
0.55	6.28 cm	12,328
0.60	6.28 cm	10,840

The values of extrapolation length and buckling reported here are preliminary values.

This series of four measurements does not encompass the maximum buckling. The minimum critical mass for the 0.175-inch rods in spherical geometry is ~170 lbs. of U, which occurs for an H_2O/U volume ratio of about 9. Measurements will be made with smaller lattice spacings in order to determine the maximum buckling for this fuel rod size.

The results of these measurements are especially interesting since they show the critical mass continues to decrease with rod size; the minimal critical mass for the 3 percent enriched uranium will occur for rod diameters less than 0.175 inch. If this trend were to continue the smallest critical mass would be obtained for a homogeneous system at an H/U atom ratio of roughly 20. This is in variance with simple theory which predicts the smallest critical mass for the heterogeneous system.

Experiments with Homogeneous Systems

Exponential experiments are being conducted on 3 percent enriched UO_3-polyethylene systems in order to determine the buckling as a function of the H/U atomic ratio for these systems. One purpose of these experiments is to determine the minimum critical mass for 3% enriched U-H_2O homogeneous systems; the data will also be used for correlating theory with experiment.

Exponential measurements are planned for H/U atom ratios of 6, 12, 18, and 22. Measurements will also be made to determine the extrapolation length of the system.

An exponential measurement was made for a homogeneous mixture of 3 percent enriched UO_3 and polyethylene contained in a Lucite tank twelve inches in diameter and 32 inches in height. The H/U atom ratio of the mixture was 18; the density of this material was 1.28 gm/cm^3. Horizontal traverse measurements were made at the H/U ratio of 18 in order to determine the extrapolation length. The preliminary value was found to be $\lambda = 9.5 \pm 1.0$ cm. Using this value for λ the buckling for the H/U ratio of 18 is found to be, $B^2 = 3900 \pm 190$ μB. The error in the buckling does not contain the error in λ since this is only a preliminary value.

In order to obtain the proper buckling for a homogeneous U-H_2O mixture, the measured buckling values must be corrected to account for the difference in density between a UO_3-CH_2 mixture and a homogeneous U-H_2O mixture. Because k_∞ is independent of density, the correction entails only changes in the migration area. Since k_∞ can be evaluated for this material from the PCTR measurements, a value of the migration area can also be obtained providing the buckling can be determined with sufficient accuracy.

Mass Spectrometry

The mass spectrometer for this program provided an isotopic analysis as a service this month.

The ion counting instrumentation for this mass spectrometer was debugged and put into operation. Studies of the characteristics of the counting system and factors contributing to its reliability as an ion detection and measurement system are in progress.

Accident and Monitoring Studies

The main program to integrate the reactor kinetics equations using an integrated Taylor series formulation has been written and compiled. The subroutines used for auxiliary calculations have been compiled, and are being debugged individually to check their operation before use in the main program.

NEUTRON CROSS SECTION PROGRAM

Slow Neutron Scattering Cross Sections

Growth of Single Metal Crystals

The program to provide large single metal crystals for use as neutron diffraction monochromators has been continued. Five single crystals of aluminum were grown from the melt during October. All of the crystals are about two inch diameter cylinders approximately eight inches long. The general features of these crystals are: The lineage structure is improved over that of the crystal grown last month. The orientation of the crystals does not indicate a preferred orientation with respect to the axis of the cylinder. The melts indicate a pronounced segregation of impurities. There is a disturbed layer on the surface of the crystals with large areas adhering to the walls of the graphite crucible.

None of the new crystals have been subjected to investigation by neutron diffraction techniques as yet.

Studies of Monochromating Crystals

The investigation of crystal reflectivity continued. The work of previous months has been analyzed for consistency and significance. The main features of selected results are tabulated below. Quantities appearing in the table are:

R_p = peak value of reflectivity curve (fraction of incident neutron beam reflected)

W = width at half-max. of reflectivity curve

I.R. = integrated reflection

R_p and W are obtained from reflectivity measurements using a beam of high angular ($\sim$0.01 deg) and energy ($\sim$0.0003 ev at 0.09 ev) resolution produced by two calcite crystals in antiparallel. The product R_p x W is a crude measure of the so-called "integrated reflection," provided $W < W^*$, the angular width of the collimation system. Otherwise, R_p x W^* is used. The integrated reflection is a measure of the relative merit of the crystal as a monochromator for the neutron scattering cross section measurements. Relative values of the integrated reflection can also be measured directly by counting the neutrons reflected from the main beam by a crystal located at the first axis position.

The reasonably good agreement between the two types of experiments for Pb#2A and Al #1A indicates that the reflectivity measurements are valid.

Crystal	Neutron Energy (ev)	R_p	W (deg)	R_p x W (deg)	Relative I.R.
+Be 1	0.09	0.19	0.78	0.15	--
+Pb 1	0.09	0.12	0.09	0.01	
NaCl 2A	0.09	0.11	0.09	0.01	
Pb 2A	0.09	0.071	(0.71 (0.50*	0.050 0.035*	1.0*
Al 1A	0.09	0.31	0.12	0.037	1.5
Al 1A	0.035	0.34	0.16	0.054	--
Al 1A	0.30	0.12	0.10	0.01	--

* Indicates a case in which the effective angular width for the integrated reflection experiment is determined by the collimation width instead of the crystal width W.

\+ Indicates the crystals previously used as monochromators in the experimental study of slow neutron scattering from water.

Slow Neutron Fission Cross Sections

The slow neutron cross section information on Pu^{239}, Pu^{240}, Pu^{241}, and Pu^{242} was reviewed. The results were presented as an invited paper on "The Status of the Low Energy Cross Sections of Plutonium" to the Conference on the Physics of Breeding at Argonne National Laboratory, October 19-21.

Subthreshold Fission

The investigation of resonance fission of Pu^{240} has been continued using the gas scintillation fission counter. The measured fission in the 1.06 ev resonance has given inconsistent results in separate runs presumably because of poor performance of the scintillator detector. Measurements are now in progress to attempt to place an upper limit on the amount of fission in the 20.4 ev resonance.

Fission foils are being prepared in Chemical Research and Development from samples of Pa^{231}, U^{234}, U^{236}, and U^{238}. Fission measurements will be started when the foils are received.

Fast Neutron Spectra

A brief run was made of the Be(d,n) reaction. The alignment of the Van de Graaff beam was worse than that of the previous run. The data obtained are being analyzed for the bias energy versus phototube voltage relation. Accelerator time has been scheduled for a thorough realignment.

Work has continued on the photomultiplier cooling system. The reliability of the system has been improved such that the temperature will stay constant within 2°C for a working day on one load of dry ice.

Irradiation Cross Sections

Three monoenergetic neutron irradiations of lutetium were made during the month using the 105-DR crystal spectrometer. Irradiations have now been made at the 0.142 ev, 2.61 ev, 4.79 ev, 5.24 ev, and 14.1 ev resonances. Isotopic assignments of the resonances have been made from the observed gamma spectrum following irradiation. These assignments agree with the assignment of Lu^{176} to the lowest resonance and Lu^{175} to the four other resonances as reported from total cross section measurements with separated isotopes at ORNL. The data are being studied in order to determine the possibility of assigning spin states to the Lu^{175} resonances.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Lattice Parameters for Low Exposure Plutonium

PCTR experiments on the 19-rod clusters of 1.8 w/o low-exposure Pu-Al fuel in a square 10 1/2-inch graphite lattice began on October 27. Very preliminary measurements indicate $k_\infty \sim 1.65$.

Lattice Parameters for High Exposure Plutonium

Specifications and a work order have been forwarded to Plutonium Metallurgy Operation for preparation of the 21.7% Pu-240 material into 0.5-inch dia. rods for PCTR measurements.

PRTR Startup Experiments

The Physics Startup Committee met during the month and reviewed the startup tests. Responsibilities for the planning of the experiments were assigned.

The specific responsibility of outlining the subcritical tests has been apportioned to Nuclear Physics Research.

The Critical Facility of the PRP

The scope description of the facility has been completed and issued as Document HW-61808.

Meetings with the designers were continued throughout the month. Typical topics which have been discussed comprise the moderator systems, core designs, regulating rods and reactor instrumentation.

A Program for Analyzing PCTR Data

The foil data processing program appears to be operating correctly. Debug runs, testing three of the several options in the program, were successfully completed. The input format, laid out before programming began, has not proved entirely satisfactory and will be revised before input forms are printed. Relatively minor interior changes will also be made to facilitate the later addition of routines to handle lutetium and fissionable foils.

Instrumentation and Systems Studies

Tests are proceeding concerning the evaluation of 150 multiplier phototubes and 87 NaI scintillation crystals for the PRTR fuel element rupture detection system. Seventeen of the last group of twenty-five NaI crystals received were unacceptable because of crystal fractures, separations, and internal moisture effects. These crystals were received on a low bid from a previously untried vendor. The seventeen crystals will be returned to the manufacturer. The 200-channel analyzer is being utilized to check phototube-crystal resolutions. Other tests include temperature effects, noise, gain, and stability factors.

Work continued on development of the gamma insensitive neutron detector based on the difference in pulse shapes between neutron induced and gamma induced scintillations. This new technique will be tried first in the neutron time-of-flight system in support of the Cross-Section Program. A circuit has been built and is being adjusted to provide a fast saturated pulse for timing purposes that may be generated by either a gamma ray or a neutron. The circuit also provides a slow pulse when the scintillation event is caused by a neutron.

Fabrication of the Wide Angle Viewer continues. Some of the parts have been received from offsite vendors.

All offsite bids for fabrication of parts of the profilometer have been received. The lowest possible fabrication cost exceeds our original estimates by 50 percent. A supplement to the work order has been requested. Discussions were held to seek ways of reducing fabrication costs. This appeared to be possible in only one component, the cell plug.

The safeguards analysis problem was again programmed on the analog computer to study the cases when the reactor loading is such that the maximum enrichment of plutonium is present.

GAS COOLED REACTOR PROGRAM

Variation of the Doppler Coefficient with S/M Ratio

Assembly of the 1.92-inch dia. mockup fuel element, containing twelve calibrated iron-constantan thermocouples, has been completed. The element has been sealed within its quartz containing tube and the system successfully evacuated to < 1 micron Hg. The supporting graphite pieces are being fabricated. Initial tests on this mockup assembly will begin in about two weeks. Coils of a special design for heating the 20-inch fuel element with the induction heater have been successfully formed and tested.

A small computational error has been found in the analysis of the 1.92-inch k_∞ data. The value of k_∞ for the dry case increased 0.7 mk, from 1.011 to 1.0117.

Rod Replacement Analysis

A subroutine which evaluates determinants of order ten or less by Crout's method of reduction has been written and has been debugged for the case of a three by three array. The precision for higher order determinants is now

being examined. A modification of the subroutine for evaluating lattice sums has been made in order to provide more rapid convergence.

Input data representative of the GCR lattice are being prepared for the F_3 program in order to compare a calculation of Δf upon insertion of control rods to the value predicted from the small source theory formulation.

NONDESTRUCTIVE TESTING RESEARCH

Responsibility for this program was transferred from FPD to HLO on October 1, 1959. The studies on broadband eddy current testing techniques were moved to new laboratory facilities in the 3707-C Building. Funding was provided Testing Methods Operation of FPD for continuation of the ultrasonic Lamb Wave research through the balance of FY-60. The Lamb Wave work will be separately reported by FPD and will also be included in the total Nondestructive Testing Research portion of the 4000 Program monthly report issued by HLO Programming Operation.

Qualitative agreement is being obtained between broadband eddy current probe output signals and the predicted pulse shape based upon analysis of the case of a test coil encircling a cylinder. The results of the analysis will be used to compute a family of probe output signals for metals of various conductivities for the cylindrical case. Such a family of curves will serve the same purpose in the broadband test as do the presently used impedance analysis curves in the single frequency case. As in the single frequency case, curves showing the effects of thickness and presence of cracks will be obtained experimentally.

Special attention was given to note the effect of variation in spacing between a flat test coil and the test specimen. In the case of impulse or step function coil current drive, such variation shows up mainly as a change in amplitude of output signal, with some shape change due to the same factors which cause the probe motion locus to be curved in the single frequency case. However, when the test coil is loaded to cause currents to flow in it which persist for some time, a portion of the output signal, representing a very short time interval and consisting of high frequency signal components, varies with probe spacing but does not vary much as a test specimen conductivity is changed. This represents the broadband result of the effect observed on single frequencies curves at the high frequency end. It is from this section of the test coil pulse output that information will be obtained concerning the spacing between coil and test specimen. This effect is still under observation and study. Theory indicates that this same effect should be obtained without the coil loading but during the time of rise of the step function drive from 0 to its final value.

The broadband principles are to be applied to a nondestructive testing problem of interest to the Plutonium Metallurgy Operation. It is desired to measure nondestructively and independently the thickness of a zirconium fuel element jacket, and the thickness of air gap existing between the jacket and the fuel element core. Tentative instrument specifications have been established for zirconium thickness and for the air gap thickness. It is planned to make initial measurements using a system assembled from laboratory equipment. When sufficient design information is obtained, a laboratory prototype instrument will be assembled which can be used for making spot measurements manually.

A sawtooth pulse generator giving a peak current of 0.3 ampere for this application has been set up, and is now providing excitation for the small (1/8-inch diameter) test coils used. Coil output signals for the zirconium thickness-air gap case are now being observed in order to determine the type of readout circuitry required.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month. There were five unscheduled shutdowns; three were due to electronic failure and two were due to faulty bypassing technique.

The 7-rod cluster $k_\infty < 1$ experiment was completed during the month, and the low 240, 19-rod cluster, 10-1/2 inch lattice k_∞ and f determination experiment was started.

The following reactor improvement items were completed:

(1) A safety platform and railing were installed on top of the reactor.

(2) Micrometers were installed on the four corners of the reactor to check the reproducibility of the face closing. The micrometers proved that the face does not reproduce after each closing. Better reproducibility of reactivity measurements can be obtained by correcting for the face position by using the differences between the average micrometer reading.

(3) Braces were put across the ends of the channel irons holding the control rod drive mechanism. The channel irons were previously supported at one end only and were not sufficiently rigid.

The operating time of the TTR was divided between the critical mass approach experiments and calibration work on neutron temperature measurements.

There were no unscheduled shutdowns during the month.

The design and experimental layout of the automatic foil counter scanner are well under way.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

The reduction of all meteorological data pertinent to the past summer's dispersion experiments was completed and copies for the Air Force components were obtained. Machine processing of the portable mast data was approximately 18% complete. Retention of the IBM 702 computer at least until January 1, 1960, assured the orderly processing of these data.

The taking of motion pictures of the various aspects of the dispersion program was also completed. These films are being edited for documentation on Project Green Glow by the U. S. Air Force.

A base map showing appropriate contour details and the location of equipment, instruments, and sampling stations was prepared and printed locally. These maps are to be used by the participants for streamline, trajectory, and isodosage analyses. A conference of the principal scientists involved in Project Green Glow has been scheduled for November 3-5 for the purpose of planning analysis and reporting schedules.

The first results on the calibration of the automatic fluorescent pigment counters by neutron activation of the zinc and gamma ray spectroscopy were received from Analytical Chemistry. An extremely precise assay of the ZnS on the most heavily loaded filters was possible, and the uncertainty of the calibration of the automatic counters was reduced significantly. The presence of spurious short-lived isotopes in the irradiated samples necessitated a longer decay time allowance prior to the assay of lesser loadings on the membrane filters. Results to date are for loadings from 10^{-4} to 10^{-5} gm of ZnS and assays for loadings from 10^{-5} to 10^{-7} gm are expected by November 13. The minimum significant loadings of 10^{-8} to 10^{-9} gm may require chemical separation prior to counting.

Sampling equipment at 200, 800, 1600, and 3200 meters from the source, including ground and tower stations, was readied for further dispersion and deposition experiments.

DOSIMETRY

An analysis was completed of the data from the first 169 subjects given routine examinations in the Shielded Personnel Monitoring Station. The mean values obtained for the quantities measured were:

Quantity	Mean Value	% Standard Deviation
gm K	128	19
gm K/lb body weight	0.76	17
mμc Zn^{65}	2.9	73
mμc Cs^{137}	7.7	31
μμc Cs^{137}/gm K	60	26

The results for potassium and cesium are similar to those obtained with other whole-body counters, although there is evidence to indicate that some of our results are 10-20% low (see below). Results such as those found for Zn^{65} have not been reported by other facilities. Since Zn^{65} is present in Hanford effluents and had been found in people in early measurements, analysis for Zn^{65} was made part of the routine of the SPMS. Small quantities were found in about 95% of the subjects examined. It was expected that residents of Pasco and Kennewick might have larger body burdens of Zn^{65} because of the nature of their water supply, but there is no noticeable difference between the subjects from these communities and from Richland. The students who spent the summer here on AEC Radiological Fellowships showed about the same distribution as Richland residents; the students were from widely scattered points in the United States but had spent the preceding school year in Seattle.

These facts suggest the possibility that a good share of the observed Zn^{65} did not come from Hanford but is the result of general fall-out. There have not been enough visitors from distant points to establish the general occurrence of Zn^{65}; a man from Colorado showed about the value found on the average locally; a man from England showed no Zn^{65}. The fall-out possibility is supported by an observed weak correlation that indicates the amounts of Zn^{65} are decreasing with time at about the rate expected from radioactive decay. This would be expected for fall-out but not for a source such as Hanford that would be continuously supplying new Zn^{65}.

Several studies were made to confirm our ability to detect the small amounts of Zn^{65} that are of interest. To avoid long counting times these had to be made on systems that gave higher counting rates but that were statistically similar to the counting of people. It can be said with fair confidence that, for example, subjects containing 0.4 mμc Zn^{65} will not be detected about 16% of the time. On the other hand subjects with no Zn^{65} will be reported to have 0.4 mμc or more about 16% of the time and 0.8 mμc or more about 4.5% of the time.

The diet of a particular local family has been under examination by Analytical Chemistry Operation for some time. The only significant source of Zn^{65} for this family has been their milk. It has contained an average of 2 μμc/gm of Zn^{65}, and the family uses one gallon per day. The husband, wife, and four children (ages 14 months to 8 years) were examined in the SPMS. Each contained between 30 and 37 mμc of Zn^{65} except for an eight-year-old boy who contained 45 mμc; he was considered the heavy milk drinker of the family. If these data are relevant in the case of the Zn^{65} in the general population, the 2.7 mμc average body burden would be produced by an intake of about 0.1 mμc of Zn^{65} per day. If milk were the most common source of Zn^{65}, it would have to contain about 0.02 μμc/gm.

There is growing evidence that our calibration for potassium is giving us low results. Three people have been counted here and at Los Alamos. Our results were 7.5, 14, and 17% lower than the Los Alamos values. One of these men had also been counted at Argonne, Harwell, and the University of Leeds. The results from these laboratories were in good agreement with that from Los Alamos. In addition, Anderson and Langham from Los Alamos recently reported [Science 130 713 (1959)] a correlation between the amount of potassium per unit of body weight and the age of the subject. Our data indicate a very similar correlation but with about 15% lower potassium values.

A subject was examined who had acquired a large body burden of plutonium in an accident over three years ago. The 60 Kev gamma rays from Am^{241}, a daughter of Pu^{241}, were detected with the large NaI crystal placed over the lungs and over the liver (these were the only positions used). The counting rate was the same as that that would have been obtained from 1 mμc Am^{241} in the lung cavity. If the biological elimination rate of Am is the same as that of Pu, 1 mμc would be equivalent in this case to approximately 40 mμc of Pu^{239}. X-rays were detected with a thin NaI crystal placed over the chest, but calibrations for this counter have not been completed.

Trouble developed with the linearity adjustment of the large NaI counter system. The nature of the difficulty was not found but an alternate method

of adjustment was found.

Two new standard positions for the large NaI counter were prepared to give less sensitivity if it is ever needed in the examination of a grossly contaminated subject. These positions give sensitivities about 1/4 and 1/8 those of the regular position.

Tests continued on the reproducibility of various parts of the precision long counter. Results have been very good. The position of the effective center and the effect of scattered neutrons were measured for several dif-

[redacted]

counter.

The National Bureau of Standard's secondary standard of neutron emission was borrowed and used to check the calibration of our Ra-Be, Pu-F, and Pu-Be sources and to calibrate our long counters. The relative calibrations appear to be within 1%. The average energy of the neutrons from the Bureau's source (a Ra-gamma-Be source) was measured with paraffin and with polyethylene double moderators to be 0.2 Mev. This is in disagreement with 0.3 Mev from cloud chamber measurements and 0.17 Mev calculated from gamma ray emissions and cross sections.

INSTRUMENTATION

After eight months of continuous satisfactory use in the 329 Building, the scintillation transistorized combined alpha-beta-gamma hand and shoe counter has proved its reliability and will now be used for plant drawings. After completion of the drawings, the instrument will be demonstrated in various buildings throughout the plant.

a demonstration model.

Investigations of the various plant area radiation background conditions are essentially complete for the standard originally proposed points. Special investigations will be undertaken later as required. Only qualitative information is being obtained and all information is chart recorded. The information obtained at each location will be distributed after it is compiled and recorded.

Some experimental circuits have been completed for a scintillation detector and chopper-transistor circuit for a portable, battery-operated, beta-gamma dose-rate meter. Two experimental prototype units will now be fabricated. They will be the size and general shape of a standard HAPO C-P instrument. Stability of the circuits has proved to be excellent thus far. The same circuitry can be easily incorporated into fixed 110 VAC-operated equipment by merely substituting transistorized power supplies for the batteries. Full scale meter, first range, stable sensitivity can be one mr/hr using a 50 microampere meter. The same unit can easily drive a 10 to 50 millivolt recorder.

A good, stable, two-transistor emitter follower circuit was developed that will easily drive 1,000 feet of coaxial signal cable. The unit has an input impedance of 200 K ohms. Power requirements are only 75 microamperes from a four-volt battery. A miniature mercury cell battery life is thus greater than 2,000 hours.

Experimental work is progressing smoothly on a logarithmic transistorized count-rate meter of compact size. The present circuit exceeds four decades in coverage with errors of less than ±5 percent. Eventual coverage will be five decades from 10 c/m to 10^6 c/m with input requirements of a negative 100 millivolt pulse. The unit will drive a standard 10 to 50 millivolt chart recorder.

Experimental work is progressing on a transistorized compact decade scaling instrument. This will encompass three to four decade scaling units and a register-driving circuit and register. Input pulse requirements will be as stated for the log count-rate meter.

Light pipe and specialized scintillation detector investigations continued during the month. The combination light pipe and detector probe, to be used for measuring approximate beta dose rates in solutions of various single radioisotopes and in various animal organs at Biology, is now fabricated. This completed probe is being evaluated with a four-inch long light pipe with an effective diameter of 0.125 inches. This probe was used to determine the relationship between dose rate and count rate in solutions of Cs^{137}, I^{131}, and Sr^{90}. It was also used to determine the relationship between concentrations and count rate in solutions of Pu^{239}.

Experimental work was started on a two-inch by seven-inch active face area scintillation probe for alpha detecting. Several two-inch by four-inch active-face area alpha scintillation probes are now being fabricated. These probes have no increase in background counts, from the usual one to two c/m, in a Ra gamma field of five r/hr and are insensitive to beta with proper amplifier circuit adjustment. The two-inch by four-inch probe has a uniform geometry for Pu^{239} alpha particle detection of better than 10 percent. The probe housings are to be fabricated of very thin stainless steel for ease of decontamina-

tion. None of the probes are affected by temperature or humidity variations and they are non-microphonic.

An instrument using a thermistor was developed for Biology to determine respiratory measurements of animals. The instrument measures the rate of displacement of air and the volume of air displaced by the animal. It was successfully demonstrated to Biology personnel. The information obtained is chart-recorded. Volume changes as small as 0.03 cubic centimeters were detected using rats. The curve slope indicates the rate of displacement at any time. A final model unit is now being fabricated.

Fabrication was completed on the experimental prototype completely transistorized count-rate meter plus loudspeaker-indicating combined alpha-beta-gamma detecting instrument. The unit is now being tested and debugged. The unit operates from 110 VAC mains and only one scintillation probe is used for alpha-beta-gamma detection. One speaker produces loud "pops" for alpha-caused pulses and the second speaker produces easily discernible 1.0 KC notes for beta-gamma-caused pulses. The count-rate meter indication is selectable for alpha-only readings or alpha-beta-gamma readings combined.

The instruction manual for the Radio Telemetering Network data stations is about one-half completed.

The chassis, steering, and drive mechanism for a small robot was built and the fabrication of an accurate odometer is in progress.

WASHINGTON DESIGNATED PROGRAM

The mass spectrometer for this program has been providing analyses of the samples furnished this month.

Study of the ion optics of the ion source region continued through the use of two dimensional equipotential plots. The plots, thus far, show a weak field in the vicinity of the ionizing filament. The importance of local fields and geometry of the triple filaments on the over-all transmission and focusing properties of this design is under investigation.

The sample sensitivity of this instrument is limited among other things by (1) the transmission of the ion source, and (2) the intensity of impurity ion peaks in the mass region of analysis. It is probable from the variation in sample sensitivity observed for different loadings of the same quantity of sample material and from preliminary analyses of the source ion optics that sample filament geometry is an important factor affecting the source transmission. Tungsten ribbon which has been used as the sample filament material is difficult to form into the required geometrical shape and tends to warp badly when heated. Sample sensitivity limiting impurity peaks which have been observed at masses 234 and 236 are due to $(K_6^{39})^+$ and $(K_5^{39}\ K^{41})^+$ ions originating from a potassium impurity inherent in tungsten. A notable improvement in the geometric stability of the sample filaments and in the elimination of potassium as a troublesome impurity has been achieved by the substitution of rhenium for tungsten as the sample filament material.

CUSTOMER WORK

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	84.3
24-Hour General	62	81.1
Special	115	89.6

Both average temperature and total precipitation were near normal. There were no important extremes.

Instrumentation

Fabrication was completed in the 328 Building Electronics Shop on eight, latest design, plug-in transistor amplifiers. Fabrication also was completed on 15 additional amplifiers and 15 transistor count-rate circuits for use in plant portable instruments. All 38 units worked satisfactorily. This amplifier and count-rate circuit has been standardized and will be used in many varied applications.

Fabrication work continued on 12 scintillation gamma criticality alarming units. These operate from 110 VAC mains and will be installed in various 300 Area buildings.

Fabrication continued on three G-M tube detector, transistorized circuit alarm monitors for Redox. Alarm levels of 0.1 to 5.0 mr/hr will be available.

Fabrication continued on a prototype, transistorized count-rate meter plus loudspeaker, alpha-only, 110 VAC-operated monitor which can be used with either a scintillation probe or an air-proportional alpha probe as desired by the operator. The unit will fit directly, as a replacement, in the plant "Cart-Poppy" vehicle.

Two new scintillation neutron detecting probes were assembled and tested for use with the portable combined scintillation and BF_3 transistorized slow-fast neutron meters. These have proved to be excellent in field tests. The new scintillation probes are about one-half inch smaller in diameter than were the original probes.

Advice was rendered concerning the conversion, as previously demonstrated, of existing mica-window G-M-tube lead-pig counters to a scintillation detector at 100-D Area.

Advice was rendered and circuit diagrams given to the Radiation Protection Operation concerning the use of the scintillation logarithmic area monitors for use at various plant sites in the 614 Building. It is proposed to fabricate some 10 to 15 self-contained and recording units. These will be similar to the ones proposed for the 105-N Building except the three decades will extend from one mr/hr to one r/hr.

Funds were received from the Plant Laundry Operation to design and fabricate a prototype conveyor system for the proposed laundry monitor. This system can eventually be used to automatically monitor alpha, beta, and gamma contamination on all plant coveralls and lab coats in use.

A requested estimate of time and material costs for the development of a digital wind recording instrument was compiled to be forwarded to the Army Corps of Engineers, Walla Walla.

Acceptance tests were completed on seven new C-P instruments. Approximately 65 new units will be purchased later.

Field tests and demonstrations continued on the scintillation, transistorized neutron instruments, on the combined portable alpha-beta-gamma instruments, and on the loudspeaker-meter G-M instruments.

Analog Computer

The stirred chemical dissolver study was completed. The results compared favorably to expected values. A report is in progress and will be issued next month.

The Goodyear (GEDA) analog computer was moved from the 326 Building to the new permanent location in Room 6 of the 3707-C Building. The analog computer facility also has a Litton Digital Differential Analyzer (DDA) and a ten-amplifier Donner computer, both of which are available for use in the 3707-C Building by anyone who so desires. A Berkeley EASE electronic analog computer is scheduled to be shipped from the factory late in November for installation in the analog computer facility. The addition of the EASE will approximately double the capacity of the facility. The new computer is expected to be in routine operation in January.

Planning was started this month on replacing the troublesome lead connections in the GEDA patchbay. It is planned to have a complete replacement of the present contacts with ones of sturdier design and reliability. This modification should improve the computer utilization considerably.

An electronic transport lag simulator is being designed based on information obtained from Boeing Airplane Company, and utilizing the principle of time domain synthesis.

Optics

Internal Diameter Optical Micrometer - Detailed design drawings have been prepared for an optical device which will be used at 105-C Fuel Examination Facilities for measuring the internal diameters of irradiated fuel elements.

Scratch Depth Illuminator - Design drawings are being prepared for components which will adapt the 105-C underwater microscope into a scratch depth measuring microscope. With this unit it will be possible to measure and observe the depth contours of pits and scratches in the surface of irradiated fuel elements.

Infrared Radiation Ratio Pyrometer - Fabrication of the mechanical components of the radiation pyrometer is 90 percent complete. Electronic and optical components have all been ordered and many have been received. It is expected that the unit can be installed on the metallograph in 326 Building early in December.

Cave Periscope for Purex - At the request of D. A. Snyder a periscope has been designed which provides a true color view of the interior of a high level cave in the Purex sample gallery. The periscope gives a field of view of over 30 degrees at about 1X magnification.

Paul F. Gast

Manager
PHYSICS AND INSTRUMENT RESEARCH
AND DEVELOPMENT
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
George Winslow	10/13	Industrial Physics and Electronics Co. Lake City, Utah	Discuss instrumentation.	GE Driver	No	300: 329
J. H. Kendron	10/13	G-E Aircraft Nuclear Propulsion Dept. Idaho Falls, Idaho	Discuss instrumentation.	GE Driver	No	300: 329
Charles Preskitt	10/19-20	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss Gas Cooled Reactor Program Physics work.	RE Heineman PF Nichols	No	300: 326 305-B
E. R. Wagner	10/19-21	Allis Chalmers Washington, D. C.				
J. L. Crandall E. J. Hennelly	10/21-22	Savannah River Lab. Aiken, S. C.	Exchange information on physics programs.	JE Faulkner	Yes	300: 326 303 105-KE 105-DR
L. M. Bollinger	10/27-29	Argonne Nat'l Lab. Chicago, Ill.	Attend Neutron Cross Section Advisory Group Meeting and tour Nuclear Physics Research Facilities.	BR Leonard JE Faulkner	Yes	300: 326 305-B 105-KE
T. W. Bonner		Rice Institute Houston, Texas				
L. Cranberg		Los Alamos Scien. Lab. Los Alamos, N. Mex.				
H. Goldstein		Nuclear Dev. Ass'n White Plains, N. Y.				
J. A. Harvey J. L. Fowler		Oak Ridge Nat'l Lab. Oak Ridge, Tenn.				
J. M. Peterson		Univ. of California Livermore, Calif.				
George Rogosa		AEC-Div. of Produc. Washington, D. C.				" and 700
R. G. Fluharty	10/27-30	Phillips Petroleum Idaho Falls, Idaho	" " " and discuss neutron cross section measurements.	BR Leonard JE Faulkner	Yes	300: 326 305-B 105-KE 105-DR
Jas. Rainwater		Columbia University New York, N. Y.				

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
I. Halpern	10/29	Univ. of Washington Seattle, Wash.	Present a talk to NCSAG Meeting and visit Van de Graaff.	BR Leonard JE Faulkner	No	300: 3746-B 700
George Kolstad	10/28-29	AEC-Div. of Produc. Washington, D. C.	Attend NCSAG Meeting.	BR Leonard	No	700

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
H. V. Larson	10/1-2	Columbia University New York, N. Y.	Learn technical details of construction and calibration of tissue equivalent chambers.	H. H. Rossi	Yes
	10/5-6	Oak Ridge National Lab. Oak Ridge, Tenn.	Discuss ORNL neutron dosimetry program.	John Auxier	Yes
	10/8-9	Los Alamos Scientific Lab. Los Alamos, N. Mex.	Discuss LASL neutron dosimetry program.	Joe Sayeg	Yes
D. G. Foster	10/1-3	Los Alamos Scientific Lab. Los Alamos, N. Mex.	Attend Neutron Capture Reactions Conference.	L. Cranberg	Yes
C. L. Brown	9/21-10/5	Oak Ridge National Lab. Oak Ridge, Tenn.	Attend Nuclear Safety Course.	Hugh Henry	No
R. A. Harvey	10/6-7	G-E Engineering Computer Users' Symposium Syracuse, N. Y.	Attend symposium.	--	No
	10/8	Nat'l Bur. of Standards Washington, D. C.	Attend IRE Committee Meeting, Nuclear Techniques.	--	No
R. S. Paul	10/15-16	G-E Aircraft Nuclear Propulsion Dept. Evendale, Ohio	Attend committee meeting.	J. D. Simpson	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. E. Faulkner	10/19-20	Washington State Univ. Pullman, Washington	Attend Nuclear Reactor Symposium.	H. W. Dodgen	No
B. R. Leonard	10/19-21	Argonne National Lab. Chicago, Ill.	Present invited paper to Conference on Breeding in Reactors.	David Okrent	Yes
D. S. Selengut	10/19	Washington State Univ. Pullman, Wash.	Talk at dedication of Research Reactor.	E. L. Wagner	No
A. L. Ruiz	10/26	General Eng'g Lab. Schenectady, N. Y.	Attend Meeting of Control Systems Steering Group.	H. Chestnut	No
	10/27-29	" "	Attend Symposium on Computers and Data Processing.	H. Chestnut	No
D. P. Brown	10/26-27	Oak Ridge National Lab. Oak Ridge, Tenn.	Radiological Instrumentation Discussions.	D. M. Papke J. A. Harter	Yes
	10/28-29	Savannah River Lab. Aiken. S. C.	Discuss instrumentation.	John Wilson	Yes
	10/30	Westinghouse Bettis Plant Pittsburgh, Pa.	Discuss instrumentation.	Floyd Herr	Yes
W. C. Roesch	10/27	AEC Headquarters Germantown, Md.	Project Tutor.	Gen. A. D. Starbird	Yes
P. F. Gast	10/31-11/2	Atomic Products Division Business Review Greenwich, Conn.	Participate in APD Business Review.	L. R. Fink	Yes
	11/4-6	Washington, D. C.	Attend American Nuclear Society Meeting.	--	No
D. S. Selengut	10/31	Knolls Atomic Power Lab. Schenectady, N. Y.	Employment Interview.	R. Ehrlich	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. S. Selengut	11/2-3	Aircraft Nuclear Propulsion Dept. Cincinnati, Ohio	Consulting.	John Krase	Yes
	11/4-6	Washington, D. C.	Attend American Nuclear Society Meeting.	--	No

Chemical Research and Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATIONS PROCESSES

Decontamination of Reactor Components

The corrosion of carbon steel when coupled to 304-L stainless steel, to Inconel, or to zirconium and immersed in various decontaminating solutions was studied. Coupled specimens were rotated in the cleaning solutions to simulate flow of these solutions through a loop. In citrate and bisulfate solutions, corrosion of carbon steel was faster by factors of two to three when coupled to these metals than when uncoupled. Coupling to Inconel produced the greatest, 304-L an intermediate, and zirconium the least increase in corrosion rate. Coupling produced no increase in corrosion rates for samples exposed to oxalic acid solutions. The ratio of the area of cathodic material to that of the anodic material in couples has a large effect on corrosion rates determined in some decontaminating agents and must, therefore, be considered in all corrosion tests.

Neither heating for two hours at 125 C nor adding 0.01 M $KMnO_4$ reduced the effectiveness of corrosion inhibitors present in proprietary Wyandotte bisulfate cleaners. Carbon steel corrosion rates in locally prepared bisulfate cleaners having thiourea or Rodine 81 as inhibitors were satisfactory at 60 C, but prohibitively high at 90 C. Iron(II) and iron(III), especially the latter, increase carbon steel corrosion rates markedly when present in Wyandotte bisulfate cleaners.

Decreasing the temperature from 60 to 25 C in the second step of a caustic permanganate-Wyandotte 75 cleaning cycle reduced decontamination factors on stainless steel about seven but did not affect carbon steel decontamination. These results are similar to those obtained previously with the APACE process when the temperature was reduced from 90 to 60 C.

Uranium Oxidation and Fission Product Volatilization

Fission product release from uranium irradiated to low level and heated in an inert atmosphere was further investigated. Results are incomplete but are expected to yield information on the mechanism of fission product release as well as yielding more data on the total amounts released.

Equipment is being readied for a meltdown test on a "cold" full scale aluminum clad Hanford fuel element held in a Zircaloy tube. The purpose of test will be to observe the mode of meltdown and to determine the intermetallic reaction products.

HW-60689, "Release of Fission Products from Uranium Heated In Air," by R. K. Hilliard, was issued. The rough draft on the release of fission products in steam atmospheres was prepared.

The facility for high exposure uranium experiments neared completion. Damage to purchased components in transit caused some delay. Equipment to dissolve the highly irradiated specimens and to sample the resulting solution was designed.

Effluent Decontamination

Research was initiated to obtain data that will assist with design of waste disposal processes for the NPR reactor. Initial laboratory studies will be directed toward the evaluation of decontamination with soils, such as would be utilized with crib disposal. Soil reactions between strontium, ruthenium, iron, and cobalt isotopes in typical decontaminating solutions will be studied first.

Analytical Services

Blood and urine Na^{24} was measured from its 2.76 Mev photo-peak by gamma spectrophotometry.

Carrier-free Te-I^{132} was prepared for multichannel analyzer calibration by modifying a USNRL DL-TR-312 method. After Dowex-1 adsorption of Te, it was eluted with dilute hydrochloric acid, adsorbed from 2 N HCl by Dowex-50, and finally eluted with dilute nitric acid. Having Te in the nitric acid system avoided volatilizing (losing) Te during calibration.

Sensitivity of impurity determinations on helium gas has been reduced to the ppm range. Impurities were concentrated by trapping at liquid nitrogen temperature at the 100-DR Gas Maritime Loop. The charcoal trap was held at -195 C during delivery to the 325 Building for gas chromatographic analysis. Impurities included nitrogen, oxygen, carbon monoxide, and carbon dioxide. A Beckman Two-Column Valve permitted using a single sample. After using a molecular sieve column for most impurities, CO_2 was subsequently determined by switching to a silica gel column.

Beginning at month end, regular analysis of P^{32} concentrations in farm produce was begun. Ashed samples are being dissolved in nitric acid and phosphorous is being separated as magnesium ammonium phosphate for beta counting. Yield has been 96-98 per cent.

Sulfur and chlorine were found by X-ray spectrometry in a 10 mg quantity of material found in a cross-header at 100-D reactor. Zinc and magnesium each represented about 0.5 per cent of the material. Emission spectrography also showed traces of calcium, copper, and iron.

A significant number of physical properties - viscosity, density, thermal conductivity, vapor pressure, freezing point, boiling point, and heat capacity - have been determined for numerous decontaminating solutions of New Production Reactor interest.

Ionium and Protactinium. Special method development and application were continued. Essentially pure Pa^{231} activity was obtained. Protactinium-233 tracer experiments indicated ~ 90 per cent recovery can be expected in uncomplicated chemical systems. A solvent extraction method and an ion exchange method were employed to separate chemical thorium from samples. Thorium (chemical) spike recovery varied widely

with sample type. Sulfate was found seriously to affect the normal resin absorption behavior of thorium. Along with thorium analysis alpha disintegration rate of purified thorium fractions is being used to estimate the Th^{230}/Th^{232} isotopic ratio. Refined measurements await mass spectrometer calibration.

SEPARATIONS PROCESSES

Dissolution of Nickel Coating

As noted previously, nickel coatings deposited on aluminum by the Kanigen Process convert rapidly (five minutes or less) to an equilibrium form when heated to 300 C or above. Dissolution of coating in the equilibrated form occurs much more rapidly in dilute nitric acid than does the "as deposited" form. A survey of equilibrated coating dissolution rate vs. nitric acid concentration in the range 0-1 M was made. Calculations based on these rate data, similar rate data for the dissolution of ingot uranium, and on the surface area of uranium normally present in a dissolver heel indicate that a 0.5 mil coating could be removed in one hour in boiling, dilute (< 0.2 M) nitric acid with a loss of uranium to the solution of less than 0.1 per cent of the heel.

Processing in Hot Semiworks

Miniature mixer-settler tests of a potential flowsheet for recovery and purification of plutonium-238 and neptunium-237 by TBP solvent extraction in Hot Semiworks equipment indicated excellent recovery of both materials and adequate fission product decontamination. The flowsheet version tested in these runs assumes dissolution of the irradiated NpO_2-Al targets and adjustment to a feed composition of 1 M HNO_3, 0.75 M $Al(NO_3)_3$. This feed (at a relative flow of 100) is contacted with 30 per cent TBP containing 0.01 M nitrous acid at a relative flow of 50 and at a temperature of 40 C. Under these conditions of low acidity and high nitrous acid the neptunium is converted largely to inextractable neptunium(V) and remains in the aqueous waste. Plutonium is efficiently extracted, however. Further partition of plutonium and neptunium is accomplished in the scrub section where the organic stream (at a relative flow of 50) is contacted with a low acid (0.5 M HNO_3) scrub at a relative flow of 25. The plutonium is stripped from the organic in a second column in which the organic extract is contacted with 0.3 M HNO_3, 0.015 M ferrous sulfamate, 0.02 M sulfamic acid at a relative flow of 25.

In a miniature mixer-settler run using neptunium-237, plutonium-239, and ca. one per cent level fission products, the plutonium loss to the aqueous waste in the first column was only 0.02 per cent while the loss to the organic waste in the second column was only 0.004 per cent. Decontamination factors were $>7.4 \times 10^3$ for Zr-Nb, 55 for Pu, 370 for Np, and 120 for Pa-233, (the daughter of Np-237). These decontamination factors are considered quite adequate. The low ruthenium decontamination is to be expected for these conditions of low acidity and the necessary additional ruthenium decontamination should be readily obtained in the final (spin) plutonium cycle where the extraction column will be operated at conditions of high acidity.

[redacted]

In this flowsheet, the neptunium-bearing aqueous waste from the first column is acidified and the neptunium recovered and partially decontaminated by a conventional neptunium(IV) TBP extraction flowsheet very similar to that used for the past several months to recover neptunium from the Purex plant. A miniature mixer-settler test of this flowsheet with the waste from the above described run (adjusted to 4 M HNO_3, 0.44 M $Al(NO_3)_3$) gave very low neptunium waste losses of 0.1 per cent to the extraction column aqueous waste and 0.06 per cent to the strip column organic waste. Decontamination factors were 1.2×10^3 for Zr-Nb, >300 for ruthenium, and >5000 for plutonium. Since the neptunium product from this operation will be processed through an anion exchange cycle for final purification, these decontaminations should be more than adequate.

It is believed that this flowsheet, which is compatible with existing or slightly modified Hot Semiworks equipment, minimizes the possibility of difficulties arising from processing the highly alpha-active plutonium-238. The magnitude of effects produced by the high alpha activity of plutonium-238 in this and other potential solvent extraction flowsheets will be evaluated in experimental studies planned for the near future and employing three grams of plutonium-238 recently obtained from the Savannah River Laboratory.

Analytical Services

Stack gas measurements of I^{131} and $Ru^{103-106}$ were made by gamma spectrometry and compared favorably with the routine beta counting results. Use of gamma techniques eliminates four distillations. A one hour reduction in analysis time has, thus, resulted from replacing daily beta counting with gamma energy analysis plus a weekly total beta analysis.

WASTE TREATMENT

Semiworks Waste Calciner Prototype

The fluid-bed calciner operations were initiated using simulated ICPP waste (2.0 M $Al(NO_3)_3$, 1.0 M HNO_3, 0.15 M $NaNO_3$) as feed and ICPP waste semiworks produced calcine as starting bed material. Four runs, each 4.3 to 6.3 hours' duration, have been completed. Bed temperature in all runs was 500 C; feed rates were 10 to 20 liters/hour. Operation of the calciner has been relatively smooth and trouble-free.

Superficial fluidizing air velocities of 0.5 to 1.5 ft/sec have been tried. Minimum fluidizing air velocity is about 0.3 ft/sec and velocities of 0.5 to 1.0 ft/sec have provided good fluidization. This compares to about 1.5 ft/sec requirements for adequate fluidization in 6-inch-diameter calciners at other sites. Velocities above about 1.0 ft/sec result in excessive slugging at the bed height tested (about 28 inches, expanded). As a result of these lower-than-expected fluidization air rate requirements, modifications in the fluidizing gas design are in progress and modifications in the scalping cyclone design are contemplated.

In the runs thus far fines from the scalping cyclone (about 10 per cent by weight of the [redacted]-overflow "product") have not been returned to the bed. This condition

[redacted]

requires that seed material be formed within the bed by either attrition or atomization or both. Despite the lack of fines returned to the bed, particle size in the bed can be reduced to undesirable sizes by atomizing air to feed volume ratios of about 360. Particle size build-up (including excessive agglomeration) occurs at atomizing air to feed ratios of about 250.

Untapped "product bulk densities have ranged from 0.67 to 0.80 g/cc, with the density generally increasing with decreasing atomizing air rates. The untapped density of the fines removed by the scalping cyclone has ranged from 0.2 to 0.45 g/cc.

ANL Fluid-Bed Calcination Studies

Exploratory studies at ANL on fluid-bed calcination of simulated Purex 'formaldehyde-killed' and threefold concentrated acid waste have been concluded. A summary report is being written by ANL personnel.

Studies reported this month consisted of two 6-hour runs using a 100 : 1 dilution of ICCP waste as radioactive tracer in the feed. Both runs were at a bed temperature of 500 C and a feed rate of 4.8 l/hr. One run was made with 120 g/l sugar in the feed while the other contained no additive.

During the run without sugar the Venturi scrubber and adsorber were by-passed. Radiation from half-hour samples of filter deposits from the total flow of gas was measured at 150 mr/hr by portable counting instruments. The run with sugar was made with only the adsorber by-passed and negligible count was detected on the sample filters. The samples in both cases were collected just upstream from the "AEC" filter. Both runs were smooth and uneventful with apparent satisfactory particle size control and negligible particle agglomerate formation.

It may be generally concluded from the ANL studies that fluid-bed calcination of Purex waste is entirely feasible. The major problems encountered (agglomerate formation and solids build-up on the nozzles) have been partially overcome and appear solvable.

Waste Solidification

Further experiments have been completed on the calcination of Redox waste and on the conversion of this waste to a glassy solid. The addition of sodium (Na:Al = 2:1) and phosphate (to form orthophosphates of the cations) was found to give a glass which melted at about 900 C and had a solubility of only 0.2 weight per cent (the lowest of any of the glasses formed from Redox waste).

Special Geological Studies

Preliminary appraisal of the Washington State University seismic geophysical tests made October 13-16 disclosed that most of the geologic features of concern and bearing on Hanford waste disposal can be located by seismic methods. Three sites were tested, (1) adjacent to well 699-1-18, about two miles south of the Hanford Wye [redacted]tion of Routes 2S and 4S, (2) adjacent to well 699-24-33, about three

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miles southeast of the southeast corner of 200 East Area, and (3) south of well 699-24-33, about three miles east of 200 East Area. The latter two sites thus lie above that part of the 200 East Area ground water mound where traces of ground water contaminants have recently appeared.

The surface of the Ringold formation was readily located by refraction methods in two of the three sites where the topmost Ringold beds are compact, locally cemented gravels. At the third site, near well 699-24-33, the topmost beds are unconsolidated silts, sands and gravels of the lower portion of the Ringold formation; the Ringold surface was here less readily distinguishable.

The river channels incised into the top of the Ringold formation are apparently readily traceable. Generally those channels lie within the compact Ringold gravels. The ground water table was evidently also detected though with considerable uncertainty.

Reflection shooting at the first two sites was necessary to detect the basalt surface. Results were excellent. A shot in the bottom of well 699-1-18 also provided reflections from two horizons within the upper part of the basalt series, and one reflection evidently from greater than 10,000 feet in depth.

Detailed evaluation of the results is underway by the WSU geophysicists.

Observation Wells

The test well sampling and analytical program was reviewed and proposed revisions circulated to interested parties for comments. Revision of the present program has been undertaken with the objective of continuing the ground water monitoring program at its present high standard while at the same time realizing an appreciable economic savings.

Attempts to determine the source of contamination appearing in three wells, two to five miles southeast of 200 East Area were unsuccessful. The two likely sources are: waste from the 216-BY cribsite which, in 1956, had been detected in this area, and Purex waste from the 216-A5 and/or 216-A8 cribs which may be moving in this direction due to decreased disposal of cooling water to the B swamp over the past year.

Disposal to Ground

Laboratory tests are underway to confirm previous estimates of the expected life of the 216-S-7 crib. A recently collected aliquot of Redox, caustic-neutralized D-2 waste is the influent to three laboratory soil columns. The columns contain composited soil samples from a well drilled near the crib. At a flow rate of 0.35 gal/ft^2/hr these columns have received about 130 column volumes of solution. Partial analytical data indicate no detectable radiostrontium breakthrough after 75 column volumes nor detectable radiocesium breakthrough after 125 column volumes of throughput. These data tend to confirm the long life estimated for this crib previously.

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TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Fission Product Isolation and Packaging Prototype

The hydrolyzer modifications discussed in last month's report were completed. Initial testing of the modified unit has indicated that the unit can be operated to avoid producing the "mastic" compound encountered in previous runs. Dried powder has been satisfactorily discharged from the unit. However, significant amounts of product are carried out with the reactor off-gases. Currently, studies are in progress to develop operating conditions which will minimize entrainment from the unit. Studies are also planned to determine whether cesium can be volatilized at the extremes of operating conditions which may exist in the hydrolyzer.

The modified hydrolyzer was also tested to determine whether it could be used as a replacement for the cesium chloride crystal dryer in which caking difficulties have been encountered. Using sodium chloride brine as a stand-in for cesium chloride, the unit successfully produced fine free flowing salt at anticipated production rates.

Multicurie Cell Investigations

A batch experiment was run to test operability of the Oak Ridge di-(2-ethylhexyl) phosphoric acid (D2EHPA) strontium recovery process with actual Purex 1WW. The principal object of the experiment was to determine ability to extract strontium from the plant solution, coalescence behavior of the aqueous-organic dispersion, and the extent of extraction of the other fission product elements. One volume of 1WW (actually supernate from a high-acid cerium sulfate strike) was mixed with one volume each of 1 M tartaric acid and 5.8 M sodium hydroxide to yield a nearly neutral solution which was a clear reddish-brown color. This solution was contacted with an equal volume of 0.3 M D2EHPA, 0.15 M TBP, Amsco solvent. After stirring for about one minute, the phases required about 15 minutes for complete separation. No solids were detected in either phase, even after standing overnight. Ninety-five per cent of the strontium was extracted into the organic phase along with two-thirds, or more, of the cerium, yttrium, and rare earths, and eleven per cent of the cesium-barium. Extraction of ruthenium and zirconium-niobium was negligible. From these results it appears that D2EHPA recovery of strontium from tartrate stabilized 1WW is probably a practical process but that either prior or subsequent separation from rare earths will be required.

Cerium-Promethium Recovery

The laboratory development of the peroxide-acetate process for the separation of cerium from the trivalent rare earths was completed. This was followed by a successful full-scale Purex plant test which fully corroborated the results of the laboratory experiments and demonstrated that this process can be used (in conjunction with the cerium double-sulfate process) for the recovery of either a cerium or a promethium concentrate in the Purex plant.

The work is described in detail in an invention report, HW-62547, and a formal summary report, HW-62505, The Separation of Cerium from the Trivalent Rare Earths Using Hydrogen Peroxide and Sodium Acetate, By E. J. Wheelwright and N. C. Howard.

Strontium Recovery

The path of strontium in the rare earth double-sulfate process has been under intensive study in an effort to devise a strontium recovery scheme which will not require precipitation and centrifugation of the iron which is present in such large amounts in 1WW. It was found that the fraction of the strontium that co-precipitates with the rare earths can be greatly increased by increasing the sulfate concentration to a value higher than is required for rare earth recovery alone. Strontium recoveries of 75 to 80 per cent were obtained by butting the sulfate content of synthetic 1WW to 3 M with sodium sulfate, partially neutralizing to pH 0, and digesting for two hours at 80 to 100 C. Without partial neutralization, but with the same sulfate concentration, strontium recovery was only about 45 per cent. The higher sulfate concentration is not necessary for, and is not deleterious to, good cerium-rare earth recovery. Substitution of other soluble sulfates for sodium sulfate was also tried. Lithium sulfate gave slightly higher strontium recovery than sodium sulfate, but ammonium sulfate, aluminum sulfate, and potassium sulfate all gave much inferior recovery.

On the basis of the above preliminary results, it is believed that a workable acid-side strontium process can be developed.

Neptunium Chemistry

A series of summary reports and journal articles are being prepared summarizing the work that has been done on the species, spectrophotometry, and solvent extraction of neptunium and uranium species.

Analytical Services

Yields of neptunium, occurring with high salt content and a ZrNb preponderance, suggested a need for sharper separation chemistry. Thirty v/o TLA extracted 99 per cent of the Np from 3-5 M HNO_3, but water stripping of the Np +4 removed only 50 per cent, (compared to 95 per cent from 10 v/o TLA). A better stripping method is being sought.

Greater uniformity in the elution rate and purity of Pm^{147}, separated by chromatography, was accomplished by preliminary batch adsorption of the separated R.E. +Y fraction by a small fraction of Dowex-50, X-4, 200-400 mesh resin. It was water-washed and added to the resin column for chromatographic separation by 1M lactic acid at pH of 3.35. Promethium fractions were more than 99 per cent pure. Duplicate analyses of six samples showed differences ranging from 0.4 to 29 per cent with an average of 13.4 per cent.

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ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Alpha Energy Analysis

A report entitled, "The Operation and Maintenance of an Alpha Energy Analyzing System," (HW-60974), has been issued which describes the Hanford alpha energy analyzer and the present status of alpha energy analysis technique. The key components, of the Hanford instrument, the chamber, power supply, and preamplifier, were designed and developed to provide high stability and reliability with a minimum of maintenance. Although a resolution of about 30 kev is possible with a gridded ion chamber, a value in the range of 40 to 60 kev, which is entirely adequate for most applications, is normal for the Hanford instrument. The background counting rate of the chamber is less than 0.1 count per minute per 100 kev energy interval and the energy drift rate of the entire system (including multichannel analyzer) is normally less than 20 kev per 24 hours.

Alpha energy analysis is used at Hanford principally for analysis of isotopic mixtures of thorium, uranium, plutonium, americium, and curium.

Analysis of Contents of 55 Gallon Drum. Another oil drum painted and marked as containing radioactive wastes was found by the AEC. Analysis of the contents by this laboratory confirmed the suspicion that it was a hoax. Alpha, beta, and gamma activities were below detection limits.

Preparation of Standard Radioisotope Sources. The business has increased to a 24 hour per week effort. This month the following were prepared:

No.	Isotope	Activity	Mount	Customer
45	Pu^{239}	up to 0.003 μc	sxs dishes	Regional Monitoring
3	RaDEF	0.003 μc	filterpaper	Regional Monitoring
3 prs.	Pu^{239}	0.001 μc	filterpaper	Regional Monitoring
3	I^{131}	up to 0.02 μc	active charcoal	Radiological Development
100	Cs^{137}	5×10^{-3}	solution	Instrument Research and Development
25	I^{131}		solution	Instrument Research and Development
4	Pu^{239}	0.25 μc	solution	Instrument Research and Development

1WW nickel was determined from the brown Ni dimethylglyoxime's transmittance at 455 m μ. Sample size was restricted to 0-10 μg of nickel to reduce radiation hazard.

The thermal ionization mass spectrometer indicated the precision of U^{235} measurement in natural uranium to be ± 0.015 to 0.055 per cent, absolute. Actual U^{235} content was found to be 0.695 to 0.702 per cent, compared to the "accepted" value of 0.7115.

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EQUIPMENT AND MATERIALS

Corrosion of Potential Valve Surface Materials in 100 Per Cent UNH

Corrosion rates for a series of metallic materials in 100 per cent UNH at 120 C were determined to establish whether the materials could be used as valve faces in this environment. Elgilloy, A-55 titanium, 17-4 Ph, 17-7 Ph, and 430 stainless steels all corroded at less than 0.5 mils/mo. Corrosion rates for Hastelloy C, 6060-T6 aluminum, and cemented tungsten carbide were about 1, 70, and 80 mils/mo, respectively. Although having a satisfactory corrosion rate, A-55 titanium probably could not be used for this service unless treated to reduce its galling tendencies.

Tank Materials for Interim Storage of Purex 1WW

Corrosion studies pertinent to interim storage of Purex 1WW were continued. Candidate materials of construction were exposed to boiling simulated Purex 1WW in which the sulfuric acid concentration was varied from 0.0 to 1.6 M. Zirconium corroded at rates less than 0.01 mils/mo at all sulfuric acid concentrations. All other materials tested, A-55 titanium, 304-L, 309-L, and 316-L stainless steels, showed some increase in corrosion rate as sulfuric acid concentration increased. Rates for the steels were in the range of 5-15 mils/mo; rates for titanium were from 0.01 to 0.2 mils/mo.

When synthetic Purex 1WW was concentrated to ca. 30 per cent of its original volume, large quantities of solids (50 volume per cent) were formed. Coupons of the above metals were exposed to the slurry at boiling point (total reflux) for about 200 hours. The coupons were placed on the bottom of the test flasks and were completely covered with solids during the run. Weight loss corrosion rates were from one to four mils/mo for the three steels, about 0.3 mils/mo for titanium and 0.01 mil/mo for zirconium. However, pitting attack was apparent for the steels and titanium. Penetration rates from four to eight mils/mo were observed for the steels and two mils/mo for the titanium. When exposed to dried solids from concentrated Purex 1WW at temperatures from 250 to 550 C, the stainless steels corroded at rates increasing from 0.01 to 1.0 mil/mo. No pitting attack was observed. Titanium corroded at less than 0.05 and zirconium at less than 0.01 mil/mo at temperatures up to 450 C; at 550 C both metals showed severe attack amounting to greater than 10 mil/mo penetration.

Several possibilities for storing partially "neutralized" Purex 1WW exist. Three of these were examined from a corrosion standpoint. All involve formaldehyde destruction of nitric acid to zero molar free nitric acid. Further treatment involves (1) none, (2) add caustic to zero molar sulfuric acid, (3) add caustic to zero molar sulfuric acid and concentrate 60 per cent. In boiling solutions simulating these three cases, zirconium and titanium corroded at rates less than 0.01 mil/mo. Stainless steels 304-L and 309-L corroded at rates of 0.2 to 0.5 mil/mo under case (1) and (3) conditions and 0.05 mil/mo under case (2) conditions.

Corrosion rates in simulated Purex 1WW containing no sulfate were determined at nitric acid concentrations ranging from 0.0 to 6 M. Ferric nitrate, instead of ferric sulfate, was used in preparing the solutions. Both titanium and zirconium

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corroded at rates less than 0.01 mil/mo in all solutions. Corrosion rates for 304-L and 309-L increased from about 1.0 to about 10 mil/mo as nitric acid concentration increased from 0.0 to 6 M.

234-5 Powder Transfer Cyclone

Testing of a 2-1/2-inch-diameter "reverse" cyclone powder transfer device continued (previously reported in August). The latest cyclone was made of Teflon(1) and employed a 7/64-inch-diameter tangential inlet and a 1/2-inch-diameter outlet tube. Twenty-four, one-kilogram batches of cerium fluoride powder were transferred successfully to a receiver using dry air as a fluidizing medium. Inspection of the cyclone after the transfer shows that a thin (approximately 1/16-inch) hard scale forms on the cyclone walls. This scale does not impair operation, nor does it continue to build up on continued use of the cyclone. Pluggage of the fluidizing air inlet does not occur if the powder is fed at a controlled rate. Using a star valve feeder, a powder transfer rate of 300 g/min was used in the tests. Air requirements were 4 scfm.

234-5 Dust Cyclone

HW-62480, "Testing of Miniature Cyclones for Possible 234-5 Dust Separation," (Secret) was issued.

Magnetic Pulser Study

An exploratory model of a magnetic pulser was assembled and successfully operated. The device consisted of an electromagnet on each end of a short stainless steel cylinder containing a free piston of stainless steel jacketed iron. The piston is four inches in diameter and the clearance between the piston and cylinder is approximately 10 mils. The stroke is 0.209-inch, thus, the displacement is 2.6 cubic inches per stroke. The actual displacement in a 3/8-inch-diameter tube connected to the piston was 0.4 cubic inch per stroke.

Bearing Testing

At the request of the Coolants Systems Development Operation, Graphitar 14 was evaluated as a material for reactor coolant canned motor pump bearings. The tests indicated that the Graphitar is attacked by caustic-permanganate decontaminating solutions which may be used in the test loop. The evaluation report recommends pile graphite as a suitable bearing material for use with the decontaminating solutions tested.

Non-Metallic Materials Testing

A rubber diaphragm from a Hammel-Dahl valve was irradiated and installed in a valve for testing. The test consisted of cyclic normal operation of the valve with psig air. After 2.17×10^8 r total dose, the diaphragm ruptured on the tenth operation of the valve.

(1) Registered Trade Mark of the duPont Company

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PROCESS CONTROL DEVELOPMENT

C-Column Instrumentation and Programming Studies

The window spacing of the traveling photometer sample cell was increased from 0.0050 to 0.0074 inch to increase the uranium sensitivity of the instrument. Although this would appear to decrease the phase separation characteristics of the instrument, the windows are still sufficiently close to prevent the organic phase from passing through the light beam, except in the form of spherical bubbles. Apparently, as long as the organic phase is in spheres and does not wet the viewing windows, it does not affect the analysis of the continuous aqueous phase. The only effect of the organic bubbles is a slight decrease in both the read out and the standardization values as the light beam is scattered, but the difference between the two readings indicating the uranium concentration of the aqueous phase remains constant.

Troubleshooting of the Data Scanning Programmer was completed this month. Several scans were made with the Programmer using a simple analog of the C-Column instrumentation to determine the time that will elapse during an average scan. About 8.5 minutes will be required per scan of 30 points.

Resin Level Detector

Laboratory tests of the Resin Level detector are 80 per cent complete. Tests were made to determine the change in sonic velocity as a function of acid concentration and temperature of solution in the column. The data indicates a maximum sonic velocity change of approximately five per cent from zero to sixty per cent nitric acid over the temperature range 20 to 60 C. This small error eliminates the necessity of having both the calibrating and measuring crystals in the ion-exchange column.

A remaining development problem is the design of a suitable crystal assembly for the resin level service. Two experimental assemblies were fabricated, but both were subject to "ringing" which made measurements closer than five inches from the crystal impossible. A critically damped crystal assembly will be purchased from Branson Instruments which should minimize the ringing problem.

Contact Alpha Counter Prototype

The prototype contact alpha counter originally designed for use on a 2-inch jumper has been modified for installation in a sample pot. Plans now are to install the detector in the sample pot of the 1BP transfer jumper rather than on the jumper itself. This change is desired to minimize potential leakage that could result from mechanical failure of the detector sealing device. All parts for this prototype have been fabricated.

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NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End Studies

Saw Studies. A power hacksaw employing a "two piece" blade has been selected for inclusion in the mechanical cell of the non-production fuels reprocessing program. The selection was based upon the following major factors: (1) adequate performance demonstrated in cutting "hardware" typical of that encountered in the fuels to be processed at Hanford; (2) low equipment and blade replacement costs; and (3) production of easily handled fines with a relatively low pyrophoric hazard.

Future hacksaw tests will determine the optimum conditions to be used in cutting the "hardware" from the fuels to be processed at Hanford. Blade life will be studied as a function of a number of variables including: (1) blade configuration, (2) "hardware" type, (3) feed rates, and (4) cutting speeds.

Difficulties have been encountered when sawing the unsupported rod section (away from tube sheets) of multirod bundles. Blade breakage has resulted when the cut tubes are free to vibrate and bind the saw blade. A "potting" technique has been investigated as a method of firming up an unclampable bundle so that cutting is possible in the rod section of a fuel element. Studies indicate that after the section to be cut is cast in Plaster-of-Paris (calcium sulphate), it can be easily cut by the hacksaw without noticeable blade damage.

Shear Basin Filtration. Underwater shearing of NPF elements is being investigated to determine the nature and extent of contamination of the basin water with UO_2 particulates produced in the shearing operation. Tests made while shearing swaged UO_2 rods show that 2 per cent of the UO_2 is less than 200 mesh and is readily dispersed and suspended in the basin water. Approximately 0.04 per cent of the UO_2 is finer than three microns and has a very low settling rate.

Clean up tests were made on the basin water using a porous bronze filter and a commercial 3-inch-diameter hydroclone. The filter (one square foot in area, 45 micron pore size) removed essentially all of the UO_2, but plugged quickly due to the high concentration of solids in the basin (approximately four pounds of U collected). The hydroclone was effective in removing only the larger solids (greater than five microns) in the feed and a cloudy overflow discharge resulted. A 1-1/2-inch hydroclone is being constructed for further testing and initial studies will use lead oxide as a stand-in for UO_2.

Shear Studies. Shear studies with a male Vee blade equipped shear have been temporarily discontinued because of design inadequacies of the test shear. Repeated jamming of the shear occurred during two months operation with Vee blades since the shear design permitted minor deflection of the point of the Vee blade as it passed through the rod bundle. Shear redesign, currently in progress, will provide more rigid blade support and better guidance of the moving shear platen.

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Pending fabrication of the redesigned shear, shear studies will include: (1) energy measurements for the high-speed shear using a straight moving blade, (2) comparison of blade life for high-speed and slow-speed shearing.

Feed Preparation

Zirflex Process. Studies on the stability (toward solids formation) of solvent extraction feeds prepared, following a Zirflex decladding, show the desirability of minimizing the amount of decladding solution carried forward into the core dissolver solution. This is particularly true if it is desired to operate the solvent extraction system with feed solutions having pH greater than zero. The maximum pH attainable without solids formation in typical feed solutions containing only 0.05 M total zirconium was between 0-0.3. Higher concentrations of zirconium restrict the maximum attainable pH to even lower values.

Trace concentrations of sodium ion do not affect the dissolution rate of Zircaloy-2 in 4 M NH_4F - 0.5 M NH_4NO_3, but concentrations in excess of 0.1 M reduce the dissolution rate markedly. For concentrations up to 0.1 M, dissolution rates were in excess of 25 mils/hr; for concentrations from 0.15 to 0.50, dissolution rates decreased from 2.9 to 0.25 mil/hr.

Total Dissolution of Zircaloy-2 Clad Fuels. Further studies on total dissolution of Zircaloy-2 clad fuels have sought to define solvent extraction feed compositions stable toward solids formation. The procedure involves Zirflex dissolution of Zircaloy-2 cladding followed by UO_2 core dissolution through addition of nitric acid and aluminum nitrate. Stable feed solutions can be prepared from a Dresden fuel (or any other having comparable Zircaloy-2 to uranium mole ratio) with uranium concentration ca. 0.5 M, free acid concentration ca. 1 M and an aluminum to fluoride mole ratio about one. Higher Al/F mole ratios or lower nitric acid concentrations result in precipitate formation.

Dissolution of U-Mo Alloys. The Piqua Reactor fuel will consist of U-2.75 w/o Mo-0.1 to 0.2 w/o Al alloy cores clad in aluminum. Silicon may be substituted for aluminum in the cores. Studies with U-3 w/o Mo-0.2 w/o Al and U-3 w/o Mo-0.2 w/o Si alloys (prepared at HAPO) show that the nitric acid-iron(III) nitrate core dissolving and feed preparation procedures already established for U-3 w/o Mo alloy apply equally well to cores containing these amounts of aluminum or silicon.

Recirculating Tube Dissolver. Two runs were made to determine the effect of recirculation rate on the dissolution of Zircaloy-2 in Zirflex solutions. Charges of Zircaloy-2 tubing were dissolved in 4 M NH_4F - 0.35 M NH_4NO_3 at recirculation rates of 20 and 65 gal/min, respectively. Approximately 60 per cent of the Zircaloy dissolved in the first hour in each run indicating no apparent difference in dissolution rate. A maximum dissolution rate of 38 mils/hr was attained corresponding to a predicted maximum rate for a batch dissolution of 40 mils/hr.

Recirculation of cold Zirflex solutions at 20 and 65 gal/min was provided by air sparge rates of 14 and 34 scfm, respectively, at lift to submergence ratio of 0.5. Air rates of only 6 and 14 scfm were required to provide the same recirculation rates for the heated solutions during reaction.

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Billets of sintered UO_2 were dissolved from a 15-inch high, 60 per cent void volume, packed bed using an excess of 9 M HNO_3. An average recirculation rate of 35 gal/min was maintained through the bed. The dissolution rate during the run was essentially constant at 210 mils/hr. This was almost identical to the rate predicted from batch data of 205 mils/hr.

The cold nitric acid charge solution (sg 1.3) was recirculated at 20 gal/min by an air rate of 28 scfm at a lift to submergence ratio of 0.4. Only 8 scfm of air was required to recirculate the hot nitric acid - UNH solution (sg 1.35) at 40 gal/min and a lift to submergence ratio of 0.5.

Glass Column Hydraulics Studies. Modification of the glass column to simulate a two-barrel dissolver with a common reservoir was completed. Initial charging of the system was made with non-uniform beds of UO_2 having calculated voids of 25 per cent. Flow could not be readily established with the air sparger geometry employed at the base of the beds. The sparge heads geometry has been modified and the location made adjustable.

Although flow in the tubes could be established with the air sparge heads just above the bed, considerable difficulty was experienced with foaming. The excessive foaming is attributed to oil entrainment in the sparge air and use of plain water as the aqueous phase. Air filters have been installed to permit further study of this problem.

Hydraulic runs are under way using uniform beds of UO_2 pellets. Evaluation of the data is not complete, but the two tubes appear to have no significant effect on one another.

Flooded Tray Dissolver - U-Mo Dissolution. Laboratory studies to determine reasons for the formation of solids in the first cold semiworks U-Mo dissolution pointed to inadequate iron(III) ion for the terminal uranium and nitric acid concentrations attained. Subsequent analytical data have confirmed this. Studies on the re-dissolution of solids formed through use of off-standard procedures in nitric acid-iron(III) nitrate dissolution of U-Mo alloys were made. Under the conditions used, it was necessary to increase the dissolver solution acidity to ca. 4 M (HNO_3) to obtain complete redissolution of solids in a short time (10-15 minutes). It is not known whether this is a minimum acidity for solids redissolution under other conditions.

In the pilot plant the suspension, produced by the dissolution of U-3 w/o Mo alloy to a terminal supernatant composition of 1 M HNO_3, 1 M UNH, 0.07 M Mo and 0.9 M $Fe(NO_3)_3$, was treated in three steps to simulate a typical feed adjustment procedure.

First, the suspension was acidified with nitric acid to dissolve the uranium-molybdenum bearing precipitate. The precipitate disappeared at 2.9 M HNO_3, 0.9 M UNH, 0.07 M Mo and 0.66 M $Fe(NO_3)_3$ although acid addition continued to 4.1 M. The acid concentration was then reduced by concentration from 4.1 to 3.2 M while adding water to maintain constant volume. The condensate volume was two-thirds the initial volume. The solution was then concentrated to boil off acid. Precipitate appeared at concentrations of 2.3 M HNO_3, 2.3 M UNH, 0.18 M Mo and 1.7 $Fe(NO_3)_3$. This precipitate was essentially free of uranium.

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Nine runs were made to determine the behavior of the equipment at near-terminal dissolution cycle conditions. Analytical results and data analysis are incomplete at this writing.

Sulfex Process. Two additional Sulfex pilot runs were completed under noncirculating dissolver conditions. Evaluation of run data is awaiting sample analyses; however, the dissolution of type 347 stainless steel in 4 M H_2SO_4 was accomplished at rates comparable to those with type 304-L stainless steel.

In other runs, there was no evidence of the reaction starting with a charge of 304-L stainless steel in about 2 M H_2SO_4. Examination of the charge revealed a mild surface etching of the stainless steel with a corresponding weight loss of about 5 per cent after an exposure of one hour to the dissolver solution. In about 2.5 M H_2SO_4 the reaction started readily and proceeded uniformly at a rate of 6-8 mils -- slightly less than the rates attained in previously reported runs at acid concentration of about 3.5 to 4.0 M H_2SO_4.

A bench-scale Sulfex run was made using a charge of 304-L stainless steel. The reaction was started in 4.0 M H_2SO_4 with the stainless steel in contact with carbon steel, after which the solution was diluted to 2 M H_2SO_4. The dissolution proceeded uniformly at a rate of 4 to 6 mils/hr. Further study of this technique is planned during future runs in the pilot dissolver.

In previous laboratory-scale studies all samples of UO_2 received have been found to contain small and variable amounts of material (presumably higher oxides) much more readily dissolved by dilute sulfuric acid than is UO_2. This has been attributed to surface oxidation of the UO_2 by air and prompted some concern as to whether it would complicate chemical processing of UO_2 fuels. Indications from a recently completed experimental study are that it probably will not. With UO_2 irradiated to ca. 1500 MWD/T and now cooled ca. ten months, it was found that the rate of conversion to readily soluble oxides on exposure to air at ambient temperature can be adequately expressed by the relation

$$\text{per cent converted} = 0.02\ (\text{days})^{0.45}$$

Thus with this material surface oxidation results in only very normal losses over prolonged periods of storage in air. However, it should be recognized that radiation effects could play a major role in such a reaction and extrapolation of the above data to high exposure, shorter cooled material is dangerous.

Zirflex Process

The rate of attack of UO_2 (irradiated to 1500 MWD/T and cooled ca. ten months) by (boiling 6 M NH_4F, 0.5 M NH_4NO_3) was measured and found to be about two per cent per hour. The penetration rate (mg/min,cm^2) is about the same as was found for unirradiated specimens of sintered and machined UO_2. It should be noted also that the rate of attack of UO_2 is not related to the loss of fissile material to the decladding solution. The latter is determined by the solubility of NH_4UF_5 in the decladding solution and is therefore independent of the rate at which UO_2 is converted to NH_4UF_5. Likewise, speculation as to the significance of a two

per cent per hour rate in relation to a potential 10 to 15 hour decladding cycle is likewise dangerous since earlier studies have shown that the formation of a coating of insoluble NH_4UF_5 on the surface of UO_2 tends to protect it from further attack.

The rate of oxidation of uranium(IV) to the more soluble uranium(VI) in Zirflex solutions exposed to air has been the topic of recent experimental investigations. It is found that the rate of oxidation is apparently dependent on the inverse first power of hydrogen ion concentration. In addition to the obvious expedient of excluding oxygen from the clad solution, these data indicate that ultimate uranium losses to the clad solution can be reduced by adding nitric acid in low concentration to the clad solution immediately after completing the decladding step. These precautions are probably not necessary during the actual decladding operation since earlier results indicate uranium(VI) is reduced to uranium(IV) by dissolution of Zircaloy-2.

Preliminary results indicate another advantage for adding nitric acid to the clad solution in that the solubility of zirconium in the clad solution is thereby increased. Adjustment of a synthetic Zirflex clad solution to 0.5 M $(NH_4)_2 ZrF_6$, 0.6 M NH_4F, and 0.2 M NH_4OH resulted in precipitation of a large fraction of the zirconium as a gelatinous precipitate, leaving a supernatant of pH 7.6. The same solution where NH_4NO_3 was substituted for NH_4OH had a pH of 6.8 and is stable toward zirconium precipitation.

Materials of Construction

Vacuum-melted Hastelloy F and Ni-o-nel coupons welded with vacuum-melted Ni-o-nel filler rod showed no preferential weld metal attack when exposed to boiling: (1) 1 M HNO_3 - 2 M HF, (2) 3.5 M H_2SO_4, (3) 3.5 M H_2SO_4 - 10 g/l stainless steel, and (4) 4 M NH_4F - 0.5 M NH_4NO_3. The Hastelloy F specimen showed some preferential attack at the base metal-weld metal interface when exposed to sulfuric acid without dissolved stainless steel. Similarly, Hastelloy-F welded with Hastelloy-F filler rod shows preferential weld metal attack in H_2SO_4 only in the absence of dissolved stainless steel. Coupons of vacuum-melted Ni-o-nel were heat-treated for one hour at temperatures from 1650 to 2100 F (inert gas atmosphere) and water quenched. Two intersecting bands of weld metal were produced, by arc fusion, on the face of each coupon after heat-treating. On exposure to boiling 1 M HNO_3 - 2 M HF all coupons corroded at about the same rate (ca. 55 mils/mo as determined by weight loss measurements). In all cases, except the coupon heat-treated at 1650 F, preferential attack of weld metal adjacent to the intersection occurred. Annealing temperatures of 1550 to 1750 are considered optimum (by the manufacturer) for air-melted Ni-o-nel. Air-melted Ni-o-nel corrodes at about 230 mils/mo in boiling 1 M HNO_3 - 2 M HF.

A Haynes 25 bayonet located in a 321 Building tank containing nitric acid-iron(III) nitrate solution suffered severe attack at the vapor-liquid interface. Extensive laboratory testing of 304-L and Hastelloy-F in solutions containing nitric acid (2-5 M) and iron(III) nitrate (0.2 to 1.0 M) has disclosed no excessive interface attack.

Precision of Level Measurements

Terminal reports on precision level measurements experiments and statistical analysis of the data were issued. Report HW-62049, "Accuracy of Volume Measurements in a Large Process Vessel," by C. L. Pleasance, describes the experimental measurements. Report HW-62177, "Statistical Analysis - Accuracy of Volume Measurements in a Large Process Vessel," by C. G. Hough, Operations Research and Synthesis, presents a statistical analysis of the experimental data.

Criticality Studies - Materials Preparation

The core materials for two shipments of 3 per cent U-235 enriched uranium trioxide and polyethylene (H/U atomic ratio of 18 and 22, respectively) were prepared and delivered. Each shipment consisted of approximately 125 pounds of homogeneous mixture of uranium trioxide and polyethylene pellets.

REACTOR DEVELOPMENT - 4000 PROGRAM

PRTR PROCESSING IN REDOX

Zirflex Process

Exposure of as-received 1.5 w/o plutonium-aluminum alloy to boiling 1 M NH_4F resulted in dissolution of plutonium to a concentration of 3.8 mg Pu/l. No change in plutonium concentration was observed on allowing the solution to stand at room temperature for one day. This observation agrees well with the terminal plutonium concentration of 3.3 mg Pu/l observed in a simulated integral Zirflex decladding operation with plutonium-aluminum alloy.

Addition of uranium(VI) to a concentration of 0.72 g U/l in the above 1 M NH_4F solution and exposure of this boiling solution to Zircaloy-2 resulted in precipitation of uranium(IV), presumably as NH_4UF_5, reducing the concentration of plutonium in the boiling solution to 1.4 mg Pu/l. On cooling the solution to room temperature, further precipitation occurred, reducing the plutonium and uranium concentrations in the supernatant to 0.07 mg Pu/l and 0.06 g U/l. Thus, there is a possibility of reducing plutonium losses in Zirflex decladding of plutonium-aluminum alloys by either a uranium(IV) scavenging operation or perhaps by addition of uranium(VI) to the dissolver toward the end of the decladding operation.

Salt Cycle Process

The electrolytic reduction of UO_2Cl_2 in molten sodium chloride-potassium chloride eutectic at 725 C was studied as a function of current density. Over a range of 5 to 30 amp/dm^2, no apparent effect on the product quality was observed, although some variation in the crystal habit was noted.

Preliminary analytical results indicate that the sodium potassium content of electrolytically produced UO_2 may be as much as tenfold greater than the chlorine content.

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A stainless steel cathode was used in one run with very little corrosion occurring below the surface of the melt.

A topical report, "The Preparation of Uranium Dioxide from a Molten Solution of Uranyl Chloride," HW-62431, was completed. This report summarizes chemical experiments to date on the cycling of UO_2 through molten NaCl-KCl and points out possible process applications.

Aluminum Chloride-Alkali Chloride System

Continued work on the distribution of uranium between aluminum and aluminum chloride-alkali chloride systems has shown similar behavior of uranium in the sodium system as in the potassium system except that the reduction maximum is less than half as great. With an equimolar mixture of sodium and potassium chlorides, the distribution maximum (at Al/K+Na ratio of 1) lies intermediate between the values for the sodium and potassium systems.

The volatility of $AlCl_3$-NaCl solutions was observed to be much greater than that of corresponding potassium salts. This is indicative of a higher aluminum chloride activity which would result in the observed decrease in the extent of reduction.

The high temperature spectrophotometer will be used for studying the solubilities of uranium salts in molten salt systems and for developing information as to the species in solution. As a prelude to this work, the variation with temperature of the spectrum of UCl_4 in molten $KAlCl_4$ was studied. The spectrum is similar to that of aqueous hydrochloric acid solutions of uranium(IV) in the absorption peaks at 550 and 650 mμ; however, at shorter wave lengths the absorption peaks appear to have shifted toward the blue in the molten salt system. A strong absorption at 602 mμ is apparently unique to the molten salt system and may be indicative of a chloride complex unknown in the aqueous system. Although analysis of the temperature dependence has been only fragmentary, it is quite clear that some peaks are affected quite differently by temperature changes than others, suggesting perhaps the presence of more than one species.

Continuous Ion-Exchange Contactor Development

Jiggler Contactor. The ability of the jiggler contactor to recycle 7 M HNO_3 and resin at a net feed rate of 160 gal/hr-sq ft has been demonstrated using a pulse frequency and amplitude of 6-1/2 cycles per minute and 1-5/8-inches, respectively. Under these conditions a resin flow of 20 gal/hr-sq ft and a slip water/resin flow ratio of 6.3 was maintained.

Demonstration of the performance of an absorption-elution cycle is to be accomplished by using two similar jiggler columns. The second column has been designed, fabricated, and installed. It is a compound column, four inches in diameter, using a 3-foot adsorption section and 1-foot scrub section.

Weiss Contactor. A new mechanical pulse generator has been installed on the 3-inch-diameter Weiss-type contactor, permitting operation at amplitudes up to 0.8-inch and frequencies up to 200 cycles per minute. Results indicate stable

operation and uniform resin transfer at fluid flow rates up to 100 gal/hr-sq ft and resin flow rates up to 70 gal/hr-sq ft (wet settled basis). (A fluid flow rate of 100 gal/hr-sq ft is not sufficient for most plutonium adsorption column applications, but is ample for the elution column.)

Operation at amplitudes of 0.125-0.25-inch and frequencies greater than 150 cycles per minute result in a semifluidized bed of resin on each support plate. Fluid channeling under these conditions should not be excessive.

Amplitudes greater than 0.5-inch and frequencies less than 10 cycles per minute, resulting in a mixer-settler-type operation, may produce minimal channeling, but the resin flow is more erratic. At intermediate pulsing conditions excessive channeling was observed.

WASTE FIXATION

Radiant Heat Spray Calciner

Runs have been made with sugar addition to simulated high-sulfate Purex waste to better define the effect of sugar addition on sulfate destruction. Phosphate was not present in these runs. The results may be summarized as follows:

1. The addition of sugar results in the removal of approximately 60 per cent of the sulfate from high-sulfate waste.

2. As reported previously, the addition of oxygen decreases the ability of sugar to reduce sulfate. However, this effect was not as pronounced as in the earlier series with phosphate.

3. Addition of oxygen near the midpoint of the column resulted in increased removal of sulfate over that observed when the oxygen was added at the top of the column.

A new filter section was designed during the month as was equipment for the study of eddy diffusivity and back mixing in the column. These latter quantities, which are important to a theoretical understanding of the spray column, will be determined by addition of helium tracer followed by sampling and analysis of the gas at selected points in the operating column.

Mineral Reactions

Samples were obtained of Purex boiling tank condensate and submitted for analysis. These were the first samples taken since the installation of surface condensers on this facility. These solutions were found to have 73 ppm total solids, including some insoluble material. Since this is much higher than would be expected from the 10^{-5} entrainment calculated for these boiling tanks (about 4 ppm solids) the reason for the discrepancy was studied. Later samples also contained undissolved solids. Investigation disclosed a leaking valve on the A-8 proportional sampler which permitted raw process water to mix with the condensate. The study also disclosed some uncertainty regarding the representativeness of samples taken

by the existing sampler from the greatly reduced volume of waste now generated since the condensate and cooling water streams are segregated. Part of the high total solids and insoluble material found could be material flushed from the surfaces of the condenser, but later samples should show a considerable reduction in this event. This condensate waste will be used for laboratory studies of waste decontamination with beds of clinoptilolite.

The breakthrough of radiocesium from a small five-gram bed of clinoptilolite was compared with that from the 50-gram bed used for most of the laboratory research with this mineral. The beds tested were the same length but the five-gram columns had a smaller diameter. The breakthrough to date from the two sizes of beds were the same within experimental accuracy. There was no evidence of wall effects in the smaller column as might be anticipated. These smaller beds will reduce the volume of waste solution needed for experiments and will reduce radiation levels around the columns.

Work is planned to study some of the basic problems associated with fixation of waste components in solids. Some of the basic problems include: the effect of high temperature and/or irradiation on crystal structures, the effect of radioactive transformation of lattice components on crystal integrity, and the nature and stability of complex ions that form in some types of waste solutions.

The CR In-Farm Scavenging Facility was occupied and necessary alterations initiated. Experimental equipment to study the decontamination of condensate streams is being readied and installation will begin in November.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

The Washington State University seismic geophysical tests, by locating the surface of the Ringold formation, reaffirmed the differences in the in-place properties of Hanford sediments, although drill-procured samples are often nearly indistinguishable. This again emphasizes the importance of use of a variety of methods in solving geologic and hydrologic problems.

The velocity distribution through sediments containing highly permeable lenses of sand or gravel was studied both with an electric analog field plotter and with a laboratory flow model. A small metal bar was used to simulate a low resistance lens on a sheet of resistance paper in the case of the electric analog. It was found that even an isolated lens such as this distorted the flow pattern markedly and increased the calculated water movement rate. This same result was obtained with a flow model in the laboratory. A column of fine soil was prepared containing an isolated lens of permeable washed sand. Using a dye tracer it was found that water movement through the sand lens was 25 times as rapid as through the fine soil. This information greatly affects the method to be used in calculating average velocities along non-homogeneous paths which may contain lenses of highly permeable material.

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Soil Chemistry and Geochemistry

Research was continued on the calcite-fluorite reaction to study some of the basic relationships between system variables and radioisotope removal. A thin section of calcite ($CaCO_3$) partially replaced with fluorite (CaF_2) was photographed. These photomicrographs clearly show the physical characteristics of replacement, including preserved physical outlines of the calcite rhomb and diffusion of CO_3^{-2} and F^- along fissures in the calcite crystal.

Studies were made of the influence of pH, temperature, flow rate, fluoride concentration, and calcite surface area on the removal of fluoride ion from solution by calcite. The relative magnitude of these influences are in the order: temperature > influent pH > calcite surface area > flow rate > fluoride concentration. The removal of radioisotopes from solution by this reaction may not be influenced in this same way since other mechanisms may be controlling.

Equilibrium sorption of cerium from 4.2×10^{-7} M solution by soils in the presence of chloride, nitrate, sulfate, acetate, phosphate, oxalate, citrate, and carbonate anions was studied as a function of pH. Of the anions studied, chloride and nitrate (sodium salts) appeared to affect to the least degree the cerium sorption. The pH range studied in the case of phosphate, oxalate, citrate, acetate and carbonate systems was somewhat limited by their high buffering capacity. These accompanying ions were studied in 0.5 M and 4.0 M systems. In solutions of strong electrolytes cerium is precipitated in slightly acid and neutral solutions. The precipitate is peptized into a finely divided colloid in the critical pH range from 7.5 to 10.5 unless the salt content is sufficiently high to prevent it. Sulfate and acetate systems showed some relative decrease in cerium removal compared with chloride and nitrate systems. In citrate and carbonate systems the reactions in the pH range 7.5 to 10.5 were markedly different from those obtained in systems of strong electrolytes. A pronounced decrease in cerium removal was evident in this pH range from citrate and carbonate solutions. Cerium was completely removed from phosphate and oxalate systems above pH 4.0, probably because of a precipitation reaction with these ions.

Ground Waste Investigations

The inability of the Hiester-Vermeulen equation to predict the behavior of soil adsorption columns was studied further. The shape of breakthrough curves from soil columns does not appear to change with increasing test column length in the same manner as do those from beds of synthetic ion exchange resins or as predicted by these equations. The possibility that this effect could be explained by non-linear longitudinal dispersion in soil columns was tested by column experiments with nitrate solutions. Carefully prepared nitrate ion breakthrough curves from soil columns of different sizes indicated that longitudinal dispersion was accurately proportional to column length, so some other explanation of the phenomenon must be sought.

The small experimental crib near Gable Mountain continued to receive calcium nitrate solution traced with Sr^{85}. More than 2200 gallons were discharged to the facility by month end. The water table beneath this experimental crib has been

gradually rising during the course of these experiments. The elevation of the water table increased above the tops of the screen sections of the well point. This created uncertainty regarding the representativeness of samples from these wells until the well points were pulled to a position in which the screens extended above the water's surface. Nitrate ion has broken through into five of the wells but the uncertainty concerning samples from these wells casts doubt on the exact time of breakthrough. Tentative interpretation of the data indicates little apparent difference in the lateral spread of solution from this crib and that of the larger crib previously studied.

Field Apparatus Development

The neutron soil moisture probe was further studied, using known moisture soil compositions. Large soil volumes in the low-water content region were determined to be necessary for accurate calibration. Resolution was adequate to permit accurately locating a dry-soil wet-soil interface through a series of readings on either side of the interface.

Well drilling was completed at the Gable Mountain test site, and the necessary preparations were made to conduct the well pumping tests.

Micromeritics

An elutriator was assembled and used to prepare fairly narrow size range ZnS particles for use in particle deposition studies. Apparatus designed to measure particle deposition in tubes was used in initial tests with results indicating an unusually high deposition velocity. It will be necessary to substantiate that particle size distributions will not be appreciably distorted in transit through the apparatus before firm deposition velocities may be reported.

A paper entitled, "Disposal of Industrial Radioactive Waste Waters at Hanford," by L. C. Schwendiman, R. E. Brown, J. F. Honstead, D. W. Pearce was presented at the Third Pacific Area International Meeting of the ASTM, in San Francisco, October 15.

Radioisotopic Measurements

Measurements have been completed on a route by which Zn^{65} released in reactor wastes to the Columbia River may enter humans. Zn^{65} was traced from the river to forage irrigated by the water, to cows and the milk they produce, and finally to those drinking the milk. Irrigation water containing 0.1×10^{-6} uc/ml resulted in about 2×10^{-6} uc/ml milk. This milk ingested daily for five months at a rate of about 630 cc per day gave body burdens of 0.030 to 0.045 (average 0.036) uc in six individuals. Bioassay samples are being analyzed to determine the excretion rates under these conditions.

An experimental addition of As^{75} (as arsenate) to two reactor tubes during reactor operation was completed. The As^{76} in the effluent water from these tubes was determined in many samples as the concentration increased as a result of the addition, and the decrease of As^{76} concentration with time was followed after the addition

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had been terminated. These data have not yet been interpreted in terms of the mechanisms of As^{75} adsorption and As^{76} release, but there is evidence that at least three mechanisms are operating which appear to be first order reactions with half times of about 40 minutes, 40 hours, and two weeks.

Since the cessation of weapons testing, the radioisotope content of local vegetation has decreased about two orders of magnitude. The main measurable radioisotopes are now K^{40} (naturally occurring), Zr^{95}-Nb^{95}, Cs^{137}, Ru^{106}, and Ce^{144}. These radioisotope concentrations may be determined from a single gamma energy analysis in the large (9-3/8-inch-diameter) well crystal.

A Varian Electron Paramagnetic Resonance (EPR) Spectrometer was assembled and tested. Although signals have been received from several test samples, further work will continue following the visit next month of the Varian technical representative.

W. H. Reas
for Manager,
Chemical Research & Development

LP Bupp:bp

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[redacted]

ORGANIZATION AND PERSONNEL

Fred D. Fischer, Engineer, was hired and assigned to the Chemical Development Operation.

Richard Fullerton, Chemist, was hired and assigned to the Chemical Effluents Technology Operation.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
B. A. Lister	9/29-30	United Kingdom, AEC Harwell, England	Radioactive Waste Disposal Discussions	DW Pearce	No
J. L. Turner L. Gallager	10/5-6/	Bohna Company San Francisco, Calif.	Architectural Engineering Consultation in conjunction with 325-A expansion.	LP Bupp KH Hammill RL Moore EA Berreth	No
S. D. Bailey J. B. Roberts C. S. Otto W. H. Farrow, Jr.	10/8/	duPont Wilmington, Delaware	Discuss non-production fuels reprocessing.	OF Hill AM Platt RJ Sloat RE Burns	No
R. Sutton	10/9/	International Nickel Co. New York, New York	Discuss corrosion problem.	WL Walker RF Maness RE Burns	No
J. W. Crosby R. E. Cavin	10/12-16/	Albrook Hydraulic Labs. Washington State Univ. Pullman, Washington	Perform contracted Geophysical Seismic Test	RE Brown JR Raymond	No
F. Morris Dr. Newman	10/15/	Turco Products, Inc. Spokane, Washington	Discuss purchasing of equipment in regard to decontamination work.	EA Berreth	No
A. R. Matheson	10/19/	Sylvania-Corning New York, New York	Chemical processing of power reactor fuels.	LP Bupp OF Hill	No
S. Lawroski	10/19/	Argonne National Lab. Lemont, Illinois	Pyroprocessing	LP Bupp OF Hill	No

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
E. Detilleux O. Jenne M. Lung H. Moekken A. Redon W. Schuller P. Suter R. Winckler	10/16-23/	Eurochemic Visitors	Technology of Chemical Processing.	LP Bupp GJ Alkire NP Wilburn OF Hill RE Burns RJ Sloat AM Platt WW Schulz VH Hammond VP Kelly GL Richardson JH Kleinpeter RF Maness DW Pearce JF Honstead RE Brown CE Linderoth BM Johnson JL Nelson GE Benedict JL Ryan WH Reas JL Swanson MT Walling	No
E. Nicholson	10/16-23/	AEC - ORNL Eurochemic	Discuss instrumentation separations technology.	LP Bupp GJ Alkire CL Pleasance NP Wilburn OF Hill RE Burns RJ Sloat AM Platt WW Schulz VH Hammond VP Kelly GL Richardson JH Kleinpeter RF Maness	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
C. Watson	10/22/	Oak Ridge National Lab. Oak Ridge, Tennessee	Protective coatings.	JH Kleinperter	No
R. Hill J. B. Jones	10/22/	Air Reduction Co. Martin Company Baltimore, Maryland	Discuss hot cells and fission product recovery.	RL Moore	Yes
B. Weidenbaum D. H. Ahmann	10/22/	Vallecitos Atomic Lab. San Jose, California	Discuss hot cells.	LP Bupp WH Reas RL Moore	Yes
F. T. Selleck	10/22/	The Fluor Corporation Whittier, California	Discuss spray calcination.	BM Johnson	No
E. W. Murbach K. L. Mattern	10/22/	Atomic International Canoga Park, Calif.	Discuss pyroprocessing.	LP Bupp WH Reas EE Voiland	Yes
J. L. Simmons O. T. Roth E. L. Anderson C. W. McLaughlin S. Sobol	10/22/	AEC Washington, D.C.	Discuss PRP.	LP Bupp MT Walling WH Reas EE Voiland	Yes
A. S. Jennings	10/22/	Savannah River Lab. Aiken, South Carolina	Palmolive discussion.	MT Walling GE Benedict	Yes
L. W. Ferriss	10/22/	Oak Ridge National Lab. Oak Ridge, Tennessee	NPF Reprocessing discussions.	JL Swanson	No
K. Saddington T. Tuchy	10/22/	United Kingdom - AEA Windscale, England	Unclassified technical discussions.	WH Reas LP Bupp	No
F. Maslan	10/22-23/	Brookhaven National Lab. Upton, Long Island New York	Design concept for NPF Processing Plant.	OF Hill VP Kelly JH Kleinpeter RW Wirta G Rey	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
A. S. Jennings	10/23/	Savannah River Laboratory Aiken, South Carolina	Instrumentation and controls separations technology.	GJ Alkire	No
A. R. Irvine L. Ferris	10/23/	Oak Ridge National Lab. Oak Ridge, Tennessee	Technology of fuels reprocessing.	GJ Alkire AM Platt WW Shculz WL Walker RF Maness	No
E. L. Anderson C. W. McLaughlin J. L. Simmons	10/23/	AEC Washington, D.C.	Plutonium Recycle Program Discussions	OF Hill RJ Sloat AM Platt	Yes
F. Maslan	10/23/	Brookhaven National Lab. Upton, Long Island, New York	Discuss pyroprocessing.	RH Moore WH Reas EE Voiland	Yes
E. Miller G. Pleat	10/26-27/	AEC Washington, D.C.	Discuss fission product recovery.	LP Bupp RL Moore WH Reas OF Hill RJ Sloat	Yes
G. H. Harnden	10/27/	Engineering Services Schenectady, N.Y.	Interest in HAPO standards activities.	LP Bupp	No
L. Gallagher	10/29/	Bohna Company San Francisco, Calif.	Discuss 325-A Building Waste Storage Vault Project.	RJ Sloat	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
U. L. Upson	10/2/	Wilson-Sprow Company Spokane, Washington	Inspect equipment.	H Wilson	No
A. M. Platt	10/10-14/	Oak Ridge National Lab. Oak Ridge, Tennessee	Attend Annual Information Meeting.	FL Culler	No
L. C. Schwendiman	10/11/	ASTM Meeting San Francisco, Calif.	Attend meeting and present paper.		No
D. R. Kalkwarf	10/12-16/	Brookhaven National Lab. Upton, Long Island New York	Attend Symposium on Bioenergetics.	L Augenstine	No
L. C. Schwendiman	10/15/	APED San Jose, California.	Discuss tracers in containment studies, particulates in waste streams, laboratory design.	RC Thorburn JM Smith HV Clukey	No
E. W. Christopherson	10/19-20/	University of Oklahoma Norman, Oklahoma	Recruiting		No
H. F. Tew	10/21/	Spokane, Washington	Present talk to Greater Spokane Science Teachers Association.		No
L. C. Schwendiman	10/21-23/	American Standards New York, New York	Participate in committee work on N5.4 Report.		No
E. W. Christopherson	10/21-23/	Oklahoma State Univ. Stillwater, Oklahoma	Recruiting		No
A. S. Wilson	10/22/	Kiwanis Club Ephrata, Washington	Present talk.		No
A. C. Leaf	10/26-28/	Gatlinburg, Tenn.	Attend conference on Analytical Chemistry.		No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. W. Perkins F. A. Scott R. W. Stromatt	10/26-28/	Gatlinburg, Tenn.	Present paper at Conference on Analytical Chemistry.		No
N. P. Wilburn	10/27-30/	General Electric Co. Schenectady, N.Y.	Attend Symposium and Conference on Processing Systems and Control.	H. Chestnut	No
R. W. Perkins	10/28/	Harshaw Chemical Co. Cleveland, Ohio	Discuss large scintillation detectors.	EC Stewart	No
A. C. Leaf	10/29-30/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss analytical methods.	LT Corbin SA Reynolds	Yes
R. W. Perkins	10/29-30/	AEC New York, New York	Discuss low-level counting techniques.	JH Harley	No
F. A. Scott	10/29-30/	Savannah River Lab. Aiken, South Carolina	Discuss determination of Pu in dissolver solution.	HM Kelley	Yes
R. W. Stromatt	10/29-30/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss Pu analysis and dissolver solutions, analysis of Np, and analytical chemistry of fused salt solutions.	MT Kelley	Yes

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

No significant changes occurred during October.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were approximately five times those observed one year ago. Values follow:

Location	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
4 Miles S.W. Redox	2×10^{-3}	5×10^{-3}	+ 20
Prosser Barricade	1×10^{-3}	2×10^{-3}	+ 5
Wahluke Slope	2×10^{-4}	4×10^{-4}	-

Columbia River Contamination

Concentrations of gross beta emitters in Columbia River organisms collected at Hanford were approximately the same as that observed one year ago. Values follow:

Sample Type	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
Minnows (entire)	2×10^{-2}	2×10^{-2}	+ 2

With a dose of X-rays which produced 99 per cent death (10 Kr), the frequency of C. columnaris strains resistant to Distrycin was increased 15-fold over the frequency in non-irradiated controls. Presuming that these are the consequence of mutation, this rate of increase is comparable to that observed in other microorganisms.

C. columnaris organisms isolated from infected fish showed no decrease in viability over a 76-hour period of being suspended in sterile de-chlorinated sanitary water. At least partial virulence was retained during this time since one trout out of four exposed was dead within two days.

Fallout Contamination

Fission products occurred in rabbits from Hanford Reservation in the following amounts:

Sample Type	μc/g Wet Materials Average	Trend Factor
Bone	6×10^{-5}	+ 3
Feces	3×10^{-5}	-
Muscle	7×10^{-6}	-
Liver	6×10^{-6}	-

Salmon Survey

Aerial surveys of spawning salmon were initated. Only 55 nests were observed which is much lower than normal. The low count is not considered significant, however, since visibility was poor due to the river flow which was about 60 per cent greater than average for the month.

Effect of Reactor Effluent on Aquatic Organisms

Results of the routine monitoring program with effluent from the 100-KE reactor were not substantially different from those reported last month. Since this test was started in June, about 39 per cent of the fish in 3 per cent reactor effluent have died as compared with 26 per cent of the controls. In each case, most of the fish which died showed symptoms of Columnaris disease.

Small suckers were sampled from an artificial river which contained 3 per cent strength effluent which had been passed through a bed of aluminum turnings. Results of radiochemical analyses are not yet available to indicate whether the aluminum turnings were effective in reducing the contamination level in the fish.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Phosphorus

Groups of cichlids (tropical fish) were maintained in aquaria which contained 1×10^{-4} μc/ml, 5×10^{-4} μc/ml, and 2×10^{-3} μc/ml phosphorus throughout the month. Some mechanical difficulties have been encountered in maintaining the concentration of isotope at the desired level in the water. No adverse effects have been observed with the possible exception that the food intake of the fish in the high level is reduced. An ancillary test to determine the best method of administering P^{32} to the cichlids indicated that the body burdens were much more consistent when the isotope was included in the food than when the isotope was added to the water.

The metabolism of P^{32} was studied in mice following oral and intraperitoneal administration. It appears that at least 50 per cent of the administered dose is absorbed after oral administration. The whole-body mouse monitor seems to work satisfactorily for detecting the bremsstrahlung of the deposited P^{32}.

Strontium

Hematological studies on trout which had been injected twice weekly with Sr^{90}-Y^{90} were completed. No significant changes were observed with the possible

exception that the mean corpuscular hemoglobin appeared to be higher in the fish which had received the greatest amount of isotope (1.5×10^{-2} μc/g of fish/injection).

The adult groups of miniature swine on daily Sr^{90} feeding are now virtually filled and a limited number of animals from the F_1 generation were started on experiment. A total of 70 animals are now on this study. Examination of x-ray plates revealed no pathology in any group fed up to 25 μc/day for over six months.

Preliminary results from the study on the effect of calcium gluconate in the diets of lactating ewes on Sr^{90}-Ca^{45} relationship indicate the following: (1) The amount of stable calcium absorbed from the gastrointestinal tract or excreted in the urine of lactating ewes appeared to be relatively independent of added calcium in the form of gluconate up to amounts of more than twice the basal ration. This suggests that calcium absorption is based upon demand and that the short time period probably did not allow the adjustment in absorption rate which is known to be somewhat dependent on calcium content of the diet. (2) The urine-blood ratio of Sr^{90} was approximately six times the similar ratio for Ca^{45}. (3) An opposite effect was observed at the mammary gland where the milk-blood ratio of Sr^{90} was 0.4 times the ratio for Ca^{45}.

Short term rate of ion uptake studies were carried out on 12-day old bean plants grown in nutrient solution. With equal concentrations of calcium and strontium in the substrate, little difference in rate of Ca^{45} and Sr^{85} accumulation was noted. There was a more rapid accumulation of both ions in younger leaves than in older ones.

Iodine

Adult swine on full feed and 70 per cent of full feed and fed either 5 or 1 μc/day of I^{131} for a prolonged period were given a single tracer dose of radioiodine to determine if there was any evidence of a change in thyroid metabolism due to radiation damage or plane of nutrition. The high-plane animals - both controls and those fed 5 μc/day over a prolonged period, showed higher thyroid uptake of the tracer dose and longer effective half-life than the animals on low plane of nutrition.

There was no definite indication of damage due to the feeding of 5 μc/day of radioiodine for three years, although there was a suggestion of a reduced thyroid avidity for I^{131} in some of the experimental animals. The accumulated dose to the thyroid during this period was about 7,000 rads.

Plutonium

Of six rats injected with 40 μc Pu/kg, four have died within a period of 42 days' post injection. Rats receiving the same amount of plutonium but treated with 1.5 mM/kg DTPA show complete survivial for the same period, thus demonstrating the survival value of DTPA treatment in cases of acute plutonium toxicity.

Comparative Toxicity of Ra^{226}, Pu^{239} and Sr^{90}

The study to determine the comparative toxicity of Ra^{226}, Pu^{239}, and Sr^{90} in 6-week, 6-month and one-year old miniature swine was initiated. The doses administered were calculated on the bases of estimated skeletal burden of these animals, as follows:

Ra^{226}	2.5 μc/Kg body weight
Pu^{239}	1 μc/Kg body weight
Sr^{90}	25 μc/Kg body weight

Radioactive Particles

Plutonium assay of tissues from 48 dogs killed at intervals after inhalation of $Pu^{239}O_2$ is nearing completion. From the data for nine dogs given in Table 1, several tentative conclusions can be drawn. There was little clearance of plutonium from the lung during the first two weeks after inhalation. During this period about half of the deposited plutonium was excreted in the feces. The pharmacodynamics of inhaled plutonium in dogs differs from that observed in rodents where smaller fractions of the deposited materials were distributed in the lungs and early rapid lung clearance occurred.

TABLE 1

Distribution of Inhaled $Pu^{239}O_2$ in Dogs
Per Cent of Originally Deposited Plutonium

	Immed.	One day	14 days
Lungs	61, 64, 53	53, 15, 64	55, 54, 81
Tracheal bronchial lymph nodes	- - -	0.01, - 0.2	0.07, 0.1, 0.1
All other tissues including intestine	39, 36, 47	47, 75, 36	0.3, 0.6, 2
Urine	- - -	0.02, 0.003, -	0.04, 0.7, 0.4
Feces	- - -	0.1, 10, -	44, 45, 16

Tissue Transplantation for Radiation Therapy

Three miniature swine were administered an LD_{100} dose of X ray (900 r) followed by an injection of fetal spleen and liver cells into two of the animals. All three animals died by the 11th day. These results, together with others, point out differences in response (and the hazards of extrapolation) between large and small animals, the latter having demonstrated a favorable response to bone-marrow and also to fetal-tissue transplantation. With supportive treatment, however, the results in large animals may be more promising.

Gastrointestinal Radiation Injury

Intraperitoneal injection of cysteine (1.0 g/kg) prior to irradiation afforded complete protection against the effects of 900 r X-irradiation on the glucose absorbing ability of the intestine.

Microbiological Studies

Increased movement of ions across irradiated yeast cell membranes was observed to result from a general increased permeability rather than mere leakage out of the cell. Irradiated cells removed phosphorus from the medium at a rate seven times that observed in unirradiated cells and at the same time phosphorus leaked out 12 times more rapidly. Glucose utilization was slightly greater in irradiated cells.

HA Kornberg
BIOLOGY OPERATION

HA Kornberg:es

IPS DATES OF ISITS	COMPANY OR ORGANIZATION REPRESENTED AND ADDRESS	REASON FOR VISIT	PERSONNEL CONTACTED	ACCESS TO RESTRICTED DATA	AREAS AND BUILDINGS VISITED
5	Oregon Fish Commission, Albany	Discuss research.	Foster, Schiffman	No	100-F, 146-FR
5-6	Div. of Biology and Med., AEC, Wash. D.C.	Discuss research.	Hungate and SS Mgrs.	No	100-F, Biology
16	Botany Dept, WSU, Pullman	Discuss research.	Kornberg & staff	No	"
/22	Tri-City Area	Tour	Horstman, Foster	No	141, 146
/13	Tri-City area	Tour	Foster, Bustad	No	141, 146

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7-10	Los Alamos Scientific Lab.	Mtg. on Measurements and Control of Pu Hazards	Milligan	No	
5-6	Oak Ridge Nat'l Lab	Bio-Medical Directors Mtg.	Hollaender	No	
15-16	Las Vegas, Nev.	Meeting on Project Chariot, AEC		No	
10/19-20	WSU, Pullman, Wash.	Nuclear Reactor Symposium	-	-	
10/19-23	U. of Minn., Minneapolis	Present lectures at Symp. on Radioisotopes in Biosphere.	-	-	
d 10/19-23	U. of Minn., Minneapolis	Attend Symp. on Radio-isotopes in Biosphere	-	-	
han,					
10/14-17	U. of Mich. and MSU	Discuss research	Fromm, Wolterink and Lauff	-	
0/14	State Dept. of Fisheries, Seattle	Discuss fisheries disease program.	Bryan Earp	-	
0/16	Everett Jr. College	Present talk at Biology Workshop	Dr. Parks	-	
0/10-16	Brookhaven Nat'l Lab.	Bioenergetics Symposium	Dr. Quastler	-	
0/23	Pullman, Wash. (WSU)	Discuss course in Radiotoxicology	Dr. Klaveno	-	
0/6	WSU, Pullman	Identification of plants.			

D. Lectures

a. Papers presented at Meetings

W. J. Bair, 10/22/59, "Radioisotope Toxicity from Pulmonary Absorption," Symposium on Radioisotopes in the Biosphere, University of Minnesota, Minneapolis, Minnesota, Oct. 19 - 23.

L. K. Bustad, 10/22/59, "Significance of Nuclear Industrial Effluents on Animal Populations," Symposium on Radioisotopes in the Biosphere, University of Minnesota, Minneapolis, Minnesota, Oct. 19 - 23.

H. A. Kornberg, 10/19/59, "The Passage of Pairs of Elements Through Food Chains," Symposium on Radioisotopes in the Biosphere, University of Minnesota, Minneapolis, Minnesota, Oct. 19 - 23.

R. C. Thompson, "Section VIII: Radioisotopes Absorption and Methods of Elimination. Nutritional Considerations," 10/21/59, Symposium on Radioisotopes in the Biosphere, University of Minnesota, Minneapolis, Minnesota, Oct. 19 - 23.

b. Off-Site Seminars

L. A. George, Jr., 10/16/59, Biology Workshop at the Northwest Junior College Science Teachers Meeting, Everett Jr. College, Everett, Wash. (The Mammalian Cell).

c. Seminars (Biology)

L. K. Bustad, 10/14/59, "Significance of Nuclear Industry Effluents in Animal Populations"

H. A. Kornberg, 10/14/59, "Objectives of Research Program"

d. Seminars (other than Biology - local)

R. F. Foster, 10/9, 16, 23, "Aquatic Biological Studies," IPD Information Meetings.

E. Publications

a. HW Publications (external distribution)

None

b. HW Publications (internal distribution)

None

c. Open Literature

None

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

October, 1959

ORGANIZATION AND PERSONNEL

There were no changes in personnel during the month of October.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Work on the GCL computer program is continuing. The central multivariate analysis subroutine has been checked with five test models and found to be satisfactory. Three production runs have been made using this routine.

Other

The declassified version of the Operation Pool report was completed and forwarded to the Atomic Energy Commission. In addition, consultation on a related program was given to personnel of the Division of International Affairs.

A first report on the mathematical and logical formulation on the concept of value and internal pricing was completed.

OPERATIONS ANALYSIS STUDIES

Redox Dissolver Study

Using the multivariate analysis subroutine now available, an analysis was made of one completely causal model and a partial analysis of two other models was made by the less efficient "straightforward least squares" technique. A report to interested CPD personnel is being prepared.

Z Plant Information Study

Due to the failure by IBM to meet commitments on the production recording equipment which was to be used in the developmental test, this program has been completely re-evaluated. Attention is now being directed toward working out details for the future process so that requirements of the system can be presented to other firms capable of providing the necessary equipment. An agreement on the future scope of this program has been reached with CPD Research and Engineering personnel.

FPD Process Control and Experimentation

Further dimensional measurements on co-extruded tubes have confirmed in general the previously observed relationships between dimensional distortion during heat treating and reduction ratio employed in the co-extrusion process. One additional set of data is being collected, since the true

relationship of Δ diameter to reduction ratio is still open to some question. Also with respect to co-extruded tubes, the extent of interface roughness was evaluated, where interface roughness is a measure of the variability in clad thickness. Along with the results of this analysis, recommendations with respect to future measurements of this characteristic were made and adopted, resulting in a considerable savings of effort.

Nickel plating of present production fuel elements to reduce corrosion effects is still being evaluated. In this connection, the effects of heat treating after plating on the bond strength of a fuel element were evaluated.

An experiment designed to evaluate the effects of charge damage on fuel element quality (porosity and dimensional changes) has been completed. The importance of controls was dramatically emphasized in this experiment, since had they not been used, entirely erroneous results would have been found.

Some further data to evaluate the effects of one-step and two-step quenching are being analyzed.

Two experiments to be run in the pilot plant were designed. In the first, four degreasing procedures in the cleaning of cans are to be evaluated. The second experiment concerns an evaluation of spire-insertion techniques, in which three methods are being considered.

Quality Certification Program

Pre-irradiation dimensional and weight data taken from monitor tubes charged under this program during June, July, and August were analyzed. This was done in order to provide a rational basis for setting product specifications. Interesting cases of non randomness and out of control situations were detected.

Discussions were held in connection with writing the product specifications for this program. It was emphasized that there are three distinct uses for the data being generated, and that much of the data are of interest only to FPD personnel. Much of the control of outgoing quality is maintained by 100% inspection such that acceptance sampling plans as such are not required. However, one can still describe the outgoing quality by variables measurements which should be useful in later studies to evaluate the effects of such characteristics on fuel element performance.

In connection with this program steps are being taken to mechanize data recording and analysis for C-Basin data, and the question of the necessity for taking five diameter measurements was raised. The effect of a reduction to three measurements was evaluated, and it was recommended that this not be done. At the same time, a recommendation was made that the desirability of using quarter point measurements to obtain a better measure of fuel element warp be evaluated. Data are being collected to quantify the reduced uncertainty that would result.

Production Tests

An analysis is being made of data from production test IP-220-A, which was

designed to compare fuel elements with cores heat treated in rod form in carbonate salt with those blank heat treated in chloride salt. Paired observations were utilized. The fuel element position effects on warp and Δ diameter are also being quantified in this analysis. The fitting of second and third degree polynomials is sufficient to explain these effects.

Fuel Element Failures

A comparison of failure performance was made between fuel elements clad in X-8001 and C-64 alloys.

Optimization of Reactor Operations

A new program is being defined to include all work done on various aspects of optimizing operating conditions for the reactors. Some of this work was previously reported under Fuel Element Failures.

Net return, as defined by Process Technology personnel, is calculated as a function of CR (a measure of fuel element quality as determined by rupture performance), power, and exposure. The results were then expressed as fourth degree polynomials in order to permit easy interpolation, and they will be used to evaluate a number of decision rules concerned with changing operating conditions on the basis of observed rupture performance. A study is being made of the "fixed" costs existing in the current net return equation to determine if they can truly be called fixed or must also be varied with changing reactor conditions. Of importance is the extent of simultaneous shutdowns of several reactors under different sets of operating conditions, and their effect on the cost structure. Work is continuing in this area.

Process Tube Leaks

An extensive report was issued giving the results of various attempts to predict more effectively which tubes are likely to experience severe external corrosion and hence be candidates for tube leaks. No marked success in improving on present prediction methods has been noted. Work will continue after discussing this report with interested personnel.

Aluminum Corrosion

Work was completed on the comparison of four models with respect to their ability to predict in-reactor corrosion. It is anticipated that a joint report with HLO and IPD corrosion representatives will be issued summarizing the results of this study.

Reactor Calculations

Discussions have been held with interested personnel relative to the rough draft issued on reactor calculations. There was general agreement on the results of this study, and it is planned to issue a final report during November. It is also tentatively planned to try to quantify the inaccuracies existing in the Foxboro power calculating system by examining available data from routine draw-down tests on a given reactor.

Final Product Specifications

As previously recommended, the number of analytical titrations per fabricated part was decreased from six to three several weeks ago. An examination of data since that date has indicated rather surprisingly that the total measurement error associated with each part has not increased as a result of this change. This is being investigated further.

A trip report was issued on the September meeting on final product specifications held at Los Alamos. This also contained a discussion of part by part acceptance. A formal proposal to alter existing specifications is being prepared.

CPD Control

Several specific problems concerned with control of materials within CPD were worked on during October. As an example, a study was made relating the extent of skull formation in Task IV furnaces to the type of material charged.

Radiation Protection Studies

Additional data from an experiment to investigate the effect of exposure angle upon gamma film badge response were obtained. Since the new data deviated from earlier for edge angle exposures, a review of all calculations has been undertaken. A report will be issued in the near future explaining the integrated result of both experiments.

Work continued on the analysis of data from the experiment to test the validity of the inverse square law as it applies to the radium gamma film badge calibrations.

A statistical study was initiated for Bio-Assay Operation to estimate the precision and accuracy of bio-assay plutonium deposition estimates from spike samples.

Systems Reliability

Using the previously developed computer program, the reliabilities of three alternative changes in the K-plant water system were compared to that of the existing system. In the sense that these computations indicate distinct differences between the alternatives considered, this work was quite successful. On the basis of these experiments additional work is being planned in this area and a new problem of a similar nature concerning NPR operational reliability is being considered.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Metallurgy

A statistical analysis was performed on maximum penetration data from two experimental investigations of the diffusion of uranium into AlSi to obtain the best estimate of the thermo diffusion coefficient, and to

[redacted] determine the significance of the difference between the two coeffi[redacted]

2000 Program - Separations Development

Conferences were held to explore the feasibility of applying statistical techniques to the design and analysis of engineering development experiments. To date, application has been discussed in two areas, power fuel circulating dissolvers and fluidized bed calcination of process waste solutions. Existing dissolver data are being examined to gain familiarity with power fuel dissolution problems. It is anticipated that this examination will lead to the design of planned experiments that should make possible a systematic evaluation of both main effects and interactions for several process variables.

4000 Program - Swelling Studies

Work continued on the development of the functional representation of the pore radii distributions for micrographs of uranium samples. Preliminary investigation of the effects of varying etch times was completed; data for a more comprehensive study will soon be available.

4000 Program - PRTR Pressure Test

Work continued on the statistical evaluation of data from the recent PRTR Pressure Test to determine the precision and accuracy of leak rate estimation. Current efforts are directed toward correcting the total number of molecules within the vessel estimate for the fluctuation in the number of water molecules due to condensation and evaporation on the walls of the vessel arising from daily temperature fluctuations.

4000 Program - Mathematical Analyses

Mathematical assistance to this program included

(1) Continued aid in the study of the elastic behavior of fuel elements,
(2) the complete solution to a non-homogeneous second order differential equation, and
(3) assistance in studying the oscillatory and growth properties of the solutions of a linear second order differential equation with periodic coefficients.

6000 Program - Biology and Medicine

Work continued on statistical analysis of excretion data from an experiment involving plutonium inhalation by dogs. A three-compartment mathematical model of retention and excretion has been constructed, and estimates of the parameters of the model have been computed. This model is in excellent agreement with the experimental data during the latter stages of experimentation, but provides only a fair explanation of results during the early portion of the experiment. Efforts are directed toward the refinement of the model so as to provide better predictability during these initial stages of experimentation.

General

A statistical analysis to determine the relative precision and accuracy of several radiochemical isotopic analysis methods was completed. Single channel analyzers are soon to be replaced by 256 multiple channel ones, and in an [redacted] to anticipate customer questions the relative characteristics of the [redacted] struments were evaluated.

[redacted]

A meeting was held to consider the feasibility of complete automation of radiochemical isotopic analysis by multi-channel gamma spectrometers. A feasibility study has been initiated of which the first step will be to consider the problem of mathematically simulating monoenergetic spectra in the range zero to 3 mev from the analysis of spectra from a selected set of standard monoenergetic sources.

A second and more efficient method of determining approximate point-wise values from space-averaged data was developed.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Irradiation Processing Department

Mathematical consultation was provided on several problems involving numerical solutions of simultaneous partial differential equations and quadrature methods on empirical data.

Chemical Processing Department

Several problems of determining optimal selection and combinatorial policies for the components of a required assembly are presently under study.

The final design and specifications of a set of cams necessary to guide the Gorton lathe during machining operations were completed.

Contract and Accounting Operation

Several aspects of the problem of allotting time on data processing equipment are being studied. These include a mathematical description of the arrival, waiting, and computational times involved, a reliability study to place confidence limits on the amount of time required for routine non-technical work; and the development of optimum techniques for the allocation of machine time.

Relations Operation

Analysis of psychological test score data obtained from plant personnel during the past three years was initiated.

Carl A Bennett

Manager,
OPERATIONS RESEARCH & SYNTHESIS

CA Bennett:kss

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
Miller Hudson	10/12-15	AEC-Washington	Reactor Safeguards Discussion	CA Bennett WR Lewis JB Work	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. A. Bennett	10/13/59	Idaho Falls Oper. Office-AEC	Consultation on Wash. Des. Prog.	W. Ginkel	Yes
C. A. Bennett	10/21/59	Savannah River Oper. Office-AEC	Consultation on Wash. Des. Prog.	N. Stetson	Yes
C. A. Bennett	10/22-29	Div. of Research-AEC Wash.	Washington Desig. Programs	Dr. S.G.English D. R. Miller	Yes
		AEC, Washington	Special Program	E. R. Gardner	Yes

PROGRAMMING OPERATION
OCTOBER 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

Special Radioisotopes

Although no uranium ore mill sample has yet been established as a source of thorium containing as much as 10 per cent ionium, analysis of material from three of a total of five mills from which samples have been received do show thorium containing about 2 to 4 per cent ionium.

The study of a possible irradiation program for U-232 and Th-228 production was continued. A continuing program based on charging a reactor with one kilogram of Th-230 per month in the form of thorium containing 10 per cent of the Th-230 isotopes should yield milligrams of Th-228 in about eighteen months and gram quantities after about five years. Such a program would require all of the Th-230 from a mill processing about two tons of uranium per day. This would be about 5 per cent of the U.S. ore processing capacity.

Work on the detailed status report covering all phases of this study was continued. The first draft is estimated to be about 90 per cent complete.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Cycle Analysis

Computer Code Development. The RBU code received extended testing early in the month, completing the period of intensive debugging of the main parts of the code. Although further test runs may indicate the presence of minor errors, it appears at this time to be operating satisfactorily. The greater part of the basic library compiling has now been done, and further progress has been made on the input and output routines. American Standard's final report has been issued (ATL-A-101) as an informal AEC research and development report, containing flow charts and descriptive information for the entire code.

Coding for the IBM-709 continued on the remaining 5 out of original 18 IBM-650 codes for the initial evaluation of self-sustaining plutonium recycle in enriched thermal reactors. One of the codes refines its own answer by "iteration". When handling the cards between iteration with the IBM-650, personal judgment was applied between iterations to hasten "convergence" or achievement of the allowable variation in successive answers. Putting such judgment into the IBM-709 routine requires care and current efforts have been plagued with "looping" wherein the machine recomputes the same number endlessly. All but one of these "bugs" have been corrected.

Analytical Studies. The analysis of stainless steel and zirconium cladding fuel cycle economics, using the Meleager and Hanford P-3 codes, was continued through the month. Results apparently agree with earlier results reported in May. The physics calculations for this project are now nearly completed.

PRTR Plans and Schedules

Study of the costs and benefits associated with the procurement of the desired amounts of plutonium containing about 20 per cent Pu-240 to advance the PRP was nearly completed. It appears that such fuel could best be prepared by plutonium irradiation at Savannah River or by the irradiation of depleted uranium at Hanford. The Savannah River route is estimated to be about one and a quarter million dollars cheaper than the Hanford route, if credit is taken for the reactor operating time saved by the 700 fewer days required to reach the state of self-sustaining operation. Even without taking credit for such savings, the shortened time permits achievement of other PRP objectives at a correspondingly earlier date, including earlier experience with high exposure plutonium fuel element fabrication and earlier experience with reactor operation with high exposure fuel.

PRTR Hazards Evaluation

The calculations of the dosage rates around the PRTR containment vessel were revised to provide values for the actual thickness of the steel walls rather than the nominal one inch thickness previously used.

PLUTONIUM VALUE STUDY

At the request of the Evaluation and Planning Branch of the AEC Division of Reactor Development, a research and development proposal was prepared concerning a "Plutonium Value Study". This study relates to the examination, both technical and economic, of plutonium fueling in specific reactors as designated by the Commission. Notice was received that the proposed program was approved, and that the first reactor type to be studied is to be of the advanced pressurized water type as recently designed by the Combustion Engineering Corporation and described in TID-8502, Parts 1, 2, and 3, and TID-8504.

C. BIOLOGY AND MEDICINE - 6000 PROGRAM

Radiological Consultation

Consultation was rendered concerning three papers on waste disposal to be presented at a foreign meeting, environmental survey, the whole body counter, hazards aspects of a PRTR loop, and on a development program on instruments for radiation protection.

The final report of the task force on Radiological Evaluation was prepared and transmitted to the Manager, Hanford Laboratories on October 30, 1959.

D. OTHER ACTIVITIES

The final report on the 1959 Summer Institute on Nuclear Energy - Chemical Processing was transmitted to the Atomic Energy Commission. Late in the month, in a meeting of the Nuclear Committee of the American Society for Engineering Education, plans for holding similar institutes during the summer of 1960 were reviewed. The society recommended that Hanford's SINE program not be repeated in 1960 owing to relatively low current demand for training in this field. Execution of a SINE program at Hanford in 1961 is to be re-examined about one year hence.

Lists of potential seminar speakers were exchanged with the University of Washington for the purpose of setting up a regular exchange of speakers between the two organizations. It was agreed to begin the series in November with a talk by E. D. Clayton of Hanford Laboratories Operation to be given to the Physics Seminar at University of Washington. The program will continue with Hanford speakers going to Seattle every other month and University of Washington speakers visiting Hanford on alternate months.

At the request of the Commission a proposal was prepared concerning the preparation at Hanford of a comprehensive book on plutonium technology.

Assistance was rendered in arranging for six tours (involving 300 people) through HLO and HAPO facilities.

L H McEwen
Manager, Programming

LH McEwen:dl

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VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
Ted Belden	10/2/59	IBM Richland, Wash.	Attend physics seminar on RBU computer.	J.R. Triplett	No	300, 3760
R.S. Mosher	10/8/59	GE - GEL Schenectady, N.Y.	Describe manipulators.	L.H. McEwen	No	300, 3760, 325, 327
Fred Warren*	10/22/59	Pickard, Warren, & Lowe Associates Washington, D.C.	Discuss Pu Recycle Program.	J.M. Atwood	No	300, 328, 308, 309
K. L. Mattern* E. W. Murbach*	10/22/59	Atomics International Canoga Park, Calif.	Discuss Pu Recycle Program.	M. Lewis	No	300, 328, 308, 309
R.L. Stanford*	10/19/59	Detroit Edison Detroit, Michigan	Discuss general fast reactor problems.	E.A. Eschbach	No	300, 328
E.L. Anderson C.W. McLaughlin J.L. Simmons S. Sobol O. T. Roth	10/20 - 10/23/59	AEC - DRD Washington, D.C.	Discuss Pu Recycle Program.	L.H. McEwen	Yes	All
M. H. Wahl	10/28/59	Savannah River Laboratories Savannah River, Georgia	Discuss high exposure plutonium for the PRP.	L.H. McEwen C.A. Rohrmann	No	300, 328
Karl Puechl	10/28/59	Nuclear Materials & Equipment Co. Apollo, Pa.	Discuss fuel cycle	E.A. Eschbach	No	300, 328, 308, 309

*Also attended AEC Symposium, 10/20-21/59.

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. B. Work	10/2/59	AEC Washington, D.C.	Combined operations discussions and job interview.	Paul C. Fine	Yes
J. W. Healy	10/5 - 10/6/59	AEC Oak Ridge, Tennessee	Biomedical Program Directors Meeting.	Dr. C. Dunham	No
M. Lewis	10/8 - 10/9/59	Iowa State University Ames, Iowa	Attend AEC Contractors University Relations Conference.	Alex Edwards	No

RADIATION PROTECTION OPERATION MONTHLY REPORT -- OCTOBER 1959

A. ORGANIZATION AND PERSONNEL

A. F. VanPatten transferred from CPD on October 12, 1959. F. L. Meeks transferred to IPD on October 19, 1959. Mildred O. Wendland was deactivated on October 19, 1959. One beneficial transfer was made within RPO during the month. The force of the Radiation Protection Operation totals 130.

B. ACTIVITIES

Two new plutonium deposition cases were confirmed. Body deposition in both cases was less than one per cent (1%) of the maximum permissible body burden (0.04 μc). The total number of deposition cases that have occurred at HAPO is 237 and 170 are currently employed.

Bioassay samples from employees involved in the plutonium-oxide hood explosion in the 231 Building in September indicated negligible deposition.

A potentially serious plutonium skin contamination case occurred at Purex on October 26. About 2,000,000 d/m was found above the right eye of an employee. Immediate decontamination to 10,000 d/m was accomplished, but complete decontamination was not possible for several days because of skin irritation. Initial bioassay samples were negative.

A total of 36 people was counted during the month in the Shielded Personnel Monitoring Station. Lead lining of the shielded cell is scheduled to begin about the middle of November and will require about two weeks to complete.

A review of plutonium contaminated injuries at HAPO was completed and documented. There were 74 known cases of plutonium contaminated injuries reviewed. HAPO experience shows that about 45% of all potentially contaminated injuries resulted in detectable internal deposition. In cases where external contamination was actually detected, about 70% resulted in detectable internal deposition.

Extensive contamination to 1.3 rads/hr in the 327 Building canyon resulted from a chemical explosion of an Na-K swelling capsule during processing. Five employees were contaminated to a maximum of 40,000 c/m. Decontamination was accomplished immediately. Bioassay samples were processed for the involved personnel.

A stack emission of particulate matter estimated at 0.7 curie followed the initial use of the newly constructed A cell in 327 Building. Cutting operations on an NPR prototype fuel element caused the emission. Ground and building surveys in the vicinity of the 327 Building stack revealed no detectable ground contamination.

The recommendation of the NCRP issued in NBS Handbook 69 on MPC's was used to examine the over-all significance of changes in MPC's as compared to Handbook 52. The per cent of MPC's in Columbia River water was calculated on both bases. The approach to MPC's for GI tract, bone, whole body, and kidney was estimated. The effect of the Handbook 69 MPC's, at the present level of approach, is not pronounced. No changes in practices are indicated.

The sampling of seasonal produce approached completion for this year. Over 300 samples have been collected and analyzed for individual isotopes. The analytical work and evaluation of these data are not yet completed; however, general observation at this time indicates the presence of Zn^{65} and Cr^{51} in some crops irrigated with Columbia River water obtained downstream from Hanford reactors. Fission product isotopes were found to be fairly uniform throughout an extensive sampling area indicating these to be largely of fallout origin.

Further study of the Savannah River small-volume bioassay sampling procedure has revealed that it is not suitable for HAPO use in its present state of development. HLO Chemical Research personnel have indicated that their efforts to obtain a comparable procedure have now been intensified.

On the basis of studies conducted to date, it has been determined that iodine air sampling based on absorption of iodine on activated charcoal equals and potentially excels the caustic scrubber methods in sensitivity. A definite advantage is the potential portability of the system and its use as a spot sampler. Air concentrations of one MPC of iodine may be detected by a five-minute sample collected at the rate of 2 cfm.

The calibration frequency for GM meters was extended from one week to two weeks. Some savings in instrument maintenance charges may be realized, as will savings in time for radiation monitoring and calibration services.

The Calibrations Operation fast neutron sources were compared with a National Bureau of Standards neutron source by the Radiological Physics Operation. A variation of only two per cent (2%) was observed in the calibrated value.

A simulated radiological emergency exercise was conducted in the 703 Plotting Room The exercise provided practical experience for those participating and revealed a need for improved communications for the Plotting Room.

C. EMPLOYEE RELATIONS

Four suggestions were received and evaluated during the month. Although none were recommended for adoption, one award of $25.00 was received by a Calibrations employee whose suggestion regarding improved calibration techniques received the approval of the Suggestion Board. There were no outstanding suggestions at month end.

There were five medical treatment injuries for a frequency of 2.35. No security violations occurred during the month.

One grievance was satisfactorily answered at Step I during the month.

Payment of a total of $2,799.56 was made to 25 radiation monitoring employees on the basis of the arbitrator's award on the Maki Arbitration Case.

Several nonexempt employees attended the Information and Orientation Series - Program VI.

Radiological training included: detailed orientation and training regarding radiation protection practices to 12 employees in the Technical Shops Operation associated with 306 Building; two radiation monitoring journeymen completed the five-week training course presented by the PRTR personnel; basic orientation

courses were presented to 40 engineers and draftsmen of the H. E. Bovay Consulting Engineers and four GE auditors from Schenectady.

Three exempt employees are actively participating in the current sessions of PBM-I.

D. SIGNIFICANT REPORTS

HW-54886 REV1 "Beta Field Dose Rate Determinations for Angular Response with the Juno Dose Rate Meter" - Revisions by G. A. Little.

HW-61358 "Estimated Effects of Variations in Plutonium Isotopic Concentrations on HAPO Personnel Exposures as Measured by Film Badges" by E. C. Watson.

HW-61893 "An X-ray Spectrometry Method for Evaluating Doses to 2000 r on Film" by W. V. Baumgartner.

HW-62274 "Hanford Experience with Plutonium Contaminated Injuries, 1945-1959" by R. H. Wilson.

HW-62277 "Analysis of Radiological Data for the Month of September, 1959" by R. L. Junkins.

HW-62386 "A Rotating Source for Calibration Purposes" by L. F. Kocher.

HW-62589 "Monthly Report - October 1959, Radiation Monitoring Operation" by A. J. Stevens.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
J. Kendron	10/13/59	GE - ANP Instrument & Control Unit, P.O. Box 2147, Idaho Falls, Idaho	Discuss pencil reader	FL Rising	No	3706:300
G.E. Winslow	10/13/59	Industrial Physics & Electronics, 470 South 10th East, Salt Lake City, Utah	Discuss pencil reader	FL Rising	No	3706:300
F. Warren	10/22/59	Pickard, Warren & Lowe Associates; Washington, D.C.	Discuss environmental monitoring	RL Junkins	No	3746:300

VISITS TO OTHER INSTALLATIONS

K.R. Heid	10/26 - 27/59	Dow Chemical, Rocky Flats Plant, Boulder, Colorado	To review personnel decontamination methods and the handling of contaminated injuries	T. S. Chapman	Yes
	10/29 - 30/59	Los Alamos Scientific Laboratory, Los Alamos, New Mexico		T. L. Shipman	Yes
R.L. Junkins	10/29 - 30/59	Pacific Northwest Sewage and Industrial Wastes Association, Coos Bay, Oregon	Present a paper	V. W. Bacon	No

ENVIRONMENTAL MONITORING - RESULTS (September 28, 1959 - October 25, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	1.0	% MPC_{GI}	--
Separations Areas	Gross Beta	1.6×10^{-7}	µc/cc	+2
Pasco	Isotopic	0.3	% MPC_{GI}	--
Kennewick	Isotopic	0.1	% MPC_{GI}	--
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	1.5×10^{-8}	µc/cc	+2
100-F Area	Isotopic	3.2	% MPC_{GI}	--
Hanford Ferry	Gross Beta	5.5×10^{-5}	µc/cc	--
Pasco	Isotopic	0.9	% MPC_{GI}	--
McNary Dam	Gross Beta	1.7×10^{-6}	µc/cc	+2
Vancouver, Washington	Gross Beta	3.5×10^{-7}	µc/cc	--
Ground Water				
Outlying Test Wells	Gross Beta	1.0×10^{-4} (Max)	µc/cc	+16
Atmosphere				
Gross Dose Rate -				
Project	Gamma	1.0	mrad/day	--
Environs	Gamma	0.4	mrad/day	--
I-131 Separations Areas	I-131	2.3×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	2.8	curies/week	--
Active Particles - Project	--	1.5	ptle/100 m^3	--
Active Particles - Environs	--	0.4	ptle/100 m^3	--
Vegetation				
Separations	I-131	1.9×10^{-6}	µc/gm	--
Residential	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	1.2×10^{-5}	µc/gm	--

* The % MPC_{GI} is the percent of the maximum permissible limit for continuous occupational exposure to the gastrointestinal tract calculated from drinking water limits.

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

1233976

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
October	0	1
1959 to Date	7	9

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
October	17,956	126	1	1
1959 to Date	251,699	1,026	44	14

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	Average Dose Per Film Packet mr(s)
October	9,918	827	62	30	30	9.80	13.80
1959 to Date	106,874	8,487	813	198	414	7.02	15.66

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
October	1,134	1	0	0	5
1959 to Date	12,441	20	2	0	67
Fast Neutron					
October	345	16	3	0	5
1959 to Date	1,610	37	17	0	65

Bioassay

	October	1959 to Date
Plutonium: Samples Assayed	667	7,485
Results above 2.2×10^{-8} μc/sample	39	371
Fission Products: Samples Assayed	691	7,433
Results above 3.1×10^{-5} μc FP/sample	1	33
Uranium: Samples Assayed	288	2,706
Confirmed Plutonium Deposition Cases	2	13*

*This brings the total number of plutonium deposition cases which have occurred at Hanford to 237.

Uranium Analyses

Sample Description	Following Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples
Fuels Preparation	134	7.2	52	12	3.3	48
Hanford Laboratories	23	7.9	50	27	7.3	21
Chemical Processing	137	8.8	75	18	4.4	63
Chemical Processing*	7.8	4.7	2	-	-	-
Special Incidents	23	10	4	-	-	-
Random	1.3	1.0	3	-	-	-

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

Thyroid Checks	October	1959 to Date
Checks Taken	0	0
Checks Above Detection Limit	0	0
Hand Checks		
Checks Taken - Alpha	36,466	353,040
- Beta-gamma	46,206	319,865
Skin Contamination		
Plutonium	47	253
Fission Products	35	392
Uranium	9	109

CALIBRATIONS	Number of Units Calibrated October	1959 to Date
Portable Instruments		
CP Meter	994	9,695
Juno	304	3,036
GM	1,494	14,008
Other	196	2,026
Total	2,988	28,765
Personnel Meters		
Badge Film	1,276	9,635
Pencils	1,781	12,283
Other	432	4,140
Total	3,489	26,058
Miscellaneous	143	3,888
Total Number of Calibrations	6,620	58,711

A R Keene
Manager
Radiation Protection

AR Keene:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - OCTOBER, 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 1.71 which is considerably below average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 18,531 hours. This includes 17,131 hours performed in the Technical Shops, 808 assigned to Minor Construction, 218 to other project shops, and 374 hours to off-site vendors. The total shop backlog is 26,456 hours of which 50% is required in the current month, with the remainder distributed over a three-month period. Overtime worked during the month was 3.5% (781 hours) of the total available hours.

Distribution of time was as follows:

	Man-hours	% of Total
Fuels Preparation Department	2964	16.0
Irradiation Processing Department	821	4.4
Chemical Processing Department	548	2.9
Hanford Laboratories Operation	13534	73.0
Construction Engineering & Utilities	614	3.3
Miscellaneous	50	.4

A reduction in the number of requests for emergency service reduced the amount of overtime worked by 30% over the previous report period. The overall backlog in the shops has been reduced 14%. The amount of work sent to Minor Construction Shops and off-site vendors was reduced approximately 40%.

Security performance was considered satisfactory with no violations. Safety performance showed a marked improvement with six medical treatment injuries compared to 13 the previous month.

RADIOGRAPHIC TESTING OPERATION

A total of 5,872 tests were made, of which 703 were radiographic (including x-ray and gamma-ray) and 5,169 were supplementary tests. Out of a total of 2,585 man-hours, 527 (20.4%) were in connection with radiographic tests, and 2,058 (79.6%) were used on supplementary tests. The supplementary test work included; autoclave, borescope, dimensional measurement (micrometric & scratch), eddy current, hardness, penetrant (fluorescent O.D. and I.D.), pickling, stress analysis (static and dymanic electric strain gages), surface treatment (alkaline cleaning), and ultrasonic (flaw detection and thickness measurements).

The number of pieces handled this month totaled 5,479 items. The feet of material represented by these items amounted to 55,124 feet. The ability to be able to handle such an unusual amount of material is possible because of the W.B. facility and the fact that the predominant material is tubing in long lengths.

Work was done for 15 different organizational components representing most of the operating departments and service organizations. A total of 31 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 30 different occasions for advice and information on general testing theory and applications for other than the jobs in Part II - Testing Statistics.

Following the successful pickling and autoclaving of the PRTR process tubes demonstrated in September, full scale testing and treatment of the tubes has been maintained. To date 89 tubes have been pickled and autolaved. Of this number 38 tubes have proven acceptable as meeting all requirements. An additional 14 have a vary slight amount of staining associated with the pickling process, and final evaluation by Coatings and Corrosion personnel has shown these to be acceptable also. Their were 20 tubes having a doubtful appearance requiring reworking. Success has not been as high in maintaining the dimensional tolerances of the tubes and 57 tubes will require straightening.

Realization of a higher acceptable output has been hindered by equipment maintenance problems. Also, scaling-up of the research and development pickling and autoclave process was not totally effective. It was necessary to make many process equipment changes at the same time a very tight testing and treatment schedule was being maintained. Process staining and tube distortion are continuing to be experienced. However, improvements made in the process throughout the month have systematically improved the quality of the autoclave film. The process is now yielding 90% good tubes. To cope with the tube distortion problem two courses are open; to forcibly straighten the tubes using a hydraulic press, and to reheat in the autoclave. Provisions have been made to use a hydraulic press; however, in the time remaining as many tubes as possible will be straightened by using the heat of the autoclave.

A schedule has been established for NPR tube preliminary testing and personnel training starting in November. The equipment and building modifications to be done by Kaiser engineers has been delineated. One of the first items of equipment to be modified is the existing autoclave. As soon as the PRTR work is completed the autoclave will be dismantled, straightened and rewired to fit the enlarged version. The design has almost been completed for enlarging the existing autoclave. In addition, bids are being solicited for an additional autoclave to be purchased off-site.

Zirconium sheath tubing is being tested at a rate in excess of 300 tubes per week. This amount is required to satisfy the needs of Ceramic and Plutonium Fuel Development for acceptable tubing. Concurrently, finished fuel element examinations are being made by both groups comprising about a 150 elements per week each. In a continuing effort to improve and shorten the testing, ultrasonic examination is now being evaluated.

Considerable effort was expended this month in assisting IPD in production test IP-278-A (verification of bulk temperature surges at the 105-DR reactor). The contribution of RTO consisted of the placement and data taking (manual and recorded) of a number of strain gages. In addition to this contribution the unique capabilities of RTO in providing 24 hour, 7 day week coverage, was especially demonstrated as being able to cope with the vagaries of reactor shutdown and start-up.

Testing Statistics

Component	No.of Tests	Ft. of Weld or Material	No. of Pieces	Description
CE&UO	160	70	160	PRTR Calandria
CPD	18	17	18	Concentrator tube bundle 304-L S.S.
HLO	5,347	54,955	5,184	33" & 8' long, 9/16" O.D swaged, zr-2 clad UO_2 fuel rods; external ribbed zr-2 tubes; .505" & .680" I.D. zr-2 tubes; .500" O.D., S.S. tubes; 1/16" O.D. swaged thermocouples; Palm Fab & Development Program; Radiography of Al-Pu fuel elements (Zirc Can) Thermocycling Project, Al-Core, Zirc clad fuel elements; Radiograph Thermocouples for position of leads (S.S. Sheath).
IPD	347	82	117	Radiograph pipe welds on KAPL loop; Radiograph brass valve fittings; Perform Rockwell hardness test of flanged zirc tubes; Fluorescent Penetrant inspection of pigtails; Strain gage measurements on rear face.
Total	5,872	55,124	5,479	

CONSTRUCTION OPERATION

On October 1, 1959, there were currently active - 3 Projects, 7 Fixed-Price Work Orders and 41 CPFF Work Orders with the J. A. Jones Construction Company. On October 25, 2 Fixed-Price and 27 CPFF Work Orders were completed and closed out. One CPFF Work Order which had been closed prior to October 1 was reopened for further work and 2 supplements were also issued.

	W. O.	Value
Active Orders (including projects) as of 9/27/59	51	$ 229,049.00 *
Active Orders reopened	1	
Active Orders supplements		3,236.00
Sub-Total	52	$ 232,285.00 *
Active Orders closed out	29	65,697.00
Active Orders remaining	23	$ 166,588.00

* This figure does not include CG-747 - Calandria money.

From the start of this component on October 1 through October 25, there have been 62 new orders and 2 supplements issued to J. A. Jones. 19 of these have been completed and closed out.

H.L. Orders issued 10/1/59 to 10/25/59	62	$ 49,501.00
H.L. Orders supplements to 10/25/59		3,500.00
Sub-Total		$ 53,001.00
H.L. Orders closed out as of 10/25/59	19	24,356.00
Orders remaining	43	$ 28,645.00
Total Open Orders	66	$ 195,233.00
Total Closed Out		$ 90,053.00

FACILITIES ENGINEERING OPERATION

Projects

The following summarizes the status of HLO project activity.

Number of authorized projects at month end: 23

Number of projects authorized during month: 3
- CGH-857, Physical & Mechanical Properties Testing Cell - 327 Building
- CGH-858, High Level Utility Cell - 327 Building
- CGH-860, Access for PRTR Fuel Elements - 327 Building.

Projects completed during month: 2
- IR-246, Alterations to the Positive Ion Accelerator - 3745-B Building
- CA-681, Hanford Equipment in the ETR.

Project proposals submitted to the AEC during month: 3
- CGH-874, Consolidation of Plutonium Metallurgy Facilities
- CGH-877, Pyrochemical Test Facility - 321-A Bldg.
- CGH-878, Additional Facilities for Isotope Study on Animals - 141-C Building Addition.

Projects awaiting AEC approval: 3
- CGH-874, Consolidation of Plutonium Metallurgy Facilities
- CGH-877, Pyrochemical Test Facility - 321-A Bldg.
- CGH-878, Additional Facilities for Isotope Study on Animals - 141-C Bldg. Addition.

Project proposals in preparation: 4
- Rattlesnake Springs Radioecology Research Area
- Uranium Scrap Burning Facility
- High Temperature, High Pressure Autoclave Facility - 306 Building
- Geological & Hydrological Wells - FY-1960.

Total authorized project funds: $ 7,797,600

Total estimated cost of authorized projects: $ 9,271,365

The attached project report details the status of individual projects.

Engineering Services

Title	Status
Isolate Crane Conductors, 314 Bldg.	Work is complete.
326 Building Retention Waste Sump Modifications	Fieldwork in progress.
Additional Lab Hoods & Air Exhaust Modifications - 146-FR Building	Field work contingent on A.R. approval.
Glycol Heat Exchangers - 325-A Bldg.	Design complete. Exchangers and valves on site. Field work to start 11-2-59.
Improve Process Ventilation, Labs 204 & 206 - 3706 Building	Field work in progress.
Heating & Air Conditioning 141-M Building	Work will not be accomplished in view of budget conditions.
329 Building Cooling Problem	Detail design is progressing.
Compressed Air System, 231-Z Bldg.	Existing compressor relocated. New unit on order. Work to be complete 11-30-59.
Revised Electrical Service 1705-F Building	Field work in progress.
Air conditioning Room 4 - 141-H Building	Design complete. Procurement in progress. Installation to start in November.
Ventilation - 314 Building	Engineering proposal complete. Estimates being compiled.
Fire Detection System - 146-FR Building	Design work complete. Estimate is being compiled.
Electrical Modifications - Room 24-A - 326 Building	Engineering complete. Field work to start in November.
Modifications, 3707-C Building	Arrival and installation of the new transformer is planned for the first week in November. Customer is using space "as is" on a temporary basis.
Lead Lining, Shielded Personnel Monitoring Cell - 747-A Building	An order has been issued to J. A. Jones for performance of the work.
Winterize 306 Building Heating and Ventilating System	Work Orders have been issued for completion of winterizing work.

Title	Status
High Level Dissolution Facility 325 Building	Dissolver design complete. Dissolver will be mocked-up after fabrication for testing before proceeding with rest of design.
Space Rearrangement - 3706 Building	An estimate for proposed work has been received. Work is awaiting approval.
Animal Farm Disposal System 141-M Building	Design nearly complete. Estimate on pump replacement is being received.
108-F Building Solvent Storage	Design complete.
Electric Hoist - Graphite Shop - 3730 Building	Design complete. Estimate to be received on alternate proposal.
Fuel Rod Feeder Tamper - 325 Bldg.	Design complete.
Unfired Pressure Vessel Survey and Inspection	Work continues on this program.

Drafting & Design Services

Design and drafting work in progress includes the following:

1. PRTR prototype loop - "As-Built" - 314 Building.
2. Manipulator Model II "As-Builts".
3. Calandria revisions during fabrication - PRTR.
4. Shielded mechanical properties testing facility - 326 Building.
5. Miscellaneous equipment for high level radiochemistry cell - 325-A Bldg.
6. Hanford area map sampling grid for atmospheric diffusion studies.
7. PRTR Fuel Examination Ducts.
8. PRTR gas loop - in-reactor.
9. Post heat treat roller.
10. Shielding for tensile machine - 326 Building.
11. Autoclave installation, 325 Building.
12. Transfer Hood with conveyor - to transfer Pu oxide - 308 Building.
13. Fuel rod wire machine - 308 Building.

In addition to the above work, miscellaneous small design drafting orders are in progress.

Work is being performed on layout and details of projects CGH-834 - Modifications and Additions to High Pressure Loop - 189-D Building; and CGH-838, Fission Product Volatilization Studies Test Facility - 292-T Building.

Maintenance & Building Engineering - Landlord Functions

Costs - September, $118,607 August, $100,607 First Quarter, $301,024

Analysis of Costs - $301,024 = 103% of forecasted $292,500, and 19% of annual $1,572,700 budgeted. Recent budget cut of $115,000 changes these percentages to 100% and 20.6% respectively. The new forecast based on first quarter actual costs reflects a reduction in the Unusual (or Improvement) Maintenance budget and in the General budget. As of October 1, we have $87,300 still in the improvement budget. Outstanding commitments such as in 327 and 328 Buildings will probably reduce this by $38,000 to $50,000.

Unusual Maintenance

Item	September	FYTD
HV Correction	$ 574	$ 2,393
Relocation & Alteration	4,424	4,914
Move Furniture	-	237
Paint	2,012	2,404
Electrical Improvements	922	922
Lighting	148	148
Refilter	701	701
Miscellaneous	-	181
	$ 8,781	$ 11,900

Miscellaneous

Approximately 170 drawings including sketches, work sheets, and form drawings were completed during the month of October by Drafting.

Approximately 13,450 square feet of prints were reproduced during the month.

The total estimated value of the 25 requisitions issued during the month was $16,000. Material procurement and control is being performed by HLO projects and plant operation.

TECHNICAL INFORMATION OPERATION

There were three personnel changes during the month. Two General Clerks left on pregnancy leave. The position of Supervisor, Reference and Publication, was filled by Peter R. Stromer, from the Light Military Electronics Department in Schenectady.

The inter-Departmental task force appointed to study the control of access to documents in the Classified Files has issued a preliminary report for Department review and comment. The report recommends that (1) we recognize four sensitive areas of information at Hanford (2) that all documents in these four sensitive categories be specially marked (3) that the present access system be abandoned entirely (4) that there be no restriction on withdrawal of documents from Files except those in sensitive categories (5) that the "Red Label" or"Circulation Limited" markings be retained for those special situations where it is desirable to closely limit the circulation of a report.

A major revision of the Standard Distribution Lists for Classified Scientific and Technical Reports (M-3679) will be made. The revision will eliminate 21 of the present 37 categories in M-3679 on the basis that there need no longer be any classified reports issued in these categories. In addition, the scope notes for C-42 (Reactors - Production) are going to be re-written and expanded. A new Category C-65 will be created into which will fall Savannah River and Hanford Research and Development reports which contain production information or information from which production data can be inferred. Under the revised system, all Research and Development reports emanating from Hanford will be either unclassified or, if classified, assigned to Categories C-42 or C-65.

Topics proposed by the Specialist, Classification-Declassification at a Washington meeting of AEC and Contractor Classification personnel and briefly discussed were as follows.

(1) The conflict between the Commission's policy of releasing all information on the disposal of radioactive material to the environs with the policy of classifying information which may disclose production information. HAPO has been in an "in-between" position in this area for some time. Compliance with classification policy accounts for the inability to release certain data. Failure to release data for classification reasons can be misinterpreted as purposely withholding the information from the public. The Director of the Division of Classification advised that he would distribute a memo to all concerned reaffirming classification policy as it relates to information on disposal of radioactive materials to the environs.

(2) AEC Conference Papers

In the past, papers for presentation at AEC Conferences, especially international meetings, have been handled outside the normal procedure. In each case, problems have arisen because of failure to follow established clearance procedures. The Director of the Division of Classification said he would continue to endeavor to obtain the cooperation of the Division of International Affairs in processing such papers through established classification-declassification procedures.

(3) Classification guidance on budget and cost data.

Work has not been completed on a proposed guide.

Two other points of interest to Hanford were mentioned: (1) A new weapons classification policy has been approved by the Commission and is now in the hands of the Military Liaison Committee and (2) a proposal made by the Division of Classification to the Commission to declassify U-235 production rates was not approved.

The Keypunch Operation has taken on additional work from two components in Physics and Instrument Research and Development Operation. A total of 22-1/2 hours was spent on these jobs with the time charged to the two units' codes.

A simplified procedure for handling unclassified microcards has been set up. The procedure eliminates the standard procedure of preparing a File Record Card in favor of stamping the word "microcard" on the number card in the reports catalog. The new procedure eliminates a great deal of typing and will save space in the Files which house the File Record Cards. New microcards are being intentionally side-tracked for about two weeks to allow time for the receipt and filing of the catalog cards from TISE, Oak Ridge.

The increasing distribution of reports in microcard form by the Commission is posing a number of problems. At the present time new microcards are coming in at the rate of about 200 a week and over a period of months a large backlog had accumulated. It has been necessary to work ten man days of overtime to reduce this backlog, even with the simplified issuance procedure mentioned above. Another problem is that microcard readers are not available in the outer areas. Future plans call for locating at least one in all major areas so that personnel will not have to travel to the 300 Area each time a microcard report is needed.

Work Volume Statistics

	September	October
Document Distribution and Files		
Documents routed and discharged (copies)	16,205	17,780
Documents issued (copies)	12,044	12,522
Documents sent offsite (copies)	3,492	3,941
Document reserves filled (copies)	916	798
Documents picked up and delivered	19,599	19,662
Document Accountability		
Holders of classified documents whose files were inventoried	461	667
Documents inventoried in Files (copies)	16,669	7,963
Documents destroyed or retired (copies)	1,167	3,912
Documents revised (copies)	1,188	827
Documents pulled and documents filed (copies)	11,017	13,280
Documents reclassified	234	171
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	209,011	212,961

	September	October
Reference and Publication		
Books cataloged (new titles)	219	103
Books added to the collection (volumes)	358	228
Ready reference questions answered by professional staff	137	98
Literature searches by professional staff	109	111
Reports abstracted (titles)	267	268
Formal reports prepared (titles)	10	8
Offsite requests for HAPO reports (copies)	328	242
Reports released to CAP (titles)	15	23
Library Acquisitions and Circulation		
Books ordered (volumes)	276	235
Periodicals ordered	93	398
Books circulated (volumes)	1,737	2,120
Periodicals circulated (issues)	2,752	3,780
Inter-Library loans	78	65
Films borrowed or rented	25	17
Industrial film showings	43	60
Bound periodicals added to the collection	217	84

Library Collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No. of books	27,731	8,268	1,503	1,986	39,488
No. of bound periodicals	12,660	1	1,431	96	14,188
	40,391	8,269	2,934	7,082	53,676

Classification and Declassification

	September	October
Documents, including drawings and photographs reviewed for downgrading or declassification	32	2
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	37	44
Documents submitted to Declassification Branch, Oak Ridge	13	6

JL Boyd

Manager,
Laboratory Auxiliaries

1233989

JL Boyd:jcw

UNCLASSIFIED

HW - 62587

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

MONTH October, 1959

BUDGET CLASSIFICATION Improvements to Production & Supporting Installations - 58-b-4

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE or Actual DESIGN / CONST.
CG-731	Critical Mass Laboratory	$1,000,000	$1,000,000 3-23-59	100 100	30 32	5-22-58 6-4-59	- - - 6-30-60	2-24-59 6-30-60
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: D. S. Jackson		

REMARKS: The contractor poured the reactor room floor slab early in the month, then put up the reinforcing steel for the walls. A 290 cubic yard portion of the reactor room walls consisting of the entire north wall and labyrinth and 9 and 11 linear feet of the east and west walls respectively were poured October 29. The frame for the large shielding door was placed ready for pouring the remainder of the walls. Essentially all stainless steel for equipment fabrication has been obtained and fabrication is progressing. Delivery dates for the hoods and instrument panels are slipping, however, it is expected the hoods will be received early enough to prevent delaying the contractor excessively. The steel roof decking for the service building was received; as soon as dents are removed from some sheets, that were mishandled during shipping, the decking will be installed. All interior partitions in the control building are in place; they must still be taped, spackled and painted. The styrofoam insulation has been placed on the exterior walls ready for plastering.

		USING COMPONENT				FEO ENGINEER		

REMARKS:

(CG-731 Continued) The fence around the facility is 99% complete.

CA-744	Metallurgical Development Facility - 306 Building ** Contractor's portion.	$2,650,000	$2,685,000 11-5-58	100 100	22* 40** 22* 40**	15*** 6-30-58 17*** 3-20-59	- - 9-1-60	9-30-59 9-1-60
		USING COMPONENT: Reactor & Fuels R & D		* Overall project. ***CPFF's portion.		FEO ENGINEER: J. T. Lloyd		

REMARKS: The building and service contractor (Jensen-Rasmussen Company) has erected the major portion of the structural steel. The insulated metal siding has been installed on over 90% of the north wall. The roofing contractor has started installation of the vermiculite concrete roofing. The chemical processing area bid package has been in the hands of the AEC since October 6, 1959. Some delay in submission of the bid package to prospective bidders was due to AEC comments and resolution of these. Procurement of equipment is progressing with some difficulty. Integration of inspection with CE&UO and HLO interested engineers has been accomplished. Chemical processing tanks requisitions were transmitted October 7 and invitations were out October 21, 1959. Bids will be opened November 16 and orders will be placed November 26, 1959 with delivery in 3 to 5 months depending on effects of the steel strike. A meeting is scheduled with AEC on procurement of tanks.

AM-7300-819 (8-58)

UNCLASSIFIED

UNCLASSIFIED

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH October, 1959

BUDGET CLASSIFICATION Improvements to Production & Supporting Installations - 58-b-4

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CA-749	High Level Radiochemistry Facility	$960,000	$960,000 10-3-58	100 100	97 99	6-15-58 8-14-58	- - - 1-1-60	11-21-58 11-30-59

USING COMPONENT: Chemical R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS: Final inspection and acceptance of this facility, with exceptions, from the fixed price contractor took place on October 7, 1959. The three remaining major exceptions are: (1) Correcting moisture blisters under paint around metal plates embedded in cell exterior; (2) Correcting gas blisters defacing Amercoat paint on outside face of cast iron doors; and (3) Putting a seal on the bottom of the Hauserman partitions. There are approximately thirty other exceptions, mostly paint touch-up. Plant forces installed eight Argonne Model 8 Mainpulators and a General Mills Manipulator. A General Mills installation engineer was here the week of October 12 during the installation. The General Mills Crane had to be modified to fit the cell. ATP testing continued and it was agreed that Bohna's contract would be modified and G. E. forces would perform the air balancing and repair of items 1 and 2 above. It is expected that operations forces will take occupancy of the building November 3, 1959 with plant forces still performing work on the project. Installation of the transfer

USING COMPONENT:
FEO ENGINEER:

REMARKS:

(CA-749 Continued) mechanisms in five transfer ducts has been delayed for 3 months pending delivery of spur gears that are scheduled for delivery November 2, 1959. Installation of these mechanisms is a 2 weeks job.

CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$350,000	$345,000 4-23-59	100 100	100 75	6-23-58 10-9-58	- - - 2-1-60	12-31-58 2-1-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: J. J. Peterson

REMARKS:

Piping for the ventilation unit is in progress. Structural steel for stub wall at column line 1 has been placed as well as steel for support of crane door. Upper half of the crane door has been placed in position. Reinstallation of wall panels, removed from the west end of the existing building, are being made on the west end of the new addition. CPFF forces have placed the blacktop on the access road to the building.

UNCLASSIFIED

BUDGET CLASSIFICATION Improvements to Production & Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH October, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN	CONST.			
			AMOUNT	SCHED.	SCHED.	DESIGN	DESIGN	DESIGN
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CGH-819	Increased Laboratory Waste Facilities - 300 Area		$30,000	100	0	3-30-59	- - -	4-1-60
		$190,765*	11-24-58	100	0	5-1-60	- - -	3-1-61
		USING COMPONENT: Chemical R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

The project proposal requesting construction funds is being routed for signatures.

* Includes $10,765 transferred capital property.

General Plant Projects - FY 1959

CAH-827	Automatic Columbia River Monitoring Station		$39,000	100	0	4-3-59	- - -	6-18-59*
		$39,000	6-30-59	100	0	12-1-59	12-31-59	4-1-60
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS:

Construction is still delayed until completion of backfilling at the PRTR river pump structure.

* A-E only.

CAH-828	Central Storage Facility - 300 Area		$40,000	N.S.	100	4-2-59	- - -	6-8-59
		$40,000	7-30-59	100	95	7-15-59	12-31-59	11-6-59
		USING COMPONENT: Finance				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The construction work is essentially complete. All tie-ins have been completed. The lock cylinders have not arrived on site. Clean-up and installation of the metal shelving remain.

AM-7300-019 (5-58)

UNCLASSIFIED

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH: October, 1959 4

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED COMP. DATE or Actual: DESIGN / CONST.
CGH-829	Building 325 Basement Improvements	$70,000	$70,000 / 2-13-59	N.S. / 100	95 / 95	2-13-59 / 3-2-59	- - - / 12-31-59	8-11-59 / 12-31-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The sprinkler system is complete except for certification. The lump sum contract work is complete except for clean-up and some patchwork. Stabilization of the banks on each side of the truck access door has been completed. Some electrical work on the mezzanine remains to be done by J. A. Jones Company.

CAH-837	Animal Pens, Isolation and Examination Facilities	$77,000	$80,000 / 3-17-59	100 / 100	100 / 90	3-30-59 / 7-10-59	- - - / 4-1-60	6-5-59 / 11-15-59
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The glazed block arrived after a delay of about two weeks. The blocks have all been laid, but have not been accepted by the AEC due to the non-uniform color and varying widths of joints. J. A. Jones Company have completed cutting new door opening in present end wall of 141-FS Building and installation of the new door. It is expected that the AEC will allow the contractor an extension of time.

CGH-840	Sheet Metal Shop Addition - 328 Building	$40,000	$40,000 / 6-18-59	N.S. / 100	91 / 87	6-22-59 / 6-25-59	- - - / 5-1-60	9-1-59 / 12-1-59
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: J. J. Peterson		

REMARKS:

Propane, water, air and steam lines have been completed. Access ladder to the roof has been installed. New equipment has been moved into position, but not energized. Concrete ramp is 50% complete. Sliding door is in process of being fabricated. Ventilation unit and unit heaters have been installed.

UNCLASSIFIED

BUDGET CLASSIFICATION 1166221
General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH October, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED or Actual COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
CAH-848	Geological and Hydrological Wells - FY 1959	$56,600	$56,600 / 6-24-59	N.S. / 100	49 / 49	5-12-59 / 7-16-59	- - - / 5-31-60	7-6-59 / 3-30-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: H. E. Ralph		

REMARKS:
To date 1,600 feet of new hole have been drilled. Eleven new wells have been developed and four existing wells have been redeveloped.

IR-246	Alterations to the Positive Ion Accelerator Facility - 3745-B Building	$18,918	$19,000 / 4-20-59	N.S. / 100	100 / 96	4-21-59 / 5-7-59	- - - / 10-20-59	5-1-59 / 10-16-59
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:
A Physical Completion Notice dated October 16, 1959 has been issued.

IR-247	Normal Electrical Service - Experimental Animal Farm - 100-F	$9,488	$12,500 / 4-28-59	N.S. / 100	100 / 100	4-22-59 / 6-5-59	- - - / 9-28-59	5-12-59 / 9-28-59
		USING COMPONENT: Biology				FEO ENGINEER: R. C. Ingersoll		

REMARKS:
A Physical Completion Notice, with exceptions, dated October 26, 1959 has been issued. The tie-in of the 2.4 KV normal electrical feeder remains and will be completed when tie-in work in connection with Project CAI-831, "Badgehouse and Fence Relocation - 100-F Area" is performed.

UNCLASSIFIED

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH October, 1959

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE or Actual	ESTIMATED COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	$120,000	$120,000 / 5-25-59	100 / 100	100 / 100	3-2-59 / 3-10-59	- - - / - - -	5-15-59 / 10-15-59

USING COMPONENT: Laboratory Auxiliaries
FEO ENGINEER: H. Radow

REMARKS: The remaining start-up item, relocation of the control switch for the pickle tank hoist, is nearing completion.

General Plant Projects FY 1960

CGH-860	Access for PRTR Fuel Elements - 327 Building	$81,000	$81,000 / 10-8-59	N.S. / 5	N.S. / 0	10-19-59 / N.S.	- - - / 8-15-60	1-15-60 / 4-30-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: J. J. Peterson

REMARKS: Directive No. HW-500, dated October 8, 1959 has been received and work on architectural and structural design is in progress. A revised project proposal is being submitted requesting a change in the method of performing work, for exterior construction, from Lump Sum Contract to CPFF Service Contractor.

CAH-864	Shielded Animal Monitoring Station - 100-F	$46,000	$46,000 / 8-6-59	0 / 0	0 / 0	- - - / N.S.	- - - / 4-1-60	12-1-59 / 4-1-60

USING COMPONENT: Biology
FEO ENGINEER: J. T. Lloyd

REMARKS: On October 13, 1959 the General Electric Company gave the AEC an approved design scope specification with a scope drawing. The Architect-Engineers (Carson, Kesterson and Moe) started work on October 22, 1959. The General Electric Company has not received the design schedule or copy of the contract from the AEC. This has been requested by FEO.

UNCLASSIFIED

AM-7300-819 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION 9666271

General Plant Projects - FY 1960

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587

MONTH October, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-874	Consolidation of Plutonium Metallurgy Facilities	$285,000	None / None	0 / 0	0 / 0	1 * / 2 *	- - - / - - -	5 * / 11 *

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. T. Lloyd

REMARKS:

The project proposal was submitted to the AEC on October 8, 1959; to date no action has been taken.

* Months after authorization.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-877	Pyrochemical Test Facility - 321-A Building	$70,000	None / None	0 / 0	0 / 0	1 * / 3 *	- - - / - - -	5 * / 10 *

USING COMPONENT: Chemical R & D

FEO ENGINEER: R. C. Ingersoll

REMARKS:

The project proposal was submitted to the AEC-HOO October 14, 1959 for approval.

* Months after authorization.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-878	Additional Facilities for Isotope Study on Animals - 141-C Building Addition	$61,000	None / None	0 / 0	0 / 0	½ * / 1 *	- - - / - - -	1 * / 4½ *

USING COMPONENT: Biology

FEO ENGINEER: J. T. Lloyd

REMARKS:

The project proposal was submitted to the AEC-HOO October 28, 1959 for approval.

* Months after authorization.

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH October, 1959

BUDGET CLASSIFICATION Improvements to Production & Supporting Facilities - 60-a-1

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CAH-870	Facilities for Recovery of Radioactive Cerium - 325 Building	$400,000	$35,000 / 9-2-59	60 * / 80 *	0 / 0	9-18-59 / N.S.	- - - / - - -	2-15-60 / 9-1-60

USING COMPONENT: Chemical R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:

The Architect-Engineer forces made two trips here to discuss preliminary design. Six prints and a report were submitted for review on October 29, 1959.

* Preliminary design.

Equipment Not Included in Construction Projects - Program Class 2900

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CG-661	Additional Heat Generation Facility - 189-D Building	$500,000	$664,000 / 9-18-57	100 / 100	100 / 99	12-6-59 / 12-3-58	- - - / 8-31-59	10-15-58 / 4-30-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: J. J. Peterson

REMARKS:

A revised project proposal requesting an extension of time is being written. The primary reason for this extension is to correct inadequacies which became apparent after start-up of the additional heat generation equipment. These inadequacies involve the temperature detection and recording devices.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	$1,055,000*	$1,140,000 / 4-1-59	100 / 100	99 / 99	9-17-56 / 4-1-58	- - - / 3-1-60	9-30-59 / 10-30-59**

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: H. Radow

REMARKS:

Work remaining to be done includes:

1. Completion of installation of remote operators for 6 x 9 loop.
2. Installation of heater control panel.
3. Delivery and hook-up of underwater examination facility.
4. Start-up of rupture detection equipment.

* Currently indicated project cost, including accrual items.
** Physically complete with exceptions.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587

MONTH October, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000 / 12-8-58	91 / 88	0 / 0	1-5-59 / N.S.	- - - / 12-31-60	12-8-59 / 12-31-60

USING COMPONENT: Reactor & Fuels R & D

FED ENGINEER: H. Radow

REMARKS:

Instrumentation design can proceed to completion as soon as the valve rack order is placed and the remaining vendor approval drawings are received. Design of the capsule removal facility is nearing completion and procurement of the capsule cutter is being processed. Procurement of the major electrical items is also underway.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$170,000 / 10-1-59	40 / 40	0 / 0	6-10-58 / N.S.	- - - / 10-31-60	1-1-60 / 3-1-61

USING COMPONENT: Reactor & Fuels R & D

FED ENGINEER: R. W. Dascenzo

REMARKS:

The total project was authorized by Directive HW-460, Modification No. 1, dated October 1, 1959. The using component has allocated only $10,000, from their equipment funds, to this project for FY 1960. A Work Release Authorization, dated October 19, 1959 was issued by Laboratory Auxiliaries for completion of project design.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-805	High Temperature Tensile Testing Cell - 327 Building	$170,000	$150,000 / 2-25-59	100 / 100	0 / 0	8-26-58 / 2-1-60	- - - / 3-31-60	6-15-59 / 4-1-61

USING COMPONENT: Reactor & Fuels R & D

FED ENGINEER: R. W. Dascenzo

REMARKS:

Although fully authorized, this project was allocated only $20,000 for FY 1960 by the using component from their equipment funds. Presently purchase orders are continuing on a lead glass window and Hanford slave manipulator. A purchase order for the Meehanite Cast Iron cell assembly was cancelled and cancellation charges requested.

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587

MONTH October, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or ACTUAL COMP. DATE DESIGN / CONST.
CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building	$700,000	$700,000 / 4-8-59	59 / 65	22 / 22	4-20-59 / 4-22-59	- - - / 10-15-60	2-9-60 / 10-15-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

Bid deadline for the high speed valves was extended to November 16, 1959 at the request of the two vendors that to date are the only ones indicating they would submit bids. Shells for the preheater order are being completed and indicated delivery for the preheaters is mid-to-late December. Approval drawings for the heat exchanger have been submitted and vendor's procurement of raw material is under way. Requisitions for the high pressure water storage and air receiver vessels have been processed. Construction activity can be accelerated upon receipt of pipe and other materials now on order and on hand at the mills, if curtailment of the strike will permit their release and shipment.

CGH-838	Fission Product Volatilization Studies Test Facility - 292-T Building	$75,000	$75,000 / 3-26-59	100 / 100	95 / 93	4-9-59 / 4-16-59	- - - / 11-30-59	9-15-59 / 11-30-59
		USING COMPONENT: Chemical R & D				FEO ENGINEER: O. M. Lyso		

REMARKS:

Installation of junior cave sample train is 90% complete. Shielding for burning capsule is complete to upper cover plate. Preliminary checks on the heating characteristics of the induction unit have been made. Repair of the temperature controller, which was damaged in shipment, has been completed on the plant. Due to the extremely high noise level of the motor generator set, a decision was made to locate this unit externally and erect an enclosure for the generator. Additional tests of work coils are planned during the first weeks of November, prior to buttoning up the shielded enclosure.

CGH-857	Physical and Mechanical Properties Testing Cell - 327 Building	$400,000	$75,000 / 10-1-59	0 / 0	0 / 0	10-20-59 / N.S.	- - - / - - -	4-1-61 / 1-1-62
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

Preliminary and detailed design was authorized by Directive No. HW-498, dated October 1, 1959, for $75,000. This project was allocated $10,000 for FY 1960 by the using component from their equipment funds. A Work Release Authorization was issued on October 19, 1959 and a design criteria only will be prepared for vendor design of major pieces of equipment.

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62587
MONTH October, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-858	High Level Utility Cell - 327 Building	$500,000	$70,000 / 10-1-59	0 / 0	0 / 0	10-20-59 / N.S.	- - - / - - -	1-1-61 / 11-1-61

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

Preliminary and detailed design was authorized by Directive No. HW-499, dated October 1, 1959, for $70,000. A Work Release Authorization was issued October 19, 1959 and a design criteria has been started for vendor design of a remotely operated milling machine and lathe.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-866	Shielded Analytical Laboratory - 325 Building	$480,000	$10,000 / 8-12-59	35 * / 35 *	0 / 0	9-5-59 * / N.S.	- - - / - - -	12-1-59 * / 6-1-61

USING COMPONENT: Chemical R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

Preliminary design is continuing. To date two drawings on cell and facility layout have been issued for comment.

* Preliminary design only.

USING COMPONENT

FEO ENGINEER

REMARKS:

AM-7300-819 (3-59)

UNCLASSIFIED

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
Marshall Dana	10/5/59	First National Bank Portland, Oregon	Learn about Tech. Info. facilities	C. G. Stevenson	No	300, 3760
P. Kreiter	10/7/59	Tri-State Paint Co. Portland, Oregon	Painting of 328 Bldg. Tech. Shops	P.F.X. Dunigan	No	300, 328
Hillis L. Griffin	10/15/59	Phillips Petroleum Co. AEC Idaho Falls, Ida.	Discuss mutual tech. infor. problems	C. G. Stevenson M.F. Orr - B.B. Lane	No	300, 3760
W. D. Buckley	10/12/59	Perry Institute Yakima, Wash.	To discuss machine shop work	L. J. Lucas	No	300, 328
James Mohondro	10/20/59	Hallidie Machinery Co. Spokane, Wash.	To discuss grinding problems.	L. J. Lucas	No	300, 328
James Woodard	10/20/59	Cincinnati Grinding & Mach.Co. Cincinnati, Ohio	To discuss grinding problems.	L. J. Lucas	No	300, 328
Julium H. Morris	10/27/59	Mid-Columbia Library Kennewick, Wash.	Learn about Tech. Info.	C. G. Stevenson	No	300, 3760
W. L. Gallagher	10/27 - 11/2/59	B. D. Bohna Co. San Francisco, Calif.	Consult on project CAH-870	R. W. Dascenzo	No	300, 325-A 328
G. H. Harnden	10/26 - 10/28/59	G. E. Co. Schenectady, N.Y.	Discussion on Engr. Stds. with HAPO personnel & ASTM committeemen	J. L. Boyd	No	300, Various Bldgs.
H. D. Ferrier	10/28/59	AEC of Canada - L. Chalk River, Canada	Learn about Tech. Publications	C. G. Stevenson P. J. Youmans J. A. Moir	No	300, 3760

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
Betty J. Borgmier	10/5 - 10/6/59	AEC Declassification Branch, Oak Ridge, Tenn.	Discuss declassification matters.	H.F. Carroll & Staff	Yes
	10/7 - 10/8/59	AEC Division of Classification Washington, D. C.	Attend meeting of Classification Committee Chairmen & representatives of major contractors to discuss classification policies & procedures.	C.L. Marshall & Staff	Yes
Donald G. Stave	10/14/59	Univ. of Idaho Moscow, Idaho	Attend meeting to discuss HAPO participation in developing union list of serials.	Lee Zimmerman	No

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION MONTHLY REPORT

GENERAL

As of October 31st, the staff of the Hanford Laboratories totalled 1320 employees, including 636 exempt and 684 nonexempt. There were 546 employees possessing technical degrees, including 334 B.S., 112 M.S. and 100 Ph.D.

COMMUNICATIONS

Preparations are underway for a half-hour television show on radiation protection tentatively scheduled for December 17.

An open house at the Plutonium Fabrication Pilot Plant was held on October 24th for employees of the Plutonium Metallurgy Operation and their families.

EMPLOYEE COMPENSATION

Copies of the booklet, "Exempt Employee Compensation and Promotion and Transfer Considerations," were made available to supervisors of exempt personnel.

HLO gained 21 new members in the Good Neighbor Fund as a result of the latest campaign. This is a gain of 1.5% in participation.

HEALTH, SAFETY AND SECURITY

The medical treatment frequency for October was 1.52 as compared with 1.97 last month. There were 5 security violations during October, bringing the total for the year to date to 38.

During the month, an injury which occurred on September 29th was reclassified as a disabling injury and occurred when an employee smashed a finger which required amputation on October 12. This represents HLO's second disabling injury since 1956.

PROFESSIONAL PLACEMENT

BS/MS recruiting for the 1959-60 recruiting year began on October 7. During the month, 7 recruiters visited 10 universities. Early indications are that the demand for engineers is increasing over last year; however, students' response to our interview visits has been excellent. Seven offers were extended to experienced graduates and 6 acceptances were received during the month. Recruiting activity in this area has decreased materially during recent weeks. Two PhD offers were extended and 2 acceptances were received during the month. Two PhD's reported on the roll for HLO. During October, HAPO participated in Company PhD recruiting at Texas, Rice, Purdue, and Illinois.

Four Technical Graduates were added to the Training Program rolls during October and 8 were placed on permanent assignment. The total force in the Training Program on October 31st was 78.

TRAINING

Classes 11 and 12, PBM-I, totalling 40 Laboratories people were started. Twelve Laboratories people enrolled in Understanding People. Fifteen Engineering Assistants were enrolled in the Applied Creativity course. The Information and Orientation

series continued.

EMPLOYMENT

Twenty-three nonexempt requisitions were filled during the month. With the receipt of 12 new requisitions and 2 cancellations, there were 15 openings at month's end, for which 6 candidates are in process and 7 transfers are pending, leaving 2 yet to be procured.

Manager,
Professional Placement
and Relations Practices

TG Marshall:tr

VISITS TO HANFORD WORKS

Name	Dates of Visits	Organization Represented & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
O. S. Hulley	10/6	Manufacturing Serv. New York, N. Y.	To discuss Manufacturing Training Program	RS Himmelright EP Galbraith TG Marshall	None	328 - 300
J. K. Wolfe	10/9	Eng'g Pers Serv Schenectady, N. Y.	To review Ph.D. recruiting procedures with HAPO technical personnel	LJ Kirby EP Galbraith TG Marshall	None	3702-300 3760-300 PRTR

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. J. Kirby	9/29	G.E. Company Schenectady, N. Y.	To attend Eastern Doctoral Centralizers' Meeting	JK Wolfe	None
L. J. Kirby	9/30	Power Tube Dept. G.E. Company Schenectady	To interview three glass blowers for prospective work at HAPO	CE Pearson	None
L. P. Henderson	10/1-10/8	Apparatus Sales Offices in: Seattle, San Francisco, Los Angeles, Phoenix, Denver	To attend Recruiter Orientation Meetings in listed cities	JB Holmes, Mgr. Western Recruiting Region	None
L. J. Kirby	10/8	G.E. Company San Francisco	To attend Western Doctoral Centralizers Meeting	JK Wolfe RN Dyruff MW Hall Don Romer JE Torrey	

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
T.G. Marshall	10/15	Eng'g Services New York	Discussions with Eng'g Register people	F.B. Nuelle	None
		Relations Services New York	Discussions regarding employee benefit plans	I.H. Dearnley	None
	10/16	Employee Comp. New York	Attend starting rates meeting	G.P. Ruderman	None
R.D. Tillson	10/19, 20, 21	Oregon State Coll. Corvalis, Oregon	Recruitment at BS/MS level	M. Haith	
L.J. Kirby	10/20 thru 23	Univ. of Illinois Urbana, Ill.	Ph.D. recruiting	Placement offcrs, professors	
R.D. Tillson	10/22, 23	Univ. of Wash. Seattle, Wash.	Recruitment at BS/MS level	James Souther	
L.P. Henderson	10/26 - 10/29	Wash. State Univ. Univ. of Idaho	Recruitment at BS/MS level	Walter Bristol Allen Janssen	

TABLE II NONEXEMPT EMPLOYMENT

NonExempt Employment Status	Sept.	Oct.
Requisitions		
At end of month	31	15
Cancelled	2	3
Received	26	12
Filled	22	23

NonExempt Transfer Request	Sept	Oct.
Transfers		
Active cases at end of mo.	83	80
Cancelled	4	6
New	4	7
Transfers effected	2	4

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A. Technical Recruiting Activity - HAPO - September 1, 1959 to Date

	Visits to Richland				Offers*			
	Cases Considered	Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll**
Ph.D.	148	44	7	19	5	2	-	2
Exp. BS/MS	102	26	21	1	20	14	3	16
Prog. BS/MS	27	-	-	-	3	2	1	3

*Offer totals include offers open on 9/1/59
Ph.D. 3
Exp. BS/MS 6

**On the Roll totals include 1958/59 Carryover acceptances.

B. Technical Recruiting Activity - HLO - September 1, 1959 to Date

	Visits to Richland				Offers*			
	Cases Considered	Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll**
Ph.D.	148	44	7	19	4	1	-	2
Exp. BS/MS	72	13	9	1	5	1	1	4

*Offer totals include offers open on 9/1/59
Ph.D. 3
Exp. BS/MS 3

**On the Roll totals include 1958/59 Carryover acceptances.

In addition to the above activity, 7 exempt employees have transferred into HLO from other HAPO departments and 1 technical graduate has accepted off-Program placement in HLO to date.

C - Technical Graduate and Technician Training Program
Month ending October 31, 1959

	TG Program	TT Program
Number Personnel on assignment	71	7
(HAPO Tech Grad Program.....63		
(Western District E.P. 8		
Distribution of assignments by Depts.		
HLO	23	3
CE&UO	1	0
FPD	1	0
IPD	38	4
CPD	8	0
Distribution of assignments by function		
R&D or Engineering	49	7
Other	22	0

FINANCIAL OPERATION MONTHLY REPORT
OCTOBER 1959

Personnel

During October, two employees (1 exempt and 1 salaried) were transferred from CE&UO Financial to HLO Cost Accounting to perform the accounting for HLO PA&C and Equipment Projects.

Activities

GENERAL ACCOUNTING OPERATION

AEC approval was requested and granted authorizing payment of an over-run of approximately $3,500 on an Assistance to Hanford job assigned to the Steam Turbine Generator Department. The Commission in approving the overpayment cautioned against further over-runs in excess of the permissible 10% limit.

A questionnaire was forwarded to Section Managers regarding the desirability of continuing the special report on "Announcement of HLO Trips and Visits".

A review of Continuity of Service accrual rates indicated that rates currently in effect would be continued through December 31 at which time a further review would be made. The review, however, resulted in a determination that it would not be necessary to make a second special accrual of $18,500 to fund incentive shares incidental to the Security and Savings Program.

A Manual on Travel and Living Expenses policies and procedures for Hanford Laboratories was distributed early in the month. Travel activity dropped sharply from that experienced in September following the trend noticeable during the past two fiscal years. Total activity for October despite the drop was considerably higher than that experienced in October 1958.

Quarterly inventory reports for the quarter ending September 30, 1959 were received from all HLO custodians of special materials and reconciled with Financial inventory records by Contract and Accounting. No discrepancies were reported between physical inventory and the reconciled book value. A comparison of the September 30, 1959 balance ($182,626) with that of June 30, 1959 ($196,114) shows a net decrease of $13,488. The decrease was principally due to an off-site shipment of platinum valued at $13,401 to the AEC New York Operation for recovery.

Classification activity included the review of 639 purchase requisitions and 802 work orders for capital-expense determination. The work load in connection with classification activity has been increasing steadily. October activity represented a 17% increase over September business.

Preparations were completed and a procedure distributed for the physical inventory of movable cataloged equipment in the custody of Biology Operation. Due to a change in the closing schedule of input data to IBM the inventory was rescheduled from November 2 to November 9, 1959 in order to have an IBM listing available for recording the count.

All field work in connection with the physical inventory of movable cataloged equipment in the custody of Laboratory Auxiliaries is complete and the reconciliation of 3 items of equipment inventoried which were not on record is in progress by Contract and Accounting. One item valued at $180 was not physically located. Upon completion of the reconciliation by C&A a formal report of findings will be issued.

The laboratory equipment pool (Building No. 3718) is nearing completion and should be ready for occupancy and operation by November 15, 1959. A revised procedure to simplify the movement of property into the building is being prepared and will be distributed soon. In addition to the new building we are to receive one of the PRTR warehouses around January 15, 1960 which will be partially utilized for the storage of contaminated equipment cleared for storage by the appropriate Radiation Monitoring group.

A comparison of equipment expenditures for FY 1960 with FY 1959 at October 31, 1959 is shown below:

Program	FY 1959	FY 1960
2000	$270,470	$315,332
3000	304	9,328
4000	47,623	90,241
5000		6,027
6000	4,956	17,750
Totals	$323,253	$438,678

We are currently $115,000 ahead of FY 1959 on expenditures, commitments are approximately one million dollars greater and appropriation requests in both quantity and dollars are about two months ahead of FY 1959.

Although expenditures for the first four months of FY 1960 are low in comparison to our total allocation, paperwork has been initiated which indicates a brisk third and fourth quarter expenditure activity.

COST ACCOUNTING OPERATION

Arrangements have been completed for transfer of accounting responsibility for thirteen presently authorized projects from CE&UO to HLO, effective with November business. Weekly reports covering these projects and newly authorized projects will be published during November. The thirteen projects to be transferred are:

CG-785	In-Reactor Studies Equipment, 100-K
CGH-801	X-Ray Diffraction Cell, 327 Building
CGH-805	High Temperature Tensile Testing Cell, 327 Building
CGH-819	Increased Laboratory Waste Facilities, 300 Area
CAH-841	High Pressure Loop
CAH-842	Critical Reactivity Measuring Facility
CGH-857	Physical and Mechanical Properties Testing Cell, 327 Building
CGH-858	High Level Utility Cell, 327 Building
CGH-860	Access for PRTR Fuel Elements, 327 Building
CAH-864	Shielded Animal Monitoring Station, 100-F
CGH-866	Shielded Analytical Laboratory
CAH-867	Fuel Element Rupture Test Facility
CAH-870	Facilities for Recovery of Radioactive Cerium, 325 Building

New projects for which HLO will provide accounting are:

CGH-874	Consolidated Plutonium Metallurgy Facility
CGH-877	Pyrochemical Test Facility, 321-A Building
CGH-878	Additional Facilities for Isotope Study on Animals, 141-C Building Addition

Weekly reports covering work assigned by HLO to J. A. Jones Construction Company are now being published by HLO Cost Accounting, first issue covered week ending October 25.

A proposed procedure covering the HLO - J. A. Jones Construction Company relationship and method of authorizing work was drafted for Laboratory Auxiliaries Operation. It has been proposed that this procedure be distributed within HLO to all components which may be requesting work from J. A. Jones Construction Company.

A special report of recruiting costs for FY 1959 was prepared with the cooperation of Professional Placement and Relations Practices Operation and submitted to Prime Contract Administration for consolidation and submission to the AEC. This report will be required each year in the future, due in the month of August.

An itemization of Hanford Laboratories off-site contracts for FY 1960 was submitted to Contract Accounting as a part of the FY 1960 Midyear Budget Review. The balance of the required data will be submitted in time to meet the November 6 due date. Revised budgets have been prepared for each section and will be included on October cost statements.

In connection with the revised budget for Buildings and Utilities Operation (reduction from $1,572,700 to $1,457,700), new rental rates were calculated and put into effect on October 1, 1959.

Two meetings were held during October with the Manager - Facilities Engineering and members of his Engineering Operation concerning conversion of this component to the work order system, effective October 26, 1959. A set of instructions and recommendations was prepared by this office and issued to interested personnel on October 23, 1959 for use as a guide on work order application.

New forms have been designed, and several meetings held, regarding conversion of Hanford Laboratories' work order servicing organizations to separate time distribution. Effective date will be November 30th, if Data Processing can provide the necessary programming in the interim.

Work Identification Code .81 was established for the accumulation of costs associated with the Actinide Element Research Program, recently funded in the amount of $100,000 by the Division of Research.

GENERAL

An audit of maintenance was started during the month. Its main purpose is to assess the adequacy of HLO maintenance levels. No specific steps to determine the accuracy of charges to HLO are planned.

The Drafting Operation's work acceptance and liquidation procedures were reviewed briefly in order to evaluate the advisability of conversion to the HAPO Work Order system. Recommendations are being drafted.

One hundred and eighty-nine employees not participating in the Savings and Security Plan received a 3.46% salary adjustment effective October 1, 1959.

Recent Bureau of Labor statistics figures indicate a further rise in the cost of living index resulting in a .59% wage increase for all salaried employees. This increase was effective October 26, 1959 to be reflected in salary checks for week-ended 11-6-59.

Statistics prepared for Consolidated Payroll Reports and Statistics, Schenectady, indicates a growth in college graduates in HLO - from 452 at 10/1/57 to 589 at 10/1/59.

W. Sale
Manager - Finance

W. Sale:bk

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Contacted	Access to Restricted Data
J. G. Rake	10/12-14	Systems and Procedures Society Toronto, Canada	Attend Systems and Procedures Society meeting	--	No
	10/15-16	General Electric Schenectady	Meet with various Accounting Services personnel	--	No
W. Sale	10/15-16	General Electric New York, NY	National Managers - Finance meeting	--	No

INVENTIONS OR DISCOVERIES

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

INVENTOR	TITLE OF INVENTION OR DISCOVERY
E. J. Wheelwright	Separation of Cerium from the Trivalent Rare Earths by Oxidation and Precipitation of Cerium Using Hydrogen Peroxide and Sodium Acetate. (HW-62547)
L. A. Bray, et al	Sulfate Process for Recovery of Strontium from Purex Waste.
R. G. Clark J. Muraoka E. E. Utz	Temperature Measurement with a Probe that does not Touch the Surface.

W. Sale
for Hoy Parker