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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT JANUARY, 1959

FEBRUARY 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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HW-59099

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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
JANUARY, 1959

71501 18A

Compiled by
Operation Managers

February 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

[redacted]

PRELIMINARY REPORT

This report was prepared only for use within General Electric Company in the course of work under Atomic Energy Commission Contract W-31-109-Eng-52. Any views or opinions expressed in the report are those of the authors only.

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE January 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	123	92	213	122	95	217	1	1	0	4
Reactor & Fuels Research & Development	182	119	301	176	118	294	7	3	1	2
Physics & Instrument Research & Development	67	26	93	64	27	91	3	0	0	1
Biology Operation	37	44	81	37	44	81	0	0	0	0
Operation Res. & Syn.	14	3	17	14	3	17	0	0	0	0
Radiation Protection	34	100	134	34	100	134	0	1	0	1
Laboratory Auxiliaries	44	184	228	44	182	226	0	5	0	3
Financial	16	33	49	16	33	49	0	0	0	0
Employee Relations	38	26	64	45	28	73	0	0	7	2
Programming	14	4	18	15	4	19	0	0	1	0
General	1	2	3	1	2	3	0	0	0	0
Totals	570	633	1203	568	636	1204	11 *	10	9	13 *
Totals excluding Internal Transfers	570	633	1203	568	636	1204	8	9	7	11

* One Nonexempt to Exempt

Composite Separation Rate	1.8287
Separation Rate (based on Separations leaving G. E.)	.9975
Controllable Separations Rate	.2493

BUDGETS AND COSTS

Costs for January were $1,609,000, an increase of $38,000 over the month of December. Fiscal year-to-date costs are 51% of the operating budget of $20,686,000. Plutonium Recycle Program costs increased $101,000 in January. The authorized funds of $4,880,000 are 49% spent at January 31. CPD Separations R and D costs further decreased in January improving the cost-budget relationship.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

The present PRTR shim control design will be replaced by either a floating rod or powered lead screw (friction) design to prevent the rod from dropping out of the core in the event of bead chain failure. The choice will be based upon the results of experimental tests now in progress.

The status of PRTR construction is: Phase I, 70% complete versus 81% scheduled; Phase II, 60% complete versus 66% scheduled; Phase II-A, 25% complete versus 23% scheduled. PFPP building construction is 68% complete versus 72% scheduled.

Calculations based on present PRTR design indicate that the primary loop pump flywheels are adequate to prevent steam formation after power failure and during the period preceding activation of back-up power or decay of the heat generation rate to a level that can be dissipated by convective cooling.

The PRTR single-tube prototype facility has been activated and operated at 485 F and 1100 psi for a short period.

Calculations indicate that as much as 20% of light water can be tolerated in the D_2O primary coolant without appreciably affecting the reactivity of PRTR.

Design criteria for the gas-cooled loop facility to be installed in PRTR have been completed in rough draft form. Fabrication of swaged UO_2 rod cluster fuel assemblies for the first loading of PRTR was started during the month.

Six swaged four-rod cluster fuel elements, 18 inches long, consisting of 1.6 w/o enriched UO_2 in a 0.035-inch wall 304 stainless steel cladding, have been discharged from KER Loop 1 after an irradiation period of five months. There was no visible cladding damage or rod distortion.

Two Zircaloy rods containing a loose-packed PuO_2-UO_2 powder mixture were irradiated at MTR. A central cavity developed and columnar grains formed, but no jacket distortion occurred and the core was easily removable.

Using electron microscope techniques, voids have been found at the grain boundaries in irradiated UO_2, indicating either trapping of gases during fabrication or migration of fission gases.

Mixed PuO_2 and UO_2 powders sintered at 1600 C for four hours showed complete solid solution on x-ray analysis. Formation of mixed crystal UO_2-PuO_2 via prior chemical procedures appears unnecessary.

Strong bonds have been obtained on injection casting of aluminum (Pu-Al stand-in) into Zircaloy tubing. It is hoped that porosity in the aluminum due to hydrogen can be eliminated by use of a different outgassing procedure.

A four-rod Pu-Al cluster was discharged from Loop 3 of the KER after several months operation at a power of 60 kw/ft in 200 C coolant. The cluster was in good condition upon visual examination in the reactor basin.

Thermocouples located in the coolant-flow spaces in a seven-rod cluster fuel assembly show a significant, but not alarming, temperature variation of approximately ± 20 C from the bulk exit water temperature of 225 C, when operating in-reactor at projected NPR heat-generation rates.

The first KER size NPR seven-rod cluster fuel elements have completed irradiation in KER Loop 1. After exposure of 1200 MWD/T in 270 C coolant, the elements appear to be unaffected externally.

Ex-reactor hydraulic experiments with NPR-type elements indicate that the pressure drop penalty due to the use of wire wrap as flow mix promoters in seven-rod cluster fuel elements is much less than was previously believed.

High-temperature irradiation testing of potential new graphites for the NPR is being accelerated in the MTR and ETR. One new type appears similar to Kendall coke (no longer available), which showed the least contraction on high-temperature irradiation.

A high-temperature graphite irradiation experiment has been designed and is being constructed for insertion in the L-48 shim rod in the MTR.

Swelling has been observed in uranium metal, ex-reactor, through bombardment with xenon ions. The possibility exists of meaningful ex-reactor study of the parameters of the swelling phenomenon.

Rupture tests of pre-defected co-extruded Zircaloy-clad uranium fuel in 300 C water (conducted in both autoclaves and high pressure out-of-reactor loops) show generally promising failure characteristics, with only slight swelling and blistering at the jacket pre-defect in one to two hours exposure. Beta heat-treated rods performed more favorably than as-extruded material in the loop tests.

The fact that excessively frangible bonds in AlSi canned Hanford slugs have been found to fail on sudden application of heat is being used as a basis for the development of a simple nondestructive test of bond quality.

A Zircaloy-2 clad thin wall uranium tube has been fabricated by a direct casting technique.

2. Chemical Research and Development

Controlled extraction of neptunium in the Purex 2A Column by addition of nitrous acid to the solvent (HAX stream) was shown to be technically feasible. Although laboratory studies to define the most favorable operating conditions

for this approach indicated near-quantitative neptunium recovery in the HA Column should be possible, they also indicated that close control would be necessary. In the first three days of plant operation, neptunium losses in the aqueous waste stream (HAW) were below the analytical detection limit. Preceding these plant tests, a third plant extraction of neptunium was very successful with 762 grams recovered.

Laboratory work to develop an anion exchange flowsheet for accomplishing purification of the Purex neptunium product was completed. The basic process used was demonstrated successfully in the plant in purification of the material recovered at the end of the December run period.

Preliminary laboratory experiments show that substantial fractions (> 45 per cent) of the radioisotopes, As 76, P-32, Mn-56, Cu-64 and Zn 65, in reactor effluent water can be removed from solution by passing the hot effluent water through a bed of aluminum turnings. There is evidence that greater removal is possible by this system such that more than 90 per cent of the As-76 and P-32 may be removed. Studies of the system are continuing over a more extensive range of experimental conditions.

Installation of a new pneumatic charge-discharge facility at the KE Reactor, use of high density linear polythene carriers, and modified counter arrangement has reduced the time needed to get samples for activation analysis from the reactor to the counter to seven minutes average. This permits measurement of half-lives as low as two minutes; a major improvement over the former minimum half-life of 30 minutes.

Experimental measurements of the rate of fission product volatilization from heated uranium indicate a considerable variation among various isotopes in the fraction volatilized in a given length of time. In tests on 11-gram irradiated bare uranium cylinders, cooled 1 to 3 days and held at 1200 C furnace temperature, preliminary analytical results indicate essentially all the iodine and tellurium is released in 80 minutes. Cesium volatilized steadily at about 0.025 per cent per minute. Strontium and ruthenium releases were less uniform.

An 8-inch by 10-foot radiant heat experimental spray calciner was put in operation during the month and is to be used to extend the work on fixation of Purex waste. Also, arrangements have been completed for Argonne National Laboratories to perform scouting calcinations on synthetic Purex IWW in a small fluid bed calciner to aid the design of proposed larger scale experiments at Hanford.

Installation of the fission product isolation and packaging prototype was begun on January 9. Shop fabrication of equipment items is approximately 70 per cent complete. Studies are being undertaken to evaluate application of this unit to the isolation of fission products other than cesium.

Installation of the Hastelloy-F pilot plant dissolver has been completed. The first Niflex dissolution of 304-L stainless steel required additional nitric acid addition to five stainless steel solution concentrations comparable to those from laboratory tests. Equipment operation was excellent.

The experimental study of the use of anion exchange to accomplish purification and concentration of plutonium in Purex 1BP has been concluded. The results indicate that a process consisting of a single cycle at anion exchange coupled to a single solvent extraction cycle such as Purex HA-HS-1B Cycle should be capable of producing routinely a 50 g Pu/liter product well within present plutonium purity specifications. A single cycle of anion exchange designed to operate in remote equipment could thus replace the 1BS, 2A, and 2B solvent extraction columns and the unshielded anion exchange contactor presently in use in the Purex Plant.

3. Physics and Instrument Research and Development

The study of temperature effects on the neutron economy of present reactors made significant progress with the beginning of a set of experiments to determine the change in the effect of water on reactivity as the graphite temperature changes.

Cluster element experiments in the PCTR for the New Production Reactor program were completed and the data is currently being analyzed. The experiments on large solid fuels mentioned last month have continued.

Requests for advice on nuclear safety problems have increased in number. During the month recommendations on nuclear safety were made to all three product departments as well as to other groups in the Laboratories.

An experiment to correlate our PCTR measurements in the nuclear safety field with critical mass measurements at ORNL has been completed. Preliminary analysis of the data indicates no serious disagreement between the two approaches.

Nuclear safety experiments designed to set limits for the handling of low enrichment uranium fuel elements have continued both here and at ORNL.

In the Plutonium Recycle Program, effort was concentrated on techniques for correcting for various perturbing effects in PCTR measurements and significant progress was made in these theoretical studies. Also, a new general approach to many of the problems of reactor theory has been worked out which promises to become useful in deciding many questions of interpretation of the results of calculations.

General Electric received the Annual Award of the American Meteorological Society for the Application of Metecrology in Industry. The award was made in recognition of the excellent work of G. R. Hilst and associates in the Atmospheric Physics Operation.

The shielded personnel monitoring station (body monitor) was occupied early in the month. Tests of shielding and instrumentation show them to be quite satisfactory.

An alarm to warn of a nuclear incident has been designed and a breadboard model checked out. Two prototype models are being fabricated. The device can be set to alarm at any desired level within a wide range and can be activated by either gamma rays or neutrons. According to present plans the gamma-type alarms will be adopted for the project now being prepared by CPD for immediate installation of some nuclear incident alarms.

Satisfactory progress was made on the many other projects in the instrument field. In the basic data field, work on the scattering cross section of water for low energy neutrons was begun.

The simulation of PRTR control system behavior on the analog computer has uncovered some areas related to the transient response of the system which will require further attention.

4. Biology

Radiostrontium added as insoluble compounds to soil continued to be about one-tenth as available to growing plants after a second cropping of contaminated soil as soluble strontium added under similar conditions.

The Cs/K ratio has recently appeared in the literature. Again, part of the justification for it is based on the presumed inverse relationship between uptake of cesium and potassium. We have repeated some of this work using the whole plant. The proportional decrease in cesium uptake due to potassium was very markedly less than inverse.

Administration of DTPA should occur within one hour after Pu contamination. This is better than repeated doses up to 21 hours. It appears that only 1% of orally administered DTPA is absorbed.

5. Programming

Further alternate methods for head-end treatment of non-production fuels were studied. Among these, one of considerable merit comprises a simplified, critically safe total dissolution facility. This proposal involves the use of the circulating "spray-tray" type dissolution of integral full length fuel elements. Intermediate solution hold-up vessels in the dissolving circuit are small enough to assure critical safety for any of the anticipated low enrichment fuels. This proposal affords major simplifications over conventional head end processing.

The first portion of a detailed study of PRTR fuel burnout, and isotopic and fission product composition was completed and a report issued. This report describes variations in core composition of Pu-Al spike and natural UO_2 assemblies during irradiation at constant flux. Data are presented in tabular and graphic form. Effects of burn-up rates and resultant compositions on scheduling and shielding are shown.

Significant progress was made in an analysis to characterize the economic potential of stainless steel cladding. The change in thermal utilization when replacing 20 mil zirconium with 7 mil stainless steel was calculated using the P_3 method. The GPR code was then used to calculate attainable exposure for plutonium recycle as well as single pass operation.

IBM 650 calculations to compare the attainable reactivity lifetimes of fuels uniformly enriched with U-235 or plutonium were essentially completed. The study considered reactors of three sizes using plutonium of four different isotopic compositions. It was found that in general plutonium enrichment containing substantial quantities of Pu-240 and Pu-241 leads to longer reactivity limited exposures than U-235 enriched fuels in reactors with good

neutron economies. The converse is true in reactors with poor neutron economies.

The Litton computer was employed for evaluating Pu-240 self-shielding and spectrum shift effects in plutonium-only fuel irradiations. With the lattice conditions used the fuel compositions studied lost both reactivity and specific power generation more rapidly than the fixed-cross-section, fixed-spectrum cases run earlier on the IBM 605 computer. "Phoenix" or long-burning behavior is evidently associated with a different initial fuel composition in this type of cycle. Indications are that higher initial 240 content and lower fuel density are the main requirements. The results are also sensitive to the poorly-known Pu-242 cross section, which also should be self-shielded to some extent.

All major sections of the RBU computer code have been debugged. Linking sections, input-output routines, and the cross-section library have yet to be completed, and this work will require considerable attention from Hanford personnel.

Assistance was rendered in the formulation of a potential research program for uranium oxidation and fission product volatilization studies. Consultation was rendered on a proposed series of guides for the Columbia River emergency plans, on possible methods of decontamination of reactor effluent water, and on the Radioactive Waste Disposal hearings in Washington.

Technical and Other Services

Difficulty with the burial of ruthenium-contaminated equipment in the Redox plant resulted in wide-spread particulate contamination down wind from the burial site both inside and outside the 200-W Area. Checks of six involved employees on prototype equipment in the new Shielded Personnel Monitoring Station indicated no significant deposition of ruthenium-106.

No cases of plutonium deposition in employees were detected during the month. The total number of cases to date is 226. This total includes all deposition cases which have occurred at Hanford and all deposition cases which occurred to present Hanford employees prior to employment at Hanford.

A review of the exposure experience in 1958 indicated that 4 employees received a dose of 3 r or more as compared to 23 employees in 1957. The maximum whole-body dose in 1958 was 3.2 r.

A final report on the CPD Control Study was issued.

Work on a model for guiding the procurement of spare parts for the NPR was completed and a report issued.

In connection with a request from the Commission, further work is being done on the statistical properties and practical application of inventory and B-PID estimates described in HW-56536, "B-PID and Inventory Estimates with Minimum Variance."

Work on two operations research studies and four operations analysis programs was continued during the month and work was initiated on an operations analysis program

for the Radiation Protection Operation. In addition to this statistical and mathematical assistance on 19 problems was given within HLO and to other departments and operations.

There were 12 authorized projects at month end with total authorized funds of $7,024,078. The total estimated cost of these projects is $7,690,078 (PRTR and PFPP are recorded separately). Two projects were completed during the month. Two new projects are awaiting AEC approval. Project proposals for thirteen new projects are in preparation.

The number of requests from customers for emergency shop service increased sharply necessitating a higher than normal overtime level. Other project shops were utilized to capacity in providing assistance to the Technical Shops. Work continued on setting up assistance type contracts with offsite shops and the final drafts should be completed so that negotiations can be conducted in February.

The use of the 221-B pipe gallery as a Pickling and Autoclaving Facility for Zirconium Tubes has been disapproved. Alternate locations have been investigated and work is proceeding toward utilizing the old automotive maintenance - heavy equipment shop at White Bluffs.

Design of the Metallurgical Development Facilities - 306 Building (Project CA-744) was completed for the building contract. AEC will issue the bid invitation about February 19. The contract provisions will attempt to obtain completion of the fourth bay of the building by October 1, 1959 for installation of the extrusion press.

Construction of the 327 Building Addition (Project CGH-790) is 25% complete compared to 21% scheduled. Due to contamination conditions at the site and high radiation levels, construction costs are exceeding the estimate. The lump sum contract for the building superstructure will be awarded in April at which time the total project cost estimate will be precise and additional funds will be requested if necessary.

Projects CAH-794, Geological and Hydrological Wells, and CGH-804, Ceramic Fuels Press Enclosure - 325 Building, were completed within the estimated cost and directive completion dates. Start-up work on the hydraulic press has involved considerable modification and adjustment by the vendor.

Supporting Functions

Data Processing Operation has agreed to install our program for accounting for offsite commitments made by HLO for materials and services. First reports are to be available in February and should be useful in planning and estimating future expenditure rate.

Project Proposal for the Equipment Storage Area Building in 300 Area was approved by AEC on January 29. No directive to proceed has been received as yet.

Inventory results of Biology Operation uninstalled cataloged equipment indicate good control over equipment and the use of proper procedures in transferring or retirement of equipment.

Withholding statements (Form W-2) for 1958 were delivered to employees on January 9, 1959. Gross wages amounted to $8,652,000. Income tax withheld was $1,234,000.

At month's end, the staff of the Hanford Laboratories Operation totalled 1203 employees, including 570 exempt and 633 nonexempt employees. There were 485 exempt employees possessing technical degrees, including 274 B.S., 106 M.S., and 105 Ph.D.

The Armed Forces Special Weapons Project Training Program for medical officers commenced January 6th and is continuing on schedule. The program will be completed February 13.

Ph.D. recruiting continues to present most serious problems with extreme competition being encountered for Ph.D. physics candidates. Four offers were extended during the month and two acceptances were received, bringing the total acceptances for the recruiting year to six. Three offers are currently open.

Experienced BS/MS recruiting and recruiting for the Technical Graduate Program continues to be very favorable. Most serious difficulty is being encountered in the employment of new bachelor's candidates in physics. Spring recruiting commenced on January 12 with visits to WSC, Idaho, Gonzaga, Oregon State, Portland University, Washington and Seattle University and will continue during the coming two months with visits to 26 additional schools.

Twenty-three graduates are currently assigned to the Technical Graduate Program with three scheduled for placement on February 1. Requests for placement exceed Program members available and this will continue until June graduates report for assignment.

Laboratories personnel worked a total of 197,040 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 5,475,100 man-hours have been completed with no disabling injuries. The medical treatment frequency for January was 1.13 as compared with 1.34 during December.

There were seven security violations during the month of January.

H M Parker

Manager,
HANFORD LABORATORIES

HM Parker:kss

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Autoclave Pretreatment of Aluminum Dynamic Corrosion Test Samples. Dynamic corrosion tests now in progress are aimed toward a general evaluation of autoclave pretreatment for dynamic corrosion coupons. Samples with and without autoclave pretreatment for various times and temperatures were subjected to dynamic corrosion testing, and the results compared. Results were also compared with those of samples exposed in the low flow section of the autoclave without pretreatment. Neutral, deionized water was used.

It is considered significant that autoclave treatment for one day at 300 C and one week at 250 C results in dynamic corrosion rates comparable to those obtained in the static section. The effect has so far been demonstrated for only one month tests. It remains to be demonstrated whether the reduction in rates as exposure increases, observed for untreated samples, are also observed for pretreated samples.

The pronounced effect of autoclaving may result from an aging of the corrosion product which renders it less soluble. The corrosion product is known to be heterogeneous and, in the case of corrosion product from dynamic samples, highly porous. The porosity results from a leaching action of the continually refreshed water on the more soluble constituents of the oxide. In the autoclave treatment, the sample is exposed to water already saturated in aluminum corrosion product. Under these conditions the soluble component of the oxide ages rather than dissolves. The aging effect of aluminum oxides and hydrates, producing a marked decrease in solubility, is well known. This experiment appears to add further confirmation to the view that increased oxide dissolution is the principal cause for high corrosion rates noted at high flow rates.

Logarithmic Corrosion of Al. The amount of corrosion for a sample of 198X (1.0% Ni, 0.1% Ti, balance 99.99% Al) prepared at ANL was found to be 0.8 mil after 10 months at 360 C. The corrosion process continues to show a logarithmic dependence on time.

A more self-consistent picture of aluminum corrosion in high temperature water follows from an analysis of U. R. Evans of the effect of cracks in heavy oxide scale. He has shown that linear, parabolic, or logarithmic dependence on time can result, depending on the type of cracking that occurs within an oxide scale. The logarithmic corrosion process, for

example, can be expected when self-healing of small cracks perpendicular to the surface occur.

It is relevant to report that the outstanding feature in the ANL 198X structure is the degree and fineness of second phase dispersion in the gamma aluminum phase. If it is assumed that the protective element in the oxide is a complex Ni-Al oxide, a spinel for example, a relation between degree of second phase dispersion and logarithmic kinetics (self-healing of oxide cracks) could be expected.

Fuel Element Rupture Kinetics. Preliminary tests have been conducted to determine the rupture characteristics and kinetics of co-extruded Zircaloy-2 clad fuel elements in water at 300 C in a static induction heated autoclave. Samples were defected with a 25-mil hole drilled through the cladding into the core. All the samples failed in the same manner. A blister is slowly formed in the cladding with the defect at its center. The blister is from 1/8" to 1/4" diameter and grows to a height of 30 to 50 mils. The blister then "pops open" as a result of the fracturing of the cladding at the perimeter of the blister. Additional exposure results in severe blistering and ripping of the cladding adjacent to the original blister. Some of the data are tabulated below.

Rupture of Defected Coextruded Elements
300 C Water - 25-mil Defects

Sample	Condition	Exposure Required to Fracture Cladding
U core, 5/8" dia., 30-mil clad	As extruded	50-100 minutes*
"	Various beta heat treating schedules	50-100 minutes*
U-2% Zr core, 0.9" dia., 20-mil clad	As extruded	300 minutes
"	Beta heat treated	400 minutes

*The samples were examined at 50 and 100 minutes. Samples with decreasing bond strength showed increasing severity of failure, indicating a faster rupture rate for the samples of lower bond strength.

An autoclave was equipped with a palladium hydrogen valve which was connected to a low pressure gauge. A defected element with a uranium core was exposed in this autoclave to water at 300 C. After 45 minutes of continuous exposure, there was a sudden generation of hydrogen. It is believed that this event corresponded with a fracture of the fuel element cladding, allowing water to decompose the uranium hydride contained within the blister at the defect.

Hydriding of Zircaloy-2. Ten attempts were made to hydride Zircaloy-2. The samples either hydrided completely with destruction of the mechanical integrity of the sample, or the sample remained ductile with little or no hydrogen pickup. Variable induction times were observed during which no reaction was observed followed by sharp drops in the hydrogen pressure of the system and rapid hydriding of the sample. The edges of samples were attacked first, before the surface of the metal. It was necessary to reduce the oxygen content of the apparatus to very low values before any hydriding could be induced. Autoclave films offered no more protection than the film formed by etching. Hydriding was observed to be very rapid in dry, oxygen-free hydrogen at 10 psi at temperatures between 350 C and 450 C.

These results all confirm the hypothesis set forth in HW-55460; that is, Zircaloy-2 depends on its oxide film for protection against hydrogen. In the absence of an oxide film, or if the oxide film has defects, Zr-2 will hydride rapidly with complete destruction of the metal. A defect-type oxide cannot form in the presence of oxygen or water because the defects will be healed. Zr-2 will not hydride in the presence of water or oxygen at temperatures under 500 C.

Gasless Etching of Zr-2. Work continued on the chromic acid-fluoride etching process. It was found that the CrO_3-HF solution is much harder to rinse out of crevices than standard HNO_3-HF etch. When the Cr^{+6} concentration becomes depleted at the metal surface or in crevices, hydrogen evolution begins with severe pitting of the surface. This gas evolution may be further suppressed by an increase in the CrO_3 concentration, but if this is done, Cr metal deposits on the Zr surface. It was found that if ammonium bifluroide ($NH_4F \cdot HF$) was substituted for the HF the last two problems could be avoided.

The bath composition was: CrO_3 - 150 g/l
$NH_4F \cdot HF$ - 50 g/l
H_2O.

In this solution gas evolution is greatly suppressed in comparison with the standard HNO_3-HF etch but is not stopped completely. The gas evolved is H_2. The pH of this bath is about two, so that the solution is much less hazardous to handle than the HNO_3-HF solution. It is expected that it will be less corrosive to materials of construction, but such tests have not yet been carried out. It produced a smooth, bright etch on Zr-2.

Corrosion tests in 400 C steam revealed the following facts:

1. The CrO_3-$NH_4F \cdot HF$ etch is hard to rinse out of crevices and severe corrosion in crevices is observed on autoclaving.
2. Except for crevices, the etchant rinses cleanly in dilute HNO_3.
3. Corrosion rates taken in 400 C, 1300 psi steam showed that Zr-2 etched in CrO_3-$NH_4 \cdot HF$ had normal low corrosion rates.
4. Allowable transfer times from etch to rinse were much longer than with the HNO_3-HF process.

Because of the severe crevice corrosion problem, the chromic acid etchant will have limited usefulness for fuel elements. However, the solution may have a very real usefulness as a tube etchant.

Low Pressure Autoclaving of Zr-2. A series of Zr-2 samples exposed to 400 C, 100 psi steam showed weight gains the same as Zr-2 exposed in 400 C, 1500 psi steam. It was concluded the steam pressure had little effect on the corrosion rate or usefulness in testing Zr-2.

After exposure in 400 C, 100 psi steam, the samples were transferred to 400 C, 1500 psi steam and continued to show normal low corrosion rates.

Effect of Electrical Potential on Rinsing of Zr-2. Sixteen assemblies of two Zr-2 coupons bolted together to create a crevice were rinsed in aluminum nitrate and in nitric acid with both positive and negative potentials (e.g., 5 volts) applied during rinsing. The samples were etched in standard HNO_3-HF etch and allowed to dry five minutes to create a serious case of "acid staining" unless thoroughly rinsed.

The samples rinsed with a positive potential in nitric acid showed a marked improvement in lack of acid staining. The positive potential probably formed a new ZrO_2 surface under the contamination and lifted it off the surface. Even in the crevice little acid staining was observed.

This process shows promise and will be explored further to evaluate its usefulness as a Zr-2 metal pretreatment.

Zirconium Etching Facility - Materials of Construction. Various materials of construction are undergoing a test in 6 M HNO_3-1M HF solution at 60 C to determine the most suitable materials for pumps, tanks, and heat exchangers. Samples of Teflon-100X, polypropylene, polyethylene, polyvinylchloride, polyvinylfluoride, graphite 347 and 309 SCb stainless steels and Hasteloy F have been evaluated. Based on these tests, Teflon-100X (heat sealable), polyethylene and polypropylene appeared the most satisfactory materials for tank construction or lining. Presumably materials such as Kel-F would also be satisfactory.

Although graphite appears to be suitable for heat exchanger and pump parts from a corrosion standpoint, it exhibits a low mechanical strength, and hence a metal with a low (10 milli-inches/hr) corrosion rate would be desirable. As-received 347 and 309 SCb stainless steel corroded at 300 and 200 mipy, respectively. As-welded Hasteloy-F corroded at a rate of 200 mipy. All showed localized attack. A special sample of 347 stainless steel showed a corrosion rate of about 120 mipy. Heat treatment of the 309 SCb and the Hasteloy-F lowered the corrosion rates to about 120 and 90 mipy, respectively, and eliminated most of the localized attack.

Radiometallurgy Laboratory Studies

Fax-film replicas were obtained from three uranium specimens which were irradiated at low temperatures and exposures (HAPO-173). Metallographic studies of unirradiated samples were made to relate the effects of

annealing and tensile testing; a sample of uranium of about 0.2 a/o U-235 burnup was polished and etched and Fax-film replicas were made for electron microscopy; studies of the uranium samples for PT-3NA were continued by beginning a cyclical annealing program for selected tensile samples; metallographic examination was begun on samples from a short term, high temperature, enriched four-rod cluster elements (PT-IP-172-A); one thorium tensile specimen (GEH-3-28) was removed from its capsule and examined; a temperature monitored uranium swelling test capsule was opened and examined. Results and conclusions from these Radiometallurgy Laboratory studies are reported in connection with the respective development programs.

High Level Cut-off and Examination Cell (Project CG-682). Work continued on modification and fabrication of the new high level examination and cut-off cell equipment prior to operation of the cell. Installation and shake-down testing proceeded on the following items of equipment during the month:

1. Cut-off machine
2. Model III Manipulators
3. Health Monitoring Chambers (now completed)
4. Cell Exhaust Alarm System
5. Can sealer installation and testing (now completed)
6. Cut-off machine filtering system
7. Cell can racks
8. Viewing platform and lighting arrangement for four-foot long fuel elements
9. Miscellaneous electrical and piping work.

In addition, establishment of camera lens requirements and photographic limitations of the 12-inch square x 18-inch thick lead glass windows was completed.

High Temperature Impact Sample Breaker. Fabrication of an impact sample breaker was completed by the shop during the month.

Microhardness Tester. Modification of some of the controls is now being carried out by the 327 Building swing shift machinist and the mock-up is expected to be complete in early February.

Density Cell. Sheet metal skirting required for this cell has been installed, and the pipefitters are now re-routing the piping to bring all valves to the operating face. The manipulator is undergoing final shake-down revisions and is expected to be ready about mid-February.

Basic Metallurgy Studies

Radiation Effects in Fissionable Materials. The design of advanced fuel elements depends upon some knowledge of the effects of irradiation on significant mechanical and physical properties. A program to obtain these data for uranium irradiated to 0.018, 0.031, 0.075, and 0.10 a/o burnup is under way. Tensile specimens representing 0.075, and 0.1 a/o burnup were cyclically annealed in vacuum between 400 and 700 C for three

cycles (six transformations) during the month. These specimens along with a similarly annealed specimen representing 0.31 a/o burnup await tensile tests to determine the effects of alpha-beta phase transformation on the recovery of irradiation-induced damage.

A series of flat uranium tensile specimens have been irradiated at low temperatures to low exposures in the snout facility at 105-KW. The purpose of this test is to find the threshold of detectable neutron damage to uranium. The exposures range from 10^{15} to 10^{18} nvt or from 5×10^{-7} to 5×10^{-4} total atom percent burnup. Post-irradiation tensile, hardness, and annealing tests have been performed to determine the amount of damage induced and the ease of removal. Significant conclusions are as follows: (1) the neutron exposure beyond which a significant change in the hardness of uranium occurs is not greater than 5×10^{16} nvt and is probably less than one spike cycle or 2.4×10^{16} nvt; (2) practically complete recovery in tensile properties, and hardness in the temperature range 200-400 C occurs with exposures up to 1×10^{17} nvt, beyond this exposure the amount of recovery decreases; (3) the exponent of strain hardening decreases with irradiation from 0.34 in the unirradiated state to approximately 0.20 for an exposure of 7×10^{17} nvt; and (4) an increase in hardness and yield strength of 11 and 55 percent, respectively, occurs with irradiation to 7×10^{17} nvt.

Radiation Effects in Structural Materials. A series of metal representing the common metal crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposure conditions. These metals include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Post-irradiation measurements of mechanical and physical properties of these metals were initiated at KAPL and will be completed at HAPO to advance the theory of neutron damage to metals. Temperature traverses were made of the six vacuum furnace tubes at 800 C. A three-inch flat temperature zone occurs at this temperature. At 100 C the temperature difference along the reduced section of a tensile specimen was less than 1 C. All furnaces have been adjusted to give this temperature control for the first isochronal anneal. Electrical resistance measurements for an unirradiated titanium specimen agreed within 0.2 percent with data reported by KAPL for the same specimen.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel materials is a direct way of detecting radiation damage in these materials. Preliminary experiments aimed at determining the feasibility of irradiating films of fissionable material, thin enough for conducting transmission electron microscopy and diffraction before and after reactor irradiation are being conducted. The objective of such studies is to gain fundamental information on the nature of reactor induced damage to fissionable material.

X-Ray Diffraction Studies. Visual examination of the AlSi bond layer of a fuel element discloses areas which differ in appearance. Materials from these areas have been characterized by x-ray diffraction. The most lustrous areas were found to be composed of UAl_3 and a small amount of

of another cubic compound with a lattice dimension of 4.14 Å. The dullest areas were composed of a single cubic compound with a lattice dimension of 4.17 Å. No pure simple cubic compounds with dimensions between 4.03 Å (USi_3) and 4.27 Å (UAl_3) are known. These results are additional evidence for the existence of a solid solution of the type $U(AlSi)_3$ in the AlSi bond layer.

A study of the annealing kinetics associated with the recovery of x-ray diffraction line broadening supplies information about radiation damage that is complementary to that obtained by an analysis of lattice parameter changes. Molybdenum irradiated to an exposure of 1.2×10^{20} nvt (fast flux) was annealed at temperatures up to and including 600 C at 100 C intervals. Total annealing time at each temperature level was 100 hours. A small amount of recovery measured by line width changes occurred during annealing ten hours at 100 C. No further recovery occurred until after ten hours at 600 C. Longer annealing times at this temperature do not produce additional recovery. These two distinct recovery processes remove approximately one-half of the original radiation damage. The data are being analyzed to determine the nature of the recovery mechanisms. This information will assist in characterizing the types of defects that are produced in metals during irradiation.

Solid State Reactions. Optimum conditions of heat treatment for zirconium, Zircaloy-2, and Zircaloy-3 are being studied as a function of percent cold work, temperature, time, and heat treatment atmosphere. Micrographs of 25 and 50 percent cold worked zirconium heat treated for 100 minutes in helium at six temperatures from 300 to 800 C have been obtained at 100 and 1000 X. The micrographs confirm the recrystallization temperatures estimated from x-ray diffraction work on these samples. It is concluded that x-ray measurements of line width and sharpening are a reliable method of determining the recrystallization temperature in cold worked zirconium. Micrographs taken at 1000 X showed the presence of more than one type of inclusion in the zirconium. A needle-like inclusion has tentatively been identified (by anodizing) as zirconium hydride. The concentration is estimated to be 10 to 30 parts per million. In addition to the needles, there is a fine dispersion of small particles throughout the grain. These particles have not been identified.

In-Reactor Measurements. A knowledge of the errors in temperature measurement using thermocouples in a neutron flux is essential for the quantitative evaluation of the effects of neutron irradiation on materials. Because such knowledge is lacking, a program of measuring thermocouple stability in-reactor is currently in progress. The quartz insulated and asbestos insulated thermocouple lead wire assemblies charged in KW Reactor have received a total of 3412 hours exposure. All the wires show a resistance between leads of greater than 10^7 ohms. Emf readings taken through the in-reactor assemblies show no deviation from readings taken using only the ex-reactor thermocouple leads. The 300 C thermocouple stability capsule charged in KW Reactor has received a total of 928 hours exposure. The thermocouples are operating at 300 C in a "gettered" helium atmosphere. The thermocouple emf's have been obtained at the thermal arrest due to melting of the lead in the capsule. Indicated arrest

temperatures are as follows:

Chromel-Alumel	328 C
Iron-Constantan	325 C
Copper-Constantan	325 C.

No drift in thermal emf has been noted since insertion of the capsule into the reactor.

New Fuel Element Development

Cluster Fuel Elements. Three, seven-rod cluster fuel elements operated satisfactorily during the past month in the ETR 3x3 loop facility. Indicated specific power is averaging 70 kw/ft with a coolant outlet temperature of 280 C. Goal exposure for this irradiation is 1500 MWD/T of which 500 MWD/T has been attained.

The maximum allowed specific power for NPR seven-rod cluster fuel elements has been assumed to be limited by channeling and inadequate mixing of the coolant around each rod, with consequent high localized water temperature. Eight, seven-rod cluster fuel elements made from natural uranium coextruded in 30 mils of Zircaloy-2 were charged into the KER Loop 3 facility with thermocouples placed into the coolant channels of the downstream element. The data indicate that coolant channeling is not severe.

To compare fuel element behavior using different clad thicknesses, four seven-rod cluster fuel elements with 20-mil cladding and three elements with 30-mil cladding were charged into the KER Loop 1 facility. In this test thermocouples were also positioned in the coolant channels of the downstream element to provide additional data on coolant mixing. Again, mixing was acceptable, agreeing with data on the first test described above. Goal exposure for this irradiation is 4500 MWD/T.

Eight rods from four, four-rod cluster fuel elements discharged from the KER Loop 2 facility early in November have been examined. All rods examined have macrocracks throughout the central core region. Microscopic examinations show finer cracks throughout the uranium structure but none in the cladding or bond region. Examinations by electron microscopy show evidence of cracks in the Zircaloy-2 cladding. These cracks are fractions of a micron in width and up to 50 microns in length. Further examination will continue to determine the cause of these cracks.

Fuel test KER-1-3, irradiation of a seven-rod cluster, NPR prototype fuel element, was completed in January. Exposure was 1200 MWD/T. The coolant bulk outlet temperature during the test was 270 C, heat output of the test was 12 watts/gm. The rods of each cluster are coextruded Zircaloy-2 clad uranium. Underwater examination revealed no changes in dimensions.

Tubular Fuel Elements. The KER Loop 4 tubular element tests continue to operate at 14 watts/gm. Bulk coolant temperature is 230 C. This NPR candidate element is 36" in length, clad with 0.030" thick Zircaloy-2.

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Fuel for Present Reactors. In recognition of the need for a non-destructive test to identify canned fuel elements having excessively frangible bonds (the so-called "brittle-bond" slugs), a simple test has been developed. Expansion of the jacket due to sudden application of heat results in the fracture of the bond if its cohesive or adhesive strength is less than the yield strength of the jacket material (ca. 4500 psi for #/245 Al cans). A phonograph pickup with amplifier and earphones properly applied identifies susceptible slugs by a succession of "pings" in the earphones. Refinement of the test will involve screening out extraneous noises and the establishment of satisfactory heating procedures.

The aluminum on two charges of C-64 clad I & E fuel elements was nickel plated electrolytically using a Zincate pretreatment and modified Thompson plating bath. These elements are to be irradiated under Production Test IP-207-A-E FP. The objective of this test is to evaluate the effluent water contamination problems associated with the use of a nickel plate as a corrosion barrier. Two charges of electroless nickel plated fuel elements (plated off-site) also will be charged under this production test. The test is to be conducted in C Reactor and is tentatively scheduled for charging during the first outage in February.

Work in cold closure is presently directed toward cold closing the I & E fuel element by forcing extended rings of internal and external jacket material to flow over the end of the element to form an annular ring joint. A satisfactory cold pressure weld has been repeatedly obtained in a ring joint which simulates the desired method of closure. This was obtained by allowing the ring joint interface to expand down into a small annular groove, simulating an annular groove in the element end below the interface, while the metal simultaneously expanded up through the annular punch. This closure will be attempted on the I & E element following development of satisfactory tooling for sizing the jacket material onto the element inside diameter.

Component Fabrication. Hot-heading is being investigated as a process for forming the ends of coextruded Zircaloy-2 clad uranium rods into shapes which are desired for assembly into cluster elements. Results to date indicate the process is feasible. Different shapes and amounts of uranium have been removed from the end face of the rod in attempts to thicken the clad wall in the formed region. The most successful attempt has merely maintained the original wall thickness. The increased thickness is desired to simplify the closure problem.

A series of coextrusion billets have been prepared for extrusion on the 280-ton press in the Plutonium Fabrication laboratory. The billet designs and component fabrication were adjusted to determine the influence of copper clad thickness and uranium structure on the uranium-Zircaloy-2 interface. The billets will be extruded at a reduction ratio of 10:1. Fabrication of additional billets for coextrusion in the equipment being fabricated for use in the 306 Building has been partially completed. Components for ten billets have been prepared with the exception of the copper jackets and assembly has begun.

Closure and Joining. A method of attaching supports to NPR fuel elements to accurately position them in the process tube is required. One method of accomplishing this is by resistance spot welding. A series of tests have been conducted to determine the effects of welding heat and pressure on the properties of the fuel element. It was found that the fusion area did not extend to a point where uranium contamination of the weld nugget occurred and the corrosion rate in the attachment area was not affected. This method can be used to attach supports to the jacket of NPR fuel elements without adversely affecting the quality of the element.

Allied Fuel Studies. Knowledge of the swelling behavior of unalloyed clad uranium operating with a cladding surface temperature of 250-350 C, and a maximum fuel temperature of 450-700 C is of importance for Hanford's fuel element development work. To provide initial uranium swelling data, five experimental assemblies with Zircaloy-2 clad coextruded uranium fuel rods are being or have been irradiated in the MTR and ETR. Burnup analysis and density measurements will complete the Radiometallurgy examination of GEH-3-31, the first of the above fuel rods to be irradiated. GEH-3-32, presently undergoing irradiation in the MTR, has approximately 65 percent of the 3500 MWD/T goal exposure. Changes in reactor conditions caused the average center uranium temperature to increase from 400 C to 540 C during the month. GEH-3-58, 3-57, and 3-59, all operating in the ETR, have approximate exposures of 1200, 875, and 500 MWD/T at average uranium temperatures of 550, 750, and 650 C, respectively. Goal exposure for these capsules is 2100 MWD/T. Fluctuations in central uranium temperatures up to 100 C occur in all these ETR capsules.

Operations Research and Synthesis has performed a statistical analysis and correlation on creep rupture data on Zircaloy-2 in connection with a calculation of the constraint of uranium swelling a fuel element jacket could offer. A least squares analysis fit of the data was made to a recently proposed equation based on the Ludwik exponential stress law for predicting creep performance. The main conclusions of this analysis were:

1. There is no significant difference between the correlation of sheet material tested in the transverse and longitudinal direction in the temperature range 150 to 500 C.

2. The correlating equations for cold work and annealed Zircaloy-2 were significantly different, particularly in the activation energy for self-diffusion estimates where the cold work estimate was more than twice that of the annealed estimate.

3. Time to rupture could not be predicted accurately with the equation.

The study of the various parameters of NPR coextruded Zircaloy-2 clad uranium fuel which affect the failure behavior of defected fuel specimens is continuing. The shear strength of the Zircaloy-2 to uranium bond in coextruded rod specimens as affected by heat treatment has been determined and varies from about 70,000 psi in the "as-extruded" condition down to

about 13,000 psi in a diffusion treated oil quenched condition. The behavior of defected specimens in a 300 C autoclave at 1250 psi during the early stages of failure depends upon the bond strength. The 70,000 psi "as-extruded" bond displays the greatest resistance to corrosion during the early stage of failure, and the 13,000 psi diffusion treated bond displays the least resistance to corrosion. Defect testing of fuel specimens in Elmo #4 (ex-reactor high temperature high pressure loop) with various types of defects to advanced stages of failure indicates that fuel corrosion rates may be about the same as for the "as-extruded" and beta treated air cooled conditions, but the degree of clad deformation and the potential for plugging of the process tube may be less in the beta treated, air cooled (or lower bond strength) condition.

Metallurgical Development. The cast forming of a Zircaloy-2 clad thin wall uranium tube was accomplished. The dimensions of this tube were 1.75" OD, 1.50" ID, by 8" in length. This element component was formed by casting molten uranium at 1475 C into a graphite mold containing the Zircaloy-2 components, preheated to 950 C, at a pressure of less than 10^{-3} mm of Hg. The cooling rate was 20 C per minute. Examination of the cast element revealed uniform bonding throughout the length of the element with several shrinkage cavities near the element top. Several extrusion billets have also been fabricated by casting molten uranium metal directly into preheated Zircaloy-2 containers followed by beta heat treatment.

Facilities and Equipment. The installation of the new electron beam vacuum welding unit in 306 Building is approximately 85 percent complete. Tests indicate that the pumping rates and the performance of the power supply are satisfactory.

2. REACTOR PROGRAM

Coolant Systems Development

X-8001 Alloy Local Attack. Moderate erosion-corrosion attack of X-8001 jackets was observed on fuel elements discharged from D Reactor. This attack is localized groove type pitting somewhat similar to the attack first noticed at H Reactor, but several differences were noted between this attack and the extensive pitting attack noted on the downstream piece in the H Reactor. The D attack does not extend over as great a surface of the fuel element as did the attack at H; the attack is a series of pits occurring in long, thin lines exclusively, indicating that mechanical scratches may provide sites for the attack. The most severe local attack on elements recently discharged from D Reactor was observed on one slug located in the seventh position from the downstream end of the charge. This is in contrast to the H attack, which was always most pronounced on the last fuel element in the tube and was never observed upstream of the #5 pieces from the rear. In the five charges of fuel elements from D, a total of 36 pieces show some localized attack.

Decontamination for NPR. Turco 4447 (Powdered 4503) was investigated as a decontaminant for carbon steel. The indications look promising, and the corrosion rate appears favorable on carbon steel. However, this

solution is acidic and contains fluorides and chlorides which are detrimental to stainless steel and Zircaloy which may be present in a carbon steel system.

Further work with Turco-4512 with the cooperation of the Turco Company has produced a modification of this phosphoric acid cleaner which appears favorable from the standpoints of both DF and corrosion rate. The concentration in use is a 6% solution of the T-4512 used at 60 C for 1/2 hour to one hour.

Additional decontamination studies were completed this month using alkaline permanganate, ammonium citrate, and ethylenediaminetetraacetic acid. The decontamination factor was quite high, 1500, but the corrosion rates were also relatively high. As yet, no satisfactory corrosion inhibitor has been found.

Corrosion coupons placed in the KER-4 mockup tube during the Turco 4501 decontamination showed very little penetration due to the decontaminating solutions. The average penetrations on precipitated 304 s/s, non-precipitated 304 s/s and Stellite-6 coupons were 0.036, 0.012, and 0.076 mil, respectively, while Zircaloy-2 and Zircaloy-3 coupons were not affected by the decontaminating solutions. Coupons pre-exposed in 300 C pH 4.5 and 290 C pH 10 water were effectively cleaned during the decontamination. Control coupons which were charged in the mockup tube after the decontamination are being exposed with coupons which were in the mockup tube during the decontamination to determine whether there are any long term corrosion effects due to decontamination.

Precipitated and non-precipitated 304 stainless steel coupons pre-treated in the Turco 4501 decontaminating process are corroding with the same rates as non pre-treated coupons in 300 C pH 4.5 water after 1200 hours exposure. A similar test in 290 C pH 10 water does not indicate any effects of the pre-treatment on the corrosion rate. The total penetration after 1200 hours is 0.009 mil in the pH 10 water compared with 0.04 mil in the pH 4.5 water.

Non-Uniform Corrosion Studies. The caustic embrittlement test on a 304 s/s specimen was terminated after 1000 hours and examined for cracking. No cracking was found. A sample of A-212 carbon steel was placed under test and will be exposed to a minimum leak rate at 300 C and an initial pH of 10.0. No stress cracking has been found on either 304 s/s or A-212 carbon steel, at 300 C under concentrating caustic conditions. A study of Zircaloy-2 fretting corrosion has been under way using a Zr-2 spring wire rubbing on a Zr-2 coupon in a 300 C, pH 10.0 (with LiOH) environment. Examination of the device has not been made at the time this report was written.

Control of Water Purity in Low pH Systems. Clean-up of the water through H_3PO_4 regenerated mixed-bed resin continued to demonstrate advantages over water not treated in this fashion. Lower impurity concentrations were maintained by such deionization. A mixed-bed resin regenerated with H_3PO_4

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has been used in Loop KER-4 to regulate pH and remove contamination from the water. The behavior has been erratic. It is apparently difficult or impossible to control pH by this method. However, this resin bed has removed crud and radioactivity from the water quite efficiently.

Corrosion of Aluminum Under Heat-Transfer Conditions. The San Jose loop studying corrosion of aluminum under high heat fluxes has completed a 1000-hour test. The conditions are 280 C, pH 6, 150,000 Btu/hr-ft^2, at 12, 14, and 16 feet/sec. Control samples with no heat flux were also studied. Samples will be sent to Hanford for data determination. Another test is being scheduled for this loop to be operated for 2000 hours and with better control over the flow through the aluminum heater sections.

Raw Water Heat Exchanger Tests. The Dowtherm Loop has been operating using raw Columbia River water as the coolant for a carbon steel heat exchanger. Outlet temperature of the water is 212 F. Since the test was resumed with maximum pipe wall temperatures of 345 F, the over-all heat transfer coefficient has dropped from 510 Btu/hr-ft^2 F to 450 Btu/hr-ft^2 F.

Descaling Studies. Tests were run to explain why the penetration on carbon steel coupons placed in the effluent line during the Elmo #1 de-rusting were so much higher than those predicted by beaker tests. It was found that the presence of ferric ion in the de-rusting solution greatly accelerates the attack of the solution on carbon steel. Coupons exposed for one hour at 60 C in de-rusting solution (inhibited H_2SO_4) with 10, 500, and 10,000 ppm $Fe_2(SO_4)_3$ had penetrations of 0.006, 0.028, and 0.23 mil, respectively.

Rupture Testing. Several coextruded Zircaloy-2 jacketed uranium fuel elements were rupture tested in 300 C water. In general, the pieces that have been beta-heat-treated are superior to the as-extruded pieces in rupture performance. Several beta-heat-treated pieces have shown no more swelling or cladding splitting after increased exposures of two or three hours than they did after one hour's exposure, although the amount of uranium attacked had increased.

Two beta heat-treated rods tested with pre-defect slits 30 mils wide, 300 mils deep, and three inches long had only minor damage, slight swelling at each end of the slit, after one and two hours' exposure. Two corresponding as-extruded pieces exhibited considerable swelling at the ends of the slits after one hour, and large amounts of swelling and clad splitting progressing away from the slitted ends after two hours' exposure.

A wire wrapped KER-size seven-rod cluster required 700 pounds force to remove from the 2.08 " ID Zr-2 tube after one hour's exposure. Two of the rods were pre-defected with 25-mil holes.

Eight beta-heat-treated rods with various pinhole and slitted defects were tested for one hour's exposure. Two rods with 25-mil side defects each exhibited a raised mound about 1/8" diameter. Two rods with

25-mil pinholes in the end cap did not show any rupture damage. Two rods with slits 30 mils wide, down to the uranium, and three inches long exhibited small bulging at the ends of the slits. The other two rods which had been pre-defected with slits 30 mils wide down to the uranium for the full length of the rods, underwent considerable damage at the end caps.

Rupture Tests on Heated Fuel Elements. An initial test was made with power to two of the 0.63" OD co-extruded rods in a seven-rod cluster. After three minutes of 25 KW power input, the rods burned in two. Water temperature averaged about 500 F. Water flow through the test section was 100 gpm, but post-examination indicates that some of the water could have been by-passing the fuel element rods. Further tests are scheduled, including both tubular fuel elements and rod-cluster types.

Thermocouple Tests. Two thermocouple tests are being run in KER. The purpose of these tests is to determine how much hotter the inner flow channels of seven-rod clusters become than the outer ones due to the unmatched split of water flow and heat generation at the different locations. The first test is essentially complete and will be discharged at the next outage; the outlet temperature was 200 C; the heat flux was about 225,000 Btu/(hr)(ft^2). The second test with enriched seven-rod clusters operated at 450,000 Btu/(hr)(ft^2) at an outlet temperature of 225 C.

The results from the two tests were essentially in agreement and showed that the temperature differences were not alarmingly large. It appears that the temperature difference is a function of the heat flux. The last experiment was comparable to NPR conditions [450,000 Btu/(hr)(ft^2)]. In this test the temperatures varied from 210 C to 250 C, the outlet temperature being 225 C.

From these tests it is tentatively concluded that temperature mixing may be sufficient to make the addition of spiral mixing wires on various rods unnecessary from a heat-transfer standpoint.

Structural Materials Development

Zircaloy Process Tubing. Development programs to solve problems in the fabrication of ribbed and ribless B-D-F type and NPR type Zircaloy-2 process tubes were continued at several sites. Major effort was applied to proposals for the fabrication of 100 ribbed B-D-F tubes and 70 NPR tubes. Contract negotiations are under way on the B-D-F tubes and should be completed in February.

Process Tube Design Criteria. The program of creep testing Zircaloy-2 at Battelle Memorial Institute was expanded by five creep-testing units, bringing the total to twenty. Contract negotiations are being initiated to provide direct support of this work during FY-60 and 61. An analysis of all of the available creep deformation and creep rupture data is being prepared for publication.

End-closures capable of withstanding 12,000 to 14,000 psi internal pressure at 650 F are being sought to permit rupture testing of the NPR tubing. A new design has been tested to 14,000 psi at room temperature and elevated temperature tests are in progress.

Nonmetallic Materials Development

Graphite Development. The second phase of testing candidate NPR graphites has begun with the arrival of samples from National Carbon Company and Speer Carbon Company. Earlier samples received were largely from electrode stocks or small samples that could be prepared on short notice which would permit testing of the relative radiation stability of graphites from new coke sources at the earliest possible date. Samples typical of the size and process to be used for NPR graphite are now arriving. Included are 4 x 4 x 50-inch extrusions from the National Carbon Company of AGOT processed Socony Vaccum coke and Continental coke. The latter is similar in nature to the old Kendall coke which contracted least of the cokes tested at high temperature but is no longer available. Samples from Speer Carbon Company are also 4 x 4 x 50-inch extrusions; however, samples have been provided which typify variations in purification techniques and coke type. Graphites from furnace loadings purified by means of a chlorine process and let down in argon and nitrogen atmospheres will be compared by means of 305 Test Pile purity results. Samples prepared from Sohio Lima coke and Texas Lockport coke with additives to improve density will also be purity tested and irradiated to determine property changes.

MTR Shim Rod Conversion. Because of existing conflicts in the use of the MTR L-42 position for high temperature irradiation of graphite tests urgently needed to assist in the selection of NPR graphite, an alternate irradiation facility has been designed. This new device consists of a sample-bearing shim rod in the L-48 position and is expected to duplicate irradiation conditions obtained in the L-42 irradiation. The modified shim rod has been designed to operate with essentially the same reactor control characteristics as a regular rod so as to minimize changes in the reactor operating conditions. Based on detailed informal discussions of this proposed modified shim-rod experiment with personnel of the Phillips Petroleum Company, it is expected that this conversion will be accepted for operation in the MTR provided the working assembly meets certain qualifying tests. Final approval by the Phillips Petroleum Company Safeguards Committee will also be required.

Fabrication of a test head, containing the electrical connecting mechanism, has been started, and tests of this device will be made during a future MTR outage. These will demonstrate the holding capacity of the magnetic coupling, which must be greater than 500 pounds, the effective release time, and the operation of the connecting mechanism. Construction has been started on parts for two shim rods. The target date for charging the first experiment into the MTR is April 1959.

High Temperature Graphite Irradiation - GEH-13. The fabrication of a new high temperature graphite irradiation experiment, GEH-13, is nearing completion. Graphite samples will be irradiated in two corner positions,

E-5 and N-14, in the Engineering Test Reactor. Eight cylindrical samples three inches long and 0.426 inch in diameter will be irradiated in each experiment to determine property changes resulting from high neutron doses at high temperatures. Depending upon the amount of gamma heat generated, sample temperatures in the first experiment, which will be monitored but not controlled, are calculated to be 1300 to 1700 C in the high flux position and 500 to 800 C in the low flux position.

Plans now call for charging the first experimental thimble into the ETR during February. Data from these tests will provide information helpful in the development and selection of improved graphites for use in high temperature reactors.

Intermediate Temperature Graphite Irradiation, IP-22. Property changes in common graphites resulting from reactor irradiation at 30 C and 400 to 500 C are quite well known. Radiation effects at the intermediate temperatures are less well known even though large volumes of most graphite reactors operate in this range. A production test, IP-22A, which is an intermediate temperature irradiation test, is being re-activated after a dormant period of many months. Assembly of the various parts is continuing at a steady rate with loading in a Hanford reactor planned for the latter part of February. The assembly consists of four sections with each section containing two standard graphite samples heated by individually controlled heaters. Temperature settings of 200, 250, 300, and 350 C are planned for the test.

X-Ray Study of Radiation Damage. A series of CSF graphite samples irradiated at 30 C from 0 to 4100 MWD/AT have been investigated for the influence of irradiation on the integrated and peak intensities of the (002) x-ray diffraction lines. Through the use of NaCl powder as a standard, the relative diffraction intensities were determined from powdered graphite samples.

Both the integrated intensity and the peak intensity were found to change drastically upon irradiation. In common with other physical properties, the peak and integrated intensities were found to decrease rapidly to 1000 MWD/AT. At that point the integrated intensity was 30 percent of the initial value for unirradiated material. The intensities decreased more slowly with irradiation out to the highest exposure in this series of samples, 4100 MWD/AT. The integrated intensity was reduced to 10 percent of the initial value after this exposure. This decrease in intensity can be attributed to a decrease in the volume of material with sufficient crystalline regularity to satisfy the conditions for the diffraction of x-rays. In addition, the sensitivity of this parameter to short cold test hole irradiations suggests this method as a means of monitoring damage from hot test hole irradiations.

Radiation Induced Oxidation of Plastics. By accounting for the diffusion and activation of oxygen through polyethylene during gamma irradiation, a theoretical equation has been developed which accurately predicts the degree of oxidation in air. The equation predicts the amount of oxidation

product (carbonyl groups) within ± 5 percent for the following range of conditions studied to date:

Total dose	5×10^6 to 1×10^8 r
Dose Rate	1×10^6 to 5×10^6 r/hr
Sample Thickness	0.001 to 0.025 inch.

Other experiments are in progress to extend the dose rate range from 10^5 to 10^7 r/hr.

Thermal Hydraulics Studies

Reactor Flow Hazard Studies. Heat transfer experiments were performed which simulated the events to be expected following the rupture of a front hydraulic connector on a charge-discharge tube at C Reactor. In these experiments the piping rupture was simulated by the instantaneous diversion of flow to the drain from a process tube containing an electrically heated mockup of a loading of I & E fuel elements. Fast responding instrumentation indicated the pressures, temperatures, and flows encountered during the experiments.

The most severe case investigated was under conditions of 1000 KW initial tube power, a 3-1/2-second delay between simulated rupture and start of power decay, initial rear header water temperature of 105 C, and a rear header pressure of 10 psig. During this case the reverse flow of water back through the tube from the rear header was sufficient to prevent temperature on the surface of the fuel elements mockup from exceeding 550 C. Two points of interest noted in this case were that the maximum surface temperature existed for about fifteen minutes after the simulated rupture and occurred toward the rear header end of the tube.

It is clear that at very high power levels or very low rear header pressures a reactor process tube could not sustain a ruptured front hydraulic connector without severe damage. However, it appears from experiments run to date that the limits of power level and rear header pressure at which severe damage would result from a ruptured hydraulic connector may be slightly beyond the values which are currently encountered at the reactors.

Hydraulic Studies. Considerable data were obtained in the laboratory investigation of orientation and pressure drop effects of wire wraps on seven-rod cluster fuel elements for the NPR. Preliminary pressure drop measurements were conducted for wire wrap pitches of two inches, four inches, and ten inches as well as for the non-wrapped seven-rod assembly. These preliminary data show a ratio of the pressure drop for the wrapped condition to the pressure drop for the non-wrapped condition of about 1.5, 3.5, and 9.5 for the ten-inch, four-inch, and two-inch pitches, respectively. The pressure drop for the non-wrapped case was found to be between 10 and 20 percent less than would be predicted by using the hydraulic radius concept and accepted smooth tube friction factors. There is a detectable but slight effect on pressure drop with respect to relative spacing of the wire on adjacent wrapped rods.

The prototype fuel element used in these experiments consisted of seven aluminum rods, 0.780 inch OD by 70 inches long, with the six outer rods wrapped in alternate directions with 0.086 inch OD copper wire. The pressure drop data were obtained both with and without the effects of end fittings.

Heat Transfer Calculations. An analysis was completed to determine transient fuel element temperatures (in particular, surface temperatures) under flow interruption conditions in the KER loops. The purpose of this analysis was to determine the maximum shutdown time for various conditions of flow interruption. It was found that at twenty hours after shutdown it would take approximately five minutes before boiling would take place with no flow through the tube.

Solutions to the problem of predicting temperature events in present Hanford reactors following a complete water loss were attempted on the UCLA IBM 709 computer. The solutions were erroneous, and it was believed that the cause was small errors in the preparation of the inputs. These calculations will be used as a test problem for the new Hanford 709 machine.

Critical and Two-Phase Flow Experiments. Further calibration tests were made on a device to measure the momentum of steam-water mixtures. Such a measurement would aid in the determination of steam quality and the slip ratio in flowing mixtures of water and steam. Calibrations have been attempted statically with nitrogen gas and dynamically with flowing cold water. The difference between measured and calculated values at flows up to 100 gpm with cold water have amounted to a maximum of four percent except at the lower flows. It was concluded that binding between mechanical parts within the device has caused poor results at the lower flows.

A test section was designed to study the pressure drop characteristics of the steam escape channels in the NPR graphite lattice.

Miscellaneous. The installation of the 32,000 ampere silicon rectifiers and associated equipment to provide additional heat generation capacity in the heat transfer laboratory is approximately 25 percent complete.

A project proposal, "Modifications and Additions to the High Pressure Heat Transfer Apparatus, 189-D Building," was prepared and is being circulated for approval. Proposed modifications are to (1) increase the capabilities of the existing high pressure apparatus to accommodate the additional heat generation of approximately 4000 KW available under Project CG-661, (2) add to the existing apparatus to allow transient type experiments to be performed, and (3) provide the additions required to allow experimentation with short test sections.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 facility operated for 440 hours during the month at temperatures between 300 and 350 C using terphenyl - biphenyl eutectic mixture as a coolant. The thermal cycling

test section was repaired and tested. A heating and cooling cycle can now be completed in 2-1/2 minutes. HW-58758, the final report on mechanical seals in organic coolants, was issued during the month.

Reactor Technology Development

Shielding Studies. The foils from the first test on ferrophosphorus concrete baked at 300 C have been irradiated and are being counted at the present time. Ionization chambers were placed in the test slabs to measure the gamma attenuation after the 300 C bake.

The foils from the first test on ordinary concrete baked at 300 C have been counted and the data sent to IMB. The foils from the second test have been irradiated and are being counted. The third set of foils was placed in the ordinary concrete slabs, and the slabs are being irradiated.

The foils from the test on pure iron have been counted and the data sent to IBM. An irradiation was made in the E test hole at the 100-F Reactor to calibrate the sulfur foils used in fast neutron attenuation measurements.

Fabrication of the test insert for the boron steel thermal shield test is 85 percent complete. Ninety percent of the thermocouples have been installed.

All chassis of the 100-channel analyzer have been set up and have been observed to operate correctly in their factory condition. The ORNL adder and add-storage circuits were bread-boarded, installed temporarily, and run for three and one-half days with no adjustments. These circuits, using the 5844 computer tube, have much more drift stability than the original circuits and are therefore being installed permanently.

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

PuO_2-UO_2 Irradiation Capsules. Four capsules of Zircaloy-clad, sintered PuO_2-UO_2 mixed crystal oxides in a UO_2 matrix are awaiting irradiation in the MTR.

High Burnup Al-Pu Alloy Capsule Irradiations. Four Zircaloy-clad capsules (GEH-14-23 through 26) containing Al-1.65 w/o Pu and Al-1.65 Pu alloy cores are currently being irradiated in the MTR. The specimens were charged prior to the initiation of MTR Cycle 116. One capsule of each alloy will be irradiated for three cycles and one of each for four cycles, which correspond to a fractional burnup of plutonium atoms of 80 and 100 percent or a total atom burnout of 0.15 and 0.19 a/o, respectively. The capsule tests are designed to verify and supplement the earlier GEH-3-24 test.

Al-Pu Alloy, PRTR Clusters for KER Irradiation. A four-rod, Zircaloy-clad cluster (IP 186A) containing Al-8 w/o Pu and Al-12 w/o Si-8 w/o Pu alloy cores was discharged from Loop 3 of the KER facility. It was well handled during the ejection operation and is in good condition. Arrangements are being made for examination of this cluster in the Radiometallurgy Laboratory.

A second cluster, which is of similar design and which has been at the reactor since August 1958, was scheduled (HW-56805) for charging into Loop 1 of the KER facility during the first quarter of 1959. Word was received that the cluster will not be charged as scheduled. It was indicated that the next opportunity for testing this element might occur about April 1959.

Thermocouple-Equipped, Prototype PRTR Cluster for KER Irradiation. The seven-rod cluster with extruded Al-1.8 w/o Pu alloy cores and Zircaloy-2 jacketing is being fabricated and will be irradiated in the KER facility on an extension of the IP 186A test. The cores are completed and are being examined. The cladding components have been machined and partially welded. The proposed thermocouple connection was designed by and is currently being tested in the Elmo-7 Loop by Coolant Systems Development.

The seven-rod cluster with aluminum cores and stainless steel cladding will be subjected to fluid flow tests in the near future but is currently being used as a model to aid in determining the best solution to the thermocouple connection problem.

PuO_2 Impregnated Graphite Capsule Irradiations. Irradiation capsules containing graphite which has been impregnated with PuO_2 are being prepared in an effort to investigate the irradiation stability of this fuel material. The samples will operate at core temperatures of about 350, 525 and 780 C. All of the components for the experiment have been fabricated,

and the graphite cores are being impregnated by the Heavy Element Chemistry group. Assembly of the experiment is awaiting completion of the impregnation.

Prototype Al-Pu Alloy PRTR Clusters for ETR Irradiations. Two Al-Pu Zircaloy clad cluster experiments are being fabricated for irradiation testing in the 3x3 and 6x9 high pressure-high temperature loops in the ETR. A seven-rod cluster is being fabricated for irradiation testing in the 3x3 loop and a 19-rod cluster is being fabricated for irradiation testing in the 6x9 loop. The cluster design is the same as that anticipated for the initial plutonium-containing elements for the PRTR. Each cluster will be 47 inches long with an active fuel section of about 35 inches.

Unsintered PuO_2-UO_2 Powder Irradiation. Uranium dioxide powder enriched with 1.0 w/o PuO_2 was successfully irradiated in the MTR at a calculated heat flux of 380,000 Btu/hr-ft^2 and a core temperature of the order of 5000 F. A three-rod, Zr-2 clad cluster was employed, two of the rods being enriched with PuO_2 and the third enriched with 2.44 w/o U-235. Original powder density was 5.0 g/cc.

After irradiation in the GEH-4 facility for one MTR cycle, visual external examination indicates no dimensional changes. Radiometallurgical examination revealed a sintered, cored, ceramic compact which was easily removed from the tube. The UO_2 was largely composed of large, columnar, radially oriented grains. The inner surface of the central cavity was glazed, and one small central body was observed which apparently had melted. A thin, unsintered powder layer persisted adjacent to the cladding. Both PuO_2-containing rods were inadvertently cut during preparation for their return from the MTR so that fission gas analysis is not possible.

Sintered PuO_2-UO_2 Irradiations. Mechanical mixtures of UO_2-PuO_2 which are comparable in specific power generation to Al-1.8, 5, 10, 15, and 20 w/o Pu alloys have been prepared at densities of 65 and 90 percent of theoretical for irradiation in the MTR. Six pellets simulating each alloy concentration will be loaded into two Zircaloy capsules for exposure to 25-50% plutonium atom burnup. The pellets will be canned and autoclaved upon GEH number assignment.

Preparation of Mixed Crystal PuO_2-UO_2. Complete solid solutions have been formed in physical mixtures of UO_2-PuO_2 sintered for four hours at 1600 C. The lattice constant, interplaner distance, and Nelson-Riley value for the individual reflections from each diffraction pattern was obtained on the IBM 650 computer. A near linear plot of composition lattice spacing up to 50 w/o PuO_2 was obtained by extrapolation of lattice constants against the Nelson-Riley value.

The observed and expected lattice function parameters follow:

Composition	Lattice Parameter Extrapolated	Vegard's Rule
PuO_2	5.3964 Å	5.3960 Å
UO_2 - 50 PuO_2	5.4315	5.4327
UO_2 - 25 PuO_2	5.4478	5.4515
UO_2 - 16 PuO_2	5.4592	5.4568
UO_2 - 10 PuO_2	5.4615	5.4615
UO_2	5.4675	5.4682

The estimated tolerance on all values is 0.0004 Å.

Extrusion Program. Installation of auxiliary equipment on the 280-ton extrusion press has been completed. Sealing of the hood for hot operation is now proceeding. Final operating procedures for production of Al-Pu core material rods are now being set up. Billets are cast as right circular cylinders with a nominal 2.5-inch diameter and a length of 10 inches. These will be extruded at a 27 to 1 reduction in area per extrusion, requiring approximately 200 tons. Two cores will be extruded per billet.

Air Pressure Injection Casting. The density of aluminum, injection cast into Zr-2 tubing, was not improved when the tubing was heated to 800 C in a vacuum of one micron for three hours prior to casting. The identity of the gas which causes up to 10% porosity in the aluminum castings may be interstitial hydrogen in the tubing since lubricant would be removed by the outgassing treatment, and even a multimolecular layer of adsorbed hydrogen on the tube walls could not account for the observed porosity. Since the tubing was outgassed in a furnace tube heated by a traveling furnace, it is probable that the interstitial hydrogen was not removed because such a system would establish a hydrogen concentration gradient between the hot and cold portion of the Zr tubing thus causing the hydrogen to diffuse back into the previously outgassed section. A sample of an injection cast aluminum core of low density was submitted for gas analysis to identify the gas or gases causing porosity. One sample of the lot of tubing which has been used for injection casting contained 32 ppm hydrogen. One-half of this volume of gas could be responsible for the observed 8 to 10% porosity in the aluminum injected into the Zircaloy tubing. A facility is being prepared to heat the full length of Zr tubing to 800 C in a vacuum of less than one micron. If the hydrogen content can be reduced to approximately five ppm it may be possible to obtain fuel rods of 98% density similar to castings made in stainless steel tubing.

Al-Zr Bond Strength. Al-Zr bonding layers, with tensile strength of 4000 to 5000 psi, were formed between injection cast aluminum cores and properly etched Zr tubing. Metallurgical bonds of this nature were capable of reducing the OD of 0.030 inch wall Zr tubing from 0.003 to 0.006 inch while the aluminum was contracting, during and after solidification.

Corrosion of Al-Pu Alloys. A high pressure, high temperature autoclave has been installed in a hood for corrosion testing of bare and clad, defected plutonium alloys. Due to temperature control problems, no quantitative results have been obtained to date. However, aluminum-plutonium alloys containing 12 w/o silicon have been shown to be far superior to aluminum-plutonium alloys from a corrosion standpoint and appear to have useful corrosion resistance in 350 C water. For aluminum alloys containing up to 13 w/o plutonium (the highest percent tested) the corrosion resistance improves with increasing plutonium content, but the improvement does not appear to be useful at 350 degrees. The corrosion sensitivity of these alloys to work has also been established.

Collapsing Tests on Zircaloy-2 Tubing. The PRTR fuel elements will require a gap between the Zircaloy end caps and the core to allow for the difference in thermal expansion between zirconium and aluminum. To determine the strength of various lengths of unsupported 0.030" wall Zircaloy tubing, capsules containing gaps of 1/8" to 2" were tested under increasing pressures at 400 C. Table I gives the results of this series.

Table I

Unsupported Length	Collapsing Pressure psig
1/8"	2500
1/4"	2500
	2300*
3/8"	2300
1/2"	2200
3/4"	2075
2"	1700

*Noticeable indentation, but not collapsed.

Fuel Element Warp Test. Two 1/2-inch diameter by eight-foot long Zircaloy tubes were loaded with pure aluminum rods and welded at both ends. Diametral clearance between the Al cores and the Zircaloy tubes was more than 0.004 inch. The loaded tubes were exposed in an autoclave at 400 C and 1300 psig for 72 hours. At the end of this exposure the rods had developed a two-inch bow or permanent set. If this situation should occur in the PRTR, serious fuel element operating and handling limitations would result. It was discovered that the warp might have occurred because the tubes had previously been cold worked by swaging and that stress relief could have taken place. Also, the tubes were supported on the bottom and rested at a slight angle in the autoclave which may have caused them to distort. Another factor is that the tubes were not bound in a bundle as will be the case in the 19-rod cluster. In view of these facts, a more thorough experiment was instigated.

Twelve full length rods and tubes are being fabricated to investigate the warp problem, if one exists, and at the same time furnish information

on a number of other questions. Points of interest are as follows:

1. The possibility of a warp problem will be investigated. The rods and tubes as assembled will be fully annealed. They will be hung from the tops and exposed in an autoclave at 400 C and 1500 psig for 72 hours.

2. Information will be obtained on the problem of inserting an eight-foot Al rod into a Zircaloy tube which has one end closed with a maximum diametral clearance of only 0.003 to 0.004 inch between the rod and tube. Problems arise because of variations in the inside diameter and ovality of the Zircaloy tubing. By selecting rods and tubes, and vibrating the tubes, it was possible to assemble a rod and tube which had a maximum of 0.005 inch clearance and a minimum clearance of 0.0025 inch. It is questionable, however, that with the difficulties experienced thus far this assembly method will be satisfactory.

3. It will be attempted to determine whether the end clearance necessary for differential thermal expansion between the fuel rod and tube must be distributed at each end, or if it can be at one end only. Two tubes will be heated in the autoclave to determine the effect of no end clearance.

4. The end closure welding techniques will be tested on full length elements.

5. It will be determined whether or not the Zircaloy tubes and wires can be cleaned and etched prior to wrapping and autoclaving. After etching, the components will have to be handled very carefully in order to prevent contamination of the surfaces with resulting autoclave failures.

6. The performance of the Zircaloy wire wraps upon heating to 400 C will be demonstrated.

7. If the tubes do not distort after this test, they will be cold worked by swaging to simulate a sizing operation and exposed again in the autoclave. This will furnish information on the effects of sizing the tube onto the core if this becomes necessary.

Welding Development. Experiments are being directed toward making the first closure on the PRP Zr canned fuel elements in a portable purge chamber using argon. Ten weld specimens were welded in this manner, after etching and autoclaving the heat affected and weld zone showed no corrosion product present.

Cluster Design Engineering. The problem of autoclaving wire wrapped fuel element rods is being studied. Two difficulties are found when attempting to etch and autoclave a wire wrapped rod. The first is the

inability of the etch solution to penetrate between the contact point of rod and wire. This leaves a small helical line on rod and wire which remains unetched. Unetched Zircaloy when autoclaved tends to be coated with white breakaway corrosion oxide. The second problem arises when acid stain is created in the crevice formed on each side of the junction of wire and rod. The acid cannot be removed by normal rinsing techniques. One 12" Zircaloy dummy fuel rod which had one pitch length of wire wrap attached was etched using ultrasonics in the etch solution, the $Al(NO_3)_3$ solution and in the first rinse water. After the standard autoclave test of 72 hours in 400 C steam at 1500 psi pressure, the rod and wire were free of white breakaway corrosion product. There was only a very dim outline of an acid stain at one end of the rod.

A drilling fixture has been completed which will drill a hole in the bottom end cap of a welded fuel element tube. This fixture will align the holes in the same place and space them the required 90° apart. It will also align and space the second pinhole in the center rod end cap.

UO_2 Fuel Development

PRTR Fuel Elements. Fabrication of swaged cluster fuel elements for the PRTR was initiated during the month. Five hundred pounds of UO_2 were prepared for swaging by crushing sintered UO_2 biscuits. The crushed UO_2 was screened to -20 + 100 mesh, and decontaminated from iron introduced during crushing by passage through a magnetic separator. The UO_2 was vacuum outgassed at 700 C before loading into tubes for swaging. After

A technique was developed whereby 45-pound lots of ball-milled UO_2 powder containing no binder are isostatically pressed into a billet approximately three inches in diameter and two feet long. The resulting billet can be sintered in a four-inch ID hydrogen tube furnace. Only 25 pounds of UO_2 prepared by more conventional methods of cold die pressing can be sintered at one time in the same furnace. UO_2 prepared in this manner is crushed for incorporation into swaged PRTR fuel elements. Other types of powder, such as arc-fused UO_2, and other techniques, such as hot swaging, are also being investigated to optimize this fabrication process.

A difficulty in mechanized welding of Zircaloy-2 was the initiation of an arc in a pure helium atmosphere. This has been eliminated by the use of an insulating sleeve around the tungsten electrode to restrict the high frequency arc to the end of the tungsten tip. Reproducible, instant arc starting is obtained for low as well as high weld currents.

Six-18" long, four-rod cluster fuel elements containing 1.6 w/o enriched UO_2 swaged to a density range of 84-89 percent of theoretical in 0.036" wall 304 stainless steel were discharged from KER Loop 1 after a five-month irradiation cycle. Visual examination of the 0.625" diameter rods in the discharge basin showed no fuel rod distortion, swelling, or corrosion as a result of the irradiation. These preliminary results support the thesis that rod warping will not be a major problem in the PRTR 19-rod cluster swaged UO_2 fuel element.

The Radiometallurgy examination of an irradiated three-rod cluster of Zircaloy-clad, swaged UO_2 (1.6 w/o U-235) has shown: (1) extensive UO_2 crystal growth occupying as much as one-third of the fuel diameter, (2) the formation of sausage-shaped voids which are aligned in rings around the fuel center and in the recrystallized area, (3) that the UO_2 outside of the recrystallized area has sintered with the exception of a thin powder layer at the UO_2-Zircaloy interface, and (4) that large irregular cracks run radially from the fuel center to the outer edge of the sintered UO_2. These observations conform to predictions made on the basis of ex-reactor crystal growth studies (cf. Basic Studies).

Basic Studies. The study of the microstructure of sintered UO_2 is a direct way of detecting radiation damage. Two techniques are being used: (1) metallographic examination of polished and etched surfaces, and (2) fractographic studies.

The microscopic study of irradiated UO_2 has required development of specimen preparation procedures suitable for electron microscope application. A satisfactory method has been established. The presence of small voids at grain boundaries on a fracture surface of UO_2 after a burnup of only 0.004 a/o at approximately 100 C has been corroborated by similar voids located at grain boundaries on polished and etched surfaces. Since such holes are not detected in unirradiated UO_2, they must arise from: (1) migration of gases trapped during the fabrication processes, (2) generation and migration of fission gases, or (3) a combination of (1) and (2). Examination of material irradiated to higher burnups should show trends in the irradiation behavior of UO_2.

Dendritic crystals of UO_2 resulting from high temperature irradiation of UO_2 powders have been found to be similar to dendrites grown from the vapor phase in ex-reactor experiments. The dendrites in the irradiated material were observed at the outer, cooler ends of large, radially oriented columnar grains. These findings constitute further evidence that the columnar grains in irradiated UO_2 are probably not formed from the melt, as was popularly assumed, and that higher heat fluxes can generally be achieved in UO_2 fuel elements without exceeding core temperature limits.

Facilities. The pusher-type hydrogen atmosphere furnace for sintering UO_2 has been in continuous operation for two months without any unexpected incidents. A liquid argon gas manifold for the manual purge gas supply to the furnace was installed and will supplement the existing helium purge supply. This addition was made necessary by the current shortage of helium.

A special hood was fabricated and installed in the basement of the 325 Building in which to load and compact UO_2 powder into Zircaloy-2 tubes prior to swaging. The hood eliminates the health hazard caused by UO_2 dust during loading of the tubes.

Installation and acceptance testing of the 300-ton automatic tabletting press is nearly complete.

Structural Materials Development

Zircaloy Jacket Tubing. The first full-length samples of ribbed Zircaloy tubing (approx. eight feet long) produced by the Thermatool process at New Rochelle Tool Company for acceptance testing have been examined and were found to be generally satisfactory. Condition of the weld and the exterior surface of tube and rib were satisfactory. The inside surface under some of the welds showed evidence of sufficient contamination to have an adverse effect on corrosion resistance. Opinion is that this should be minimized but is not of prime importance since the inside of the tube will not be exposed in use to the corrosive environment.

Samples of the 2.998" ID tubes have not yet been received. The vendor has not been able to weld the 0.085" ribs because of overheating in this small section. Rib of 0.100" height proved no better. A weld was achieved with material of 0.115" height but the rib was distorted to such an extent that it would not pass through the machine on succeeding welds. Success was achieved with 0.135" ribs. It appears that this must be accepted as a limitation of the machine. It will be necessary to machine these ribs to size to achieve the lower rib height required for narrower annuli. Attempts to upset the rib to smaller dimension in the welding operation have been limited by distortion of the tube.

Tooling is now being fabricated with which to return to round condition those 1.802" diameter tubing samples which distorted in the welding operation. This consists of a series of plugs and drawing dies with which to expand and sink the tubing as needed.

The proposal of the New Rochelle Tool Company to adapt the machine to a spiral rib configuration is now undergoing cost scrutiny by AEC purchasing. Resolution of this factor will expedite finalization of the contract modification. Work can then begin on alteration of the machine.

Modification No. 4 to contract DDR-29 has been approved at HAPO and forwarded to NYOO-AEC. This modification will extend the work at Nuclear Metals, Inc., on the development of an extruded ribbed jacket tube. Diameters have been changed on all tubes and the wall thickness increased to 0.060". These tubes will be used for the PRTR Mark II-c fuel element.

Wolverine Tube Company has completed the fabrication of the 0.680-inch ID x 0.035-inch wall Zircaloy tubing to be used for swaged UO_2 fuel elements for the PRTR. Of the 2280 lengths completed, 1337 lengths have been accepted and shipped to HAPO. Non-destructive testing, eddy current, dye penetrant, Vidigage and radiography of this tubing have revealed that about 30% of the tubes exhibit light to moderate galling on the inside surface. Samples of each type of indicated defect are being thoroughly characterized by metallographic methods and the severity of each type of defect will be determined through swaging operations. Fabricating techniques were altered to reduce or eliminate these defects. Pressed-in copper inclusions and small cracks found on the inside surface of a few tubes in an earlier lot were not found in this tubing. Considerable care and effort is being expended by the fabricator to produce completely satisfactory tubing.

Of the 2280 lengths of 0.505-inch ID x 0.030-inch wall, Zircaloy tubing for the Al-Pu fuel elements, 575 lengths have been accepted by inspection and shipped to HAPO. Preliminary non-destructive testing indicates that this tubing is of excellent quality. Absence of galling is attributed to a difference in fabricating technique compared with the methods employed for the 0.680-inch diameter tubing, above.

Zircaloy Process Tubing. Examination of the extrusions for PRTR process tubes furnished by Chase Brass and Copper is continuing. Preliminary reports on the majority of the tubing indicate that marked improvements in concentricity and surface quality were obtained. Rockrite tube reducing was performed on 45 extrusions followed by vacuum annealing the portion of the tube to be tapered. Problems associated with distortion during vacuum annealing have been solved. Tapering was accomplished in a single pass on two tubes. Severe die pick-up on the outside surface necessitated redesign of the tools, but the inside surface appeared to be smooth.

Samples of various flange designs were tested for strength and examined for integrity. A modified design incorporating a threaded and welded flange is being prepared for test. All flanges tested withstood a higher pressure than the tube wall; failure occurred at a point well removed from the flange. Sections of process tubes fabricated by cold working 40% followed by vacuum annealing were tested under pressure at 300 C. Failure occurred at a nominal pressure of 4200 psi (approximately four times the expected working pressure) and a circumferential fiber stress of 46,000 psi.

Radiometallurgy Laboratory Studies

Examination of a PuO_2-UO_2 powder, three-rod cluster fuel element (GEH-4-28) continued. Two of the rods were penetrated by a hacksaw at the MTR which prevented rare gas analyses. Procedures were developed for producing satisfactory metallographic etches of irradiated UO_2, and suitable replicas were obtained from 88 and 98 percent of theoretical density UO_2 specimens which were irradiated to 1000 MWD/T (IP-149-D); collection of rare gas from one of the three-rod clusters (GEH-4-33) was prevented by uncovering a 0.060-inch hole during the usual facing operation; and metallography studies of an unruptured UO_2 powder fuel element (GEH-4-30) were completed. Results and conclusions from the above studies are reported in detail in connection with the respective development programs.

Thermal Hydraulics Studies

The calculations of the flow decay after power failure to the primary coolant pump in the PRTR (reported in HW-51767 Rev) were revised to account for the various design changes in the reactor since the original calculations were performed. It was found that for the present reactor design the pump flywheels should provide for sufficient pumping to prevent steam formation within the primary coolant loop. It was also calculated that the pump by-pass line should be opened at some time between 45 seconds and five minutes after power loss. During the first 45 seconds the pumping power as supplied by the flywheels is necessary for adequate flow while after five minutes the pumps act as a resistance and hinder the flow by free convection.

Refinement of the calculated water loss rates from the PRTR was started. The revision of these calculations for the final hazards report has been necessitated as a result of changes in the primary coolant system. Four cases will be considered; a complete parting of a main 14-inch header, a failure in the side of a 14-inch header with a flow area equivalent to that of a 14-inch pipe, a top jumper break, and a bottom jumper break. Using these water loss rates, Battelle will calculate the fuel temperature transients.

Installation of the electrically heated mockup of the Mark II-b fuel element was continued. An attempt was made to find a satisfactory method of providing an electrical insulation between the electrically heated part of the test section and the rest of the apparatus.

The original proposal for flange insulation was flame spraying of the flange face with an oxide coating and then application of Markal DA-8 paint (a waterproof paint capable of withstanding high temperatures). This method has proved unsatisfactory in that when the flexitallic gaskets are compressed to the required torque loading, the small stainless steel portion of the gasket breaks the oxide coating and thus causes a direct short between the flanges.

The following schemes have also been tried but have proven unsatisfactory: rounding the edges of the tongue, applying an oxide coat, and painting with Markal DA-8; applying a woven glass cloth to one face of the gasket; wrapping the entire gasket with woven glass cloth; and applying Markal DA-8 paint to the face of each flange.

It appears that an acceptable seal and sufficient electrical insulation can be provided by attaching a thin asbestos gasket to one face of the gasket.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. The discharge cask of the charge-discharge machine will contain a shroud to direct a flow of air to cool the fuel element. The shroud is constructed in two movable pieces which are moved apart for the raising of the fuel element into the discharge cask, and then are closed around the fuel element. A mockup of the shroud is being constructed to insure that the expected swinging motion of the bottom end of the fuel element will not interfere with the closing of the shroud.

Design Test PR-10 - Primary Loop Mockup. The first primary pump was assembled and cold performance tests run. The tests results showed a total developed head of 294 feet at a flow of 4200 gpm. The eight-inch pump discharge check valve was received.

Design Test PR-13 - Injection Pump Test. Testing of the 15 gpm, 1200 psi discharge injection pump continued. No difficulty has been experienced during a total of 203 operating hours.

Design Test PR-20 - Calandria Characteristics. Additional dump tests were run using one and two dump valves. Work was almost completed on valve synchronization to provide for the instantaneous opening of two, three, or four valves.

Design Test PR-24 - Shroud Tube Bellows. The bellows from the Masters Product Company for the six-inch central process tube were received and testing started. The bellows were not damaged in a 14,000-cycle flexure test; however, the helium leak rate at room temperature was not within specifications. This leak rate decreased to 0.4 cubic foot per hour when the bellows were heated to 500 F. Corrosion tests are now being conducted.

Design Test PR-40 - Shim Control Mockup. The shim control assembly is being redesigned to prevent the control rod from falling out of the reactor in the event that the supporting bead chain breaks. Two new designs are currently being developed, the floating rod and the powered lead screw. The approach under investigation to obtain a floating rod is to flame spray the poison material on a buoyant material, such as "Foamsil".

Design Test PR-50 - Reactor Piping Seal Testing. Thermal cycling of Process Tube Assembly "A", containing prototype seals, was completed with a total of 2500 temperature cycles from 200 to 580 F at a pressure of 1900 psi. The nozzle to process tube seal was the only water seal which showed signs of leakage during this test period. Visual inspection of the seals after disassembly revealed no signs of damage.

The fully prototype nozzles were received. One nozzle will be installed on Elmo-7 early in February. This unit, utilizing a three-foot Zircaloy tube, will be called Process Tube Assembly "C" and will be subjected to thermal cycle testing. The assembly will contain all of the process tube seals.

Flat type copper gaskets with an asbestos filler have been used for the outlet gas seals located at the centering flange and between the flanged end of the Zircaloy process tube and the ring flange. Design changes are under way to utilize this type of gasket instead of "O" rings.

Design Test PR-51 - Reactor Piping Structural Integrity. Flexure testing of a medium length outlet jumper with considerable bends has been completed after 51,200 cycles of one-half inch deflection at an internal pressure of 1500 psi. No leakage, distortion of the jumper, or loosening of the Parker fittings were observed. The installation of the heating loop for testing jumpers at elevated temperatures is 85 percent complete.

Fabrication of the thermal barrier for the lower face mockup was resumed. A full scale drawing of the barrier was made to check the barrier layout.

Design Test PR-52 - Process Tube Thermal Cycling and Pressure Testing. The full size process tube and shroud tube assembly was installed in the process tube test pit and connected to Phase I of the Single Tube Prototype Mockup. Hydrostatic testing was completed and testing at PRTR operating conditions will start shortly.

Design Test PR-70 - Helium Compressor Test. The investigation of methods to detect a ruptured compressor diaphragm indicated that the change in gas conductivity might be used. This change is caused by oil contamination of the gas after the diaphragm ruptures.

Single Tube Prototype Mockup. Phase I of the mockup was operated 60 hours during the month. The maximum operating conditions reached were 485 F, 1100 psi, and 124 gpm. The final acceptance test (temperature control system) was completed. Hot loop tests on the prototype pump for this phase started at the Byron Jackson Pump Company plant on January 27. Seal testing in their laboratory is continuing.

Construction of Phase II continued. The 14-inch primary loop gate valve was installed. Preparations were made for the installation of the eight-inch primary pump discharge check valve.

Inconel "X" Supercritical Pressure Mockup. Fabrication of the mockup was completed and start-up tests were begun. The mockup is electrically heated rather than employing molten lead as the heat source, because the lead would cause stress cracks in the Inconel "X".

Zirconium Tube Burst Tests. Testing continued at pressures of 2500 psi and temperatures of 650 F. HW-58620, describing the test program and results to date, was issued during the month.

Reactor Technology Development

All scheduled testing on resistance temperature detectors and flow transmitters was completed. Final reports on the design tests are in preparation. Operational checks will be continued on surviving units as full scale mockup facilities are completed. A paper on resistance temperature detectors was forwarded for possible presentation at the Fifth Nuclear Congress.

A study of containment systems was completed. The study was initiated in an attempt to discover a scheme or system equal to, and cheaper than, the system currently planned for the PRTR. It was concluded that the most applicable alternate approach is that of improving the ability of the fuel element jackets to contain fission products by the addition of back-up cooling system(s). A report summarizing the study is in preparation.

Design Development

Phase I PRTR Construction Status. The Phase I PRTR contractor is approximately 70% completed versus 81.3% scheduled. The five-foot thick section of the O-O slab in the containment vessel was poured. The installation of siding and roof decking on the storage basin was started and is approximately 25% completed. The last pour on the ion exchange vault has been made.

Phase II PRTR Construction Status. The Phase II PRTR contractor is 59.5% completed versus 66% scheduled. The brine pit was relocated in order to provide a clear area for future building extension. The drain lines on the east side of the building, in the vicinity of the load-out facility, were revised in order to make provisions for the new stack design.

Phase II-A PRTR Construction Status. The Phase II-A PRTR contractor is estimated to be 25% completed versus 23% scheduled. Excavation was started for the river pump structure.

Design Analysis Studies. A preliminary study of alternatives to a containment vessel for the PRTR has been prepared in rough draft form. The study compares the probabilities of containment vessel failure during an incident with the probabilities of inoperation of various backup systems.

Calculation of reactor power as a function of time after a scram with normal coolant conditions has been completed. Comparison of the power available for dissipation to the primary coolant of PRTR with that

obtained for the NPD reactor shows the former to be lower in the range from 0.8 second to 35 seconds after scram, due to the more rapid drop in fission power in the PRTR. The initial design of the primary coolant system, based on the NPD data, is therefore shown to be sufficiently conservative. A report describing this work will be issued.

An investigation of the effect of H_2O contamination of the primary coolant on reactivity and the neutron spectrum has been completed. It was found that this has relatively little effect on reactivity out to concentrations of the order of 20 mol percent H_2O. However, the effect on the neutron spectrum is such that the fraction of neutrons in the epithermal part of the spectrum is significantly reduced and may have to be taken into account in certain experiments. Report HW-58893, presenting this study, is in preparation.

A calculation of the radiation intensity at the location of the dump valve, to determine whether Teflon valve seats will have sufficient life, was completed. Results indicated that the dose rate on the valve seats is not expected to exceed 50 r/hr. Since the break-even point for the use of Teflon at this location is about 100 r/hr, it was found to be acceptable.

Reactor Flow Systems. Heat-capacity data developed by Byron Jackson Company during a cold test of the first PRTR pump showed about 13 percent higher discharge pressure at design flow than was previously anticipated - 294 feet versus 260 feet. Pump motor horsepower requirements are correspondingly increased from 295 to about 320 h.p. at design conditions. Pump efficiency was found to be higher than anticipated, with a maximum of about 88 percent.

The pump manufacturer has recommended that the condition of pump bearings and the adequacy of lubrication be monitored by use of thermocouples placed in wells drilled alongside the bearing cases.

Permission was granted the Phase III contractor to furnish boiler feed pumps with flanged rather than welded discharge connections for reasons of cost and delivery schedule. However, leakage collection shrouds will be provided at each of these connections.

Reactor Core Components. Continued analysis of PRTR reactivity transients disclosed that it would be necessary to carry the fuel temperature reactivity transient in moderator level control. This transient is of the order of 12 mk for certain loadings, once the primary coolant is at operating temperature and the reactor at low power. Twelve mk corresponds to approximately 20 inches of moderator level. To provide this degree of level control without possible moderator boiling, it was necessary to revise the calandria top drain system. The original top drain header and outlet orifices were lowered by 2-3/4 inches to increase the range of moderator level over which the system was operative. An additional top drain header and set of orifices (of identical design to the original) were added at an elevation 13 inches below the upper header. The outlet lines from these two headers run concentrically through the calandria down to an elevation a few inches above the bottom of the calandria.

In addition, the moderator inlet plenum at the bottom of the calandria was divided into two plenums, an inner (roughly circular) and an outer annular plenum. The outer plenum is fed moderator by the original inlet system. The center plenum is fed by an additional line passing through the bottom shield. The flow to the two plenums will be adjustable by throttle valves. Control of the distribution of the inlet water between the center of the calandria and the outer regions will be useful in eliminating any moderator hot spots which may form.

Instrumentation and Control. Comment prints on the PRTR gas moisture detection system have been issued and reviewed. This system is designed to detect heavy water leaks in the calandria or process tube by monitoring the dew point of the dry gas surrounding each process tube and that of the bulk inlet and outlet gas.

The flow monitor system has been revised to provide better control over by-passing of monitors. Individual monitors can now be by-passed only by the use of special, non-standard plugs fitting the by-pass jacks. Auxiliary contacts in the by-pass jack light the appropriate lamp in the 85-point flow monitor display panel and actuate a common alarm annunciator alarm, whenever a monitor is by-passed.

The design of the effluent activity monitor system is being revised to increase its reliability and to provide better control for total containment of the reactor building. High reliability equipment similar to reactor nuclear safety system equipment will be used in the system, and two channels will be provided. Coincident tripping of both channels will be required to initiate total containment.

Fuel Element Examination Facility. The ventilation inlets and outlets from the facility were moved from the cast iron wall to the concrete shielding walls to reduce radiation leakage into the experimental cell.

Bid packages on the primary manipulator were sent to prospective bidders. The bid opening date is February 16.

The designs of both the prototype wide angle viewer and combination viewer-profilometer are approaching completion. Fabrication of components of the viewers has been started.

Plutonium Fabrication Pilot Plant

Construction is 65.2% complete. Project design is 87% complete.

Phase II Construction. Phase II construction is 68% complete compared to 72% scheduled. The last major structural concrete pour was made during the month, and roof construction is progressing well.

The contractor dropped behind schedule several days this month because of inability to pour concrete in sub-freezing weather. The lost ground should be partially regained during February.

Phase III Design. Preliminary schedules were drawn up covering design for equipment groups 4 and 5.

Procurement. Three key purchase orders went behind schedule two to four weeks during the month; liaison efforts to improve scheduling of these orders are in progress. Purchase orders totaling $708,000 have been placed. Three requisitions estimated at a total of $28,000 are awaiting action. Requisitions for the rolling mill, the extrusion press, and the oxide sintering furnaces remain to be submitted.

2. BASIC SWELLING STUDIES PROGRAM

Irradiation Program. The swelling behavior capsules for controlled temperature irradiations will be the first to be assembled. Delivery of the temperature controllers has been postponed until the latter part of February.

A study of methods of preparation of high purity uranium is being conducted to supply the enriched uranium metal necessary for the in-reactor and ex-reactor swelling experiments. A consolidation melt produced another ingot weighing about one pound this month.

Simulated Swelling Experiments. Uranium swelling has been simulated in the laboratory by the introduction of xenon gas into uranium at elevated temperatures. Design was completed this month for a simple apparatus for the introduction of inert gas in a modified bell jar. Four units will be built. These units are necessary since the original apparatus is now being used for investigation of the mobility of xenon in uranium.

Mechanisms and Theory. Optical and electron microscopy afford a direct physical means for studying certain aspects of swelling, namely, the number and size of pores in uranium. Accordingly, various specimens of irradiated uranium differing in burnup, irradiation temperatures, and post-irradiation annealing history have been examined. Pores found in such specimens vary in size and location. As a consequence of the radiation induced microstructural changes, little correlation between microstructure and pore location is possible on specimens studied to date. A possible exception to this conclusion is a recently studied specimen of Zircaloy-2 clad, co-extruded uranium irradiated to a burnup of about 0.2 a/o at a core temperature sufficient to show some microstructure which resembles that of unirradiated beta heat treated uranium. In this specimen pores are distributed quite randomly, but superimposed on this type of distribution is a tendency for many pores to fall on grain boundaries and to be aligned on crystallographic planes, such as twin boundaries. On the basis of a purely qualitative estimate of the distribution of pore sizes, this specimen differs from previously examined specimens in one other respect: largest pores are present near the periphery of the element rather than near the axis. Perhaps this condition is related to the thermal history of the core (possible transformation during irradiation).

In order to establish the effect of flux intensity and degree of burnup at three specific irradiation temperatures, six capsules containing unrestrained, precharacterized uranium specimens immersed in NaK have been prepared and shipped to the MTR for irradiation. Post-irradiation measurements will include density, dimensions, microstructure, hardness and x-ray diffraction line breadth changes.

The rate of diffusion of fission gas into pores determines the pressure in the pores as a function of time and temperature. For this reason the mobility of xenon in uranium is now being studied. The mobilities of argon, krypton, and xenon in silver have been determined; however, attempts to measure the mobility of rare gases in uranium by the same methods were not successful. A new method utilizing glow discharge to continuously introduce xenon into one side of a hot uranium disc is now being studied. The rate of xenon evolution from the far side of the disc will then be measured to determine the mobility of the gas in uranium. Activation analysis, used in previous experiments to measure minute quantities of krypton and xenon, requires reactor irradiation of the gas samples. In addition to being cumbersome, this method of analysis risks loss of samples through handling. It may be possible to use a modified helium leak detector to determine the amount of xenon evolved. The rate of helium penetration through uranium will be measured, using a standard helium leak detector, to determine the feasibility of this method.

The effects of xenon gas introduced into unirradiated uranium using a glow discharge upon the physical and mechanical properties of uranium will be determined. Selected physical and mechanical tests are planned which are sensitive to the presence of gas filled pores and microcracks. Initially, emphasis will be placed upon room temperature and elevated temperature tensile tests. It is anticipated that these tests will yield information about the dispersion of the gas filled pores.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility. Rough drafts of all sections of the design criteria text for the gas loop have been completed. Final comment issues of the first four sections have been issued, with issuance of the final five sections scheduled for February 4.

The facility will be designed for studies of the chemical and physical behavior of reactor materials under conditions likely to exist in advanced gas-cooled reactors and particularly for in-reactor studies of the CO_2-graphite reaction. In addition, the loop will be designed to accommodate the irradiation testing of fissionable materials having up to 500 KW heat generation. The in-reactor test section of the loop will be located in channel 1946 of the PRTR. Gas blowers, heaters, coolers, gas analysis, control and make-up facilities will be located in B cell of the PRTR building. Design of the loop will be based on the following maximum operating conditions: pressure, 500 psig; outlet test section gas temperature, 1100 F;

gas flow rate, 15,000 lb CO_2/hr. Studies of the CO_2-graphite reaction require the maintenance of an initially supplied gas volume within the loop for extended periods of time and measurement of changes in gas composition with time. Because of leakage considerations, welded rather than flanged construction will be used wherever possible and the number of valves in the loop will be kept to a minimum. Procuring the loop components in prefabricated, tested sub-assemblies will reduce the time required for loop installation in the PRTR building. The present schedule calls for completion of the loop by June 18, 1960.

All funds authorized for the gas loop project have been released, with authorization to spend $175,000 during FY-1959.

A study was made of the effect on the project of increasing design temperature of the loop to 1500 F. An increased cost of $175,000 was estimated, resulting from changing a major portion of the loop to inconel and from the more stringent safety requirements at the higher temperature.

Coatings for Graphite. A general survey of the literature on coatings for graphite has been completed. Many different materials have been tried for the protection of graphite in an oxidizing atmosphere. At present, the most promising material for use in nuclear reactors appears to be silicon carbide. The development of silicon carbide coatings for graphite is being actively pursued by National Carbon Company, Minnesota Mining and Manufacturing, and Carborundum Company.

Graphite samples coated with silicon carbide have been received from National Carbon Company. During the measurement of surface area by the BET adsorption method, it was found that at 10^{-5} mm pressure and 300 C an oily material was evolved from the sample. After repeated applications of vacuum and heat, the surface stabilized. No definite conclusions have been formed as to the character of this material. However, the literature indicates that silicon carbide coatings can be applied using a "resin" binder.

Contact was established with the Minnesota Mining and Manufacturing Company during the month, and samples of different types of graphite were shipped to them for coating. Minnesota Mining and Manufacturing Company will send Hanford some coated samples of the graphite type they prefer to use.

Information was received from Hawker Siddeley Nuclear Power Company, Ltd., that samples of impermeable graphite produced by them would be shipped to Hanford some time in March.

Graphite Pore Size Distribution. A method for measurement of pore size distribution of graphite samples has been written which gives a brief treatise of the theory involved, operating procedure, and method of computation. The method of computation of the pore size distribution is long and tedious requiring one to two man days. In order to gain

greater efficiency and economy, representatives of Data Processing Operation are investigating the feasibility of programming the problem for the IBM 709 computer. It is anticipated that computer computation will greatly reduce the time required for data reduction and analysis.

Microwave Glow Discharge Studies. The reaction rate of gases with graphite is enhanced by reactor radiations. In the CO_2-graphite system, this enhancement is due to the production of oxygen atoms or activated molecules followed by rapid oxidation of the graphite. The use of a microwave glow discharge appears to be a convenient way to simulate in the laboratory the effects of reactor radiations. Recent discussions with personnel who have had experience with microwave glow discharges at the Aberdeen Proving Ground and the National Bureau of Standards resulted in suggestions on cell design and experimental techniques for experiments planned at Hanford. Oxidation resistant graphites and coated graphites will be tested in candidate reactor coolants.

D. CUSTOMER WORK

Radiometallurgical Examinations

IP-132-C Depleted I & E Pieces 2079 C (RM-256). Four 0.2 a/o U-235 depleted uranium slugs were received for sectioning and delivery to Analytical Chemistry for U-235 burnup analyses. The sectioning of all four elements was completed. One wafer and one set of dissolver solution samples have been delivered to Analytical Chemistry.

Preparation of Samples for Project C-791 (RM-267). Nineteen uranium bars (approximately 1/4" x 1/4" x 2") were sectioned from two I & E fuel elements for shipment to ORNL. These bars will be melted to determine the quantity of fission product release in connection with Project C-791.

Metallography Laboratories

Samples processed during the month:

Total samples processed: 197

Photographs:

Micrographs	271
Macrographs	46
Total	317

F. W. Albaugh
Manager, Reactor and Fuels Research
and Development Operation

1240863

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DE Rasmussen	1/19 - 21	Jones & Laughlin Steel, Los Angeles, Calif. Pacific Metals Co., LTD., Los Angeles, Calif. Aluminum Co. of Amer., Los Angeles, Calif. Reynolds Metal Co., Los Angeles, Calif. Saginaw Steering Gear Div., N. Hollywood, Calif. Joe Davidson & Assoc., Los Angeles, Calif. Babcock & Wilcox Co., Los Angeles, Calif.	Consult on PRTR and supercritical pressure components.	SF Shiffette GL Taylor TG Halligan R Hancock MK Horan F Simpson RH Collins	No " " " " " "
PA Scott	1/21 - 31	Byron Jackson Pump Co., Los Angeles, Calif.	Consult on PRTR pumps.	A Bunke	No
DJ Foley	1/5-7 1/14	Consolidated Western Steel, Los Angeles, Calif. "	Discuss PRTR calandria fabrication Approve CWSD shop drawings for PRTR calandria.	DJ Bentley "	No "
JC Fox	1/19 - 20	Willamette Iron & Steel, Portland, Ore.	Discuss fuel handler.	W Dortmund	No
HK Nelson	1/26	Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.	Discuss controller design.	EB Dahlin	No
MK Millhollen	1/5 1/6	Hunter-Douglas Corp., Riverside, Calif. Thompson Products, Bell, Calif. Toi-Shan Mfg. Co., Culver City, Calif.	Discuss fabrication of PRTR fuel element end caps and hanger fittings.	RA Quadt P Sheehan J Storoba	No " "

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
SH Bush	1/13 - 15	duPont, Aiken, S.C.	Attend meeting of Working Comm. of Fuel Element Development Committee.	TC Evans	Yes
	1/16	NMI, Concord, Mass.	Discuss coextrusion work.	P Loewenstein	"
GS Allison	1/13	Steel Improvement & Forge Co., Cleveland, O.	Discuss forging process.	J Russ	No
	1/14	Autoclave Eng. Sales Corp., E ie, Pa.	Discuss equipment	JF Allison	"
	1/15	Natl. Lead Co., Albany, N.Y.	" "	E Blasch	"
	1/16	NMI, Concord, Mass.	Discuss coextrusion work.	P Loewenstein	Yes
RS Kemper	1/13	Clevite Res. Center, Cleveland, O.	Discuss fabrication of nuclear components.	GW LaPier	Yes
	1/14	C. I. Hayes, Co.,	Discuss heating equipment.	W Sauler	No
	1/15	Natl. Lead Co., Albany, N.Y.	Discuss equipment.	E Blasch	"
	1/16	NMI, Concord, Mass.	Discuss coextrusion work.	P Loewenstein	Yes
LJ Chockie	1/20	ASM Chapter Spokane, Wn.	Present paper.	--	No
DC Kaulitz	1/19 - 20	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Discuss ETR facilities.	LH Jones	Yes
DC Kaulitz JE Minor	1/21	Res. Welding & Eng. Co., Compton, Calif.	Initiate work on development contract.	G Garfield	No
EA Evans	1/22	US-AEC, Washington, D.C.	Discuss UO_2 technology.	JM Simmons	Yes
	1/26 - 30	U.K. Atomic Energy, London, Risley, Harwell, Springfields; England	Discuss basic research & development involving uranium dioxide fuels.	LB Werner-AEC Liaison	Yes
JL Bates	1/26 - 27	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Investigate irradiations of ETR & MTR.	R Neidner	Yes
LE Mills	1/29	New Rochelle Tool Co., New Rochelle, N.Y.	Observe operation of Thermotool process on attaching ribs to Zr-2 tubing under contract.	CA Tudbury	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
GS Allison FB Quinlan	1/28	Acme Machine Tool & Dye Co., Spokane, Wn.	Evaluate concern for contract purposes.	K Slaughter	No
AL Bement LJ Chockie	1/29 - 30	Technical Industries, Inc., Pasadena, Calif.	Discuss swelling capsules & high temperature water-proof thermocouples and connectors. Also, discuss creep in-reactor.	J Kyle	No
LD Perrigo	1/29	GE, Idaho Falls, Ida.	Inspect 3x3 loop in ETR for fission product de-contamination studies.	R Neidner	Yes
TJ Clark	1/15 - 17	Natl. Bureau of Stds., Washington, D.C. Aberdeen Prov. Grnds., American Instr. Co., Silver Spring, Md.	Discuss microwave discharge cells.	HP Broida F Kaufman S Dosik	No " "
RE Nightingale	1/13 - 17	Div. of Prod., AEC, Washington D.C.	Appear before Gen. Advis. Comm. at request of AEC.	EJ Bloch	Yes
JM Davidson	1/12 - 14	MTR, Phillips Pet. Co., Idaho Falls, Ida.	Discuss MTR shim rod conversion	RB Johns FL McMillan	Yes
LA Hartcorn RL Brandt	1/13 - 16	Armour Res. Foundation, Chicago, Ill.	Attend AEC Metallography group meeting.	RJ VanThyne	Yes
RL Brandt	1/13	ANL, Lemont, Ill.	Observe hot lab operations.	R Blomgren & W Doe	Yes
HP Oakes	1/7	Fenn Mfg. Co., Hartford, Conn.	Consult on fabrication of zirconium.	Mr. Charpentier	No
	1/8	Allegheny-Ludlum Steel, Watervliet, N.Y.		J Preston	"
	1/9	Wolverine Tube Co., Detroit, Mich.		EA Wright	"

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VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RC Aungst	1/29	New Rochelle Tool, New Rochelle, N.Y.	Consult on fabrication of zirconium.	CA Tudbury	No
	1/30	Nuclear Metals, Concord, Mass.		T Tarpey	"
JW Riches	1/19	Chase Brass & Copper Co., Waterbury, Conn.	Consult on fabrication of zirconium.	DK Crampton	No
	1/20	Tube Reducing Corp., Wallington, N.J.		EH Fisher	"
	1/21	Superior Tube Co., Norristown, Pa.		EC Reber	"
	1/22	Allegheny Ludlum Steel, Pittsburgh, Pa.		TT Magel	"
	1/23	Mallory Sharon Niles, O.		DB Brown	"
RL Knecht	1/26	Chase Brass & Copper Co., Waterbury, Conn.	Consult on fabrication of zirconium.	DK Crampton	No
	1/27	Tube Reducing Co., Wallington, N.J.		CL Megargle	"
	1/28	Aluminum Co. of Amer., New Kensington, Pa.		DD McCracken	"
	1/30	Hunter-Douglas, Riverside, Calif.		RA Quadt	"
RE Dunn	1/11-12	Panellit Inc., Chicago, Ill.	Consult on contract for PRTR control room panels.	AF Sperry	No
RE Sharp ID Thomas	1/13-18	Calif.Precision Casting, Glendale, Calif.	Consult re casting fuel element parts	Mr. Boyer	No
		Ferro Casting Corp., Santa Monica, Calif.		Mr. Veenker	"
		Tectron, Inc., Los Angeles		Mr. Montgomery	"
		Bone Eng. Corp., Glendale		Mr. Worthen	"
ID Thomas	1/27-30	LASL, Los Alamos, N.M.	Discuss plutonium metallurgy.	Max Roy	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
J Howieson ECW Perryman JAL Robertson	1/19-21	AECL, Chalk River, Ontario	Obtain thermal hydraulic info pertaining to PRTR.	FW Albaugh JM Batch	Yes No	300, 328, 327, 325, 326 100-D, 1707, 189
HC Quigley		duPont, Wilmington, Del.	UO_2 technology. Zr fabrication & corrosion.	WE Roake FW Woodfield JA Ayres C Groot	Yes " 	200-W, 2704-Z, 231
			Pu fuel fabrication & testing.	OJ Wick ID Thomas	"	
H Rosenthal KG Comstock	1/28	Army Ord., Phila, Pa. Army Res. Off.,Wash., D.C.	Discuss shielding materials - PRTR.	FW Albaugh FW Woodfield JW Finnigan JL Weeks	Yes	300, 328
FJ Leitz FE Cooke AE Galson P Greebler	1/12-16	APED, San Jose, Calif.	Discuss PRTR design audit.	RM Fryar,et al	No	300, 314, 328 100-D, 1707 700, 760 PRTR Site
JE Burke	1/5	GE Research Lab., Schenectady	Discuss ceramic fuel technology Discuss graphite irradiation effects.	JJ Cadwell EA Evans FW Woodfield JM Davidson HH Yoshikawa	No No	300, 326, 325, 328
RV Elliott RR Mawson	1/13	Consol. Electrodynamics Corp., Monrovia, Calif.	Discuss equipment for in-reactor creep & swelling programs.	JJ Cadwell JC Tobin DC Kaulitz JM Tobin	No	300, 326
E Bartol	1/28	Scientific Supplies, Seattle, Wn.	Assist in repair & maintenance of x-ray diffraction unit.	WV Cummings	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
S Meyers	1/26	New York Op. Off., N. Y.	Discuss process tubes & corrosion studies.	FW Woodfield	Yes	300, 328
P Cohen	1/20	WAPD, Bettis Field, Pittsburgh, Pa.	Discuss corrosion & coolant technology.	FW Woodfield JA Ayres C Groot	Yes	300, 326, 328 100-K, 1704
TD Daniels	1/15	GE Silicones, Waterford, N.Y.	Discuss GE silicone products.	R Harrington	No	300, 326
JW Whealdon	1/20	A.I.R. Supplies, Seattle, Wn.	Discuss their products.	R Harrington	No	300, 326
E Wagner	1/21	A.C.F. Industries, Washington, D.C.	Discuss graphite damage data.	RE Nightingale HH Yoshikawa EM Woodruff	Yes	300, 326
J Hackett J Bradshaw	1/21	Speer Carbon Co., Niagara Falls, N.Y.	Discuss NPR graphite procurement.	RE Nightingale RW Benoliel	No	300, 326 200-E, 2101
RE Tate S Bronisz	1/13-14	LASL, Los Alamos N.M.	Discuss plutonium metallurgy.	OJ Wick	Yes	200-W, 231-Z, 234-5, 2704-Z
MJ Sinnott	1/19-22	U. of Michigan, Ann Arbor, Mich.	Consultant Agreement #199	FW Albaugh JJ Cadwell SH Bush, EA Evans OJ Wick, ID Thomas	Yes	300, 306, 325, 326, 328 200-W, 231-Z
M Cook D Hoff	1/20 21	Lawrence Rad. Lab., Livermore, Calif.	Discuss special target fabrication	OJ Wick RW Stewart	Yes	200-W, 231-Z
R Carlson F Peterseim	1/22	BMI, Columbus, O.	Discuss plutonium handling facilities.	OJ Wick	Yes	200-W, 231-Z

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

JANUARY 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety in the Fuels Preparation Department

At the request of FPD, a review was made of a design (proposed by the National Lead Company of Fernald, Ohio) for a fuel element shipping container for enriched fuel (0.95 percent U^{235}). The shipping container consists of 200 tubes made of 12 gauge (0.109-inch thick wall) steel. Since an infinite array of this fuel (1.34-inch diameter solid, or 1.37-inch O.D. x 0.48-inch I.D. I and E fuel elements) was determined to be subcritical, any array of the proposed shipping containers containing the 0.95 percent uranium will be safe.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

Experiments to obtain indirect information on the lattice neutron temperatures have been conducted up to a graphite temperature of 640° C. The experiments have determined the ratio of the thermal fission cross sections of Pu^{239} to U^{235} up to 500° C; the ratio of the fission cross sections of P^{239} to those of U^{235} with $\frac{1}{2}$-inch diameter foils mounted in the center of an 8-inch natural uranium slug in a dry process tube up to a temperature of 500° C; and the same ratio when the slug is in a water cooled process tube and the graphite temperature was extended to 640° C. Cadmium ratios are being taken to enable the data taken for one slug in a column to be extended to a full column of slugs.

Blocking Effect of Coolant

The blocking effect of a coolant annulus as a function of graphite moderator temperature, which is the only difference between the wet and dry temperature coefficients of k_{∞}, is being measured for lattice cells having similar temperature distributions.

This measurement has been completed for a single column of 8-inch slugs in a thermal column with a graphite temperature of 400° C. The data are obtained from manganese foils.

Thermal Neutron Flux in a Medium with a Temperature Discontinuity

A comprehensive paper is now being written which presents the analytical and numerical results of the investigation to date of the temperature discon-

tinuity problem. The paper will thus consider only the case of a discontinuity across a plane interface in infinite geometry. Further investigations have begun of more complicated infinite geometries and formal analytic solutions have been found for (a) a slab of width w at temperature T_1 bounded on either side by media at temperature T_2, and (b) a cylinder of radius R at temperature T_1 surrounded by a medium at temperature T_2. The expressions for the flux in these two cases resemble the solution of the plane geometry problem, with the exponential spatial dependence of the plane problem replaced by hyperbolic cosine and Bessel functions in the appropriate geometries. However, the coefficients in the series solutions, which were constants in the plane case, are complicated functions of slab thickness w or cylinder radius R.

Neutron Energy Spectrum in the Vicinity of a Boundary with a Temperature Discontinuity

The experimental data taken in the course of this work has been submitted for inclusion in the October-December 1958 Quarterly Report. The reaction rate of a 1/v-absorber is shown near a temperature discontinuity for graphite temperatures ranging from 108° K to 666° K.

The procedures being used to fit these data were discussed last month. In the past month it has been shown that the slowing down distribution fits an expression which is quadratic in the space variable, rather than linear, as had been assumed for calculations performed previously. A quadratic dependence is expected since the fuel loading of the PCTR is essentially cylindrical. In view of this result new and simpler solutions to two thermal group equations have been obtained. The thermal neutron reaction rates are now being recomputed using the new solutions.

Instrumentation

At the request of IPD, a member of our staff attended a second conference with the management of EPSCO, Incorporated, and their representative in this area. The purpose of the meeting was to discuss an addendum to EPSCO's proposal to project CGI-802, High-Speed Scanning System.

A simple computer for the purpose of demonstrating the use of magnetic cores for data storage and handling is being fabricated. Most circuitry has been developed using transistors. The circuits have been designed along the module idea, and each complete circuit is built onto a printed circuit board. These circuit boards are in the process of being fabricated at the present. When they are completed, the basic units of the computer will be assembled and further circuitry will be designed.

The investigation of new neutron detectors continued with emphasis on solid state devices and fission detectors. A search was started on new solid state devices.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for 1.92-inch and 2.5-inch Fuel Elements

A detailed series of extrapolation length measurements on an exponential assembly with a lattice spacing of 8-3/8 inches has been completed. The expon-

ential assembly was charged with 1.92-inch diameter solid, natural uranium fuel elements. The data indicate that the extrapolation length increases nearly linearly with graphite reflector thickness for reflector thicknesses up to six inches. The average front-rear extrapolation length is about 1.05 inches with air coolant. A homogeneous two-region calculation has been started in an attempt to understand the reflector effect. If successful, such calculations would make it possible to re-evaluate all previous small pile measurements.

Material buckling measurements for 2.5-inch diameter solid, natural uranium fuel elements have been started. Extrapolation lengths will be measured for each exponential assembly used in this series.

PCTR Measurements of k_{oo} and f for Selected Cluster Elements

Analysis is continuing of the data obtained in the PCTR measurement of k_{oo} and f for a 10-1/2-inch graphite lattice fueled with a seven-rod cluster of 0.925-inch diameter natural uranium rods.

Some multiplying factors have been calculated to correct the activities of copper foils for the nonflatness of response of the 5-inch crystal over the area of the foils. It was found that the correction factor is, within practical limits, independent of the shape of the activity over the foil area. This fact will greatly ease the calculation of the factors and contribute to the accuracy of the results.

Coordinated Theoretical-Experimental Reactor Physics Development

Integral reactor experiments and various activation experiments form the basis for checking theoretical formulations of reactor parameters. Therefore, some time has been spent reviewing the scope of the methods, and their precision, used in measuring and calculating these parameters. An existing machine code (IPD Survey Code) has been used to calculate some parameters to compare with experiment. The review has pointed out areas in which additional experiments, or increased precision, are needed. These needs are being considered. Additional work will be devoted to the development of a new code for our use in the analysis and planning of experiments.

A 650 OMNICODE program to correct the exponential pile data for the effect of the aluminum content has been written and is in operation. The available HAPO exponential pile data for solid, natural uranium rods in dry square graphite lattices are being processed by this program, as 650 operating time permits. Analysis has begun of the data already obtained.

NPR Lattice Measurements

A cost estimate of the NPR high-temperature mockup facility has been received from CEO and submitted to IPD for consideration. The estimate is $850,000 if constructed in 300 Area, or $450,000 if constructed in 189-D utilizing existing facilities for housing, power, and high pressure water system. This estimate does not include fuel or neutron sources. Methods for reducing the cost are under consideration.

Cross-coolant tubes are not included because of the small amount of water involved relative to the water already in the process tubes.

Full Size PCTR

The project proposal for the new PCTR has been completed and is currently circulating for the required G-E approvals. It is planned that physics work in support of the scope design will begin in February 1959.

Intercalibration of Graphite Purity

Purity measurements have been completed on the graphite bars obtained from France and the United Kingdom for an intercalibration of graphite purity indices. New calibration data were obtained for the Hanford Test Reactor to facilitate interpretation of the purity measurements on each graphite bar in terms of the effective absorption cross section per carbon nucleus. Tests were also made on two bars of American graphite which had been tested concurrently with the bars sent to the United Kingdom in 1958.

An evaluation of the results is now in progress.

New Production Reactor Nuclear Safety

At the request of the Process Design Operation (IPD) a study was begun on the nuclear safety in the storage and handling of NPR fuels in the discharge and storage basins. The fuels under study are solid rods of 0.664-inch outside diameter and tube-in-tube fuel elements (outer tube: 1.85" I.D. x 2.46" O.D. and inner tube: 0.52" I.D. x 1.43" O.D.). The initial enrichments of the rods are 0.94 percent U^{235} and 1.50 percent U^{235}. The maximum reactivity of the 0.94 percent U^{235} fuel on irradiation is being considered as equivalent to unirradiated 0.98 percent U^{235} fuel. The maximum reactivity of the 1.50 percent U^{235} fuel is being considered to be that of the unirradiated fuel of this enrichment.

Computational Programs and Services

At the present time, the 650 simulator for the 709 operates satisfactorily with OMNICODE programs but, with one minor exception, it has not been successful with 650 programs requiring an 80-80 plugboard. The 650 P-3 and VALPROD programs fall in this unsuccessful category. Work on this problem continues.

A 709 version of the program for processing exponential pile data is also being written. Instructions have been written for the first four of the five parts; however, these represent probably less than half of the total instructions.

Radiation Damage to Graphite

As a start on the study of radiation damage to graphite, a method is being developed for measuring the energy loss of electrons in thin layers of materials. The technique was suggested by an energy monitoring device described at a recent accelerator conference. Our recently completed capacitor-divider voltage measuring system makes possible a precise energy calibration of the device and hence its use for energy measurements.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazard Specifications

Nuclear Safety in Hanford Laboratories Operation

At the request of the Fuel Fabrication Development Operation (Fuels Development Operation) a review was made of the temporary fuels storage facility in the southwest end of the 306 Building. This storage section consists of a cabinet of shelves on 18-inch centers. Fuels of various enrichment are stored on these shelves as well as on the floor in front of the shelves. The storage area on the floor is a fenced-off area about 30 inches wide and greater than 10 feet long. The storage facility is located near the large door entrance to the building through which fuels are transported. Therefore, the fuel on the transporting vehicle can pass very close to the array of fuel in the storage facility.

The following criteria have been established for the safe handling and storage of fuel in this area.

Storage Limits on Shelves.--The maximum safe limit per shelf of fuels whose enrichment is $\leq$ 2.0 percent U^{235} is 100 pounds uranium. For highly enriched U^{235} alloy fuels, the maximum safe limit per shelf is 100 grams of contained U^{235} provided no other fuel whose enrichment is greater than natural uranium is on the same shelf.

Storage Limits on Floor.--The maximum allowable storage limit on the floor is 20 pounds uranium per square foot of floor space when the maximum enrichment is 1.6 percent U^{235}.

The maximum allowable storage limit on the floor is 14 pounds uranium per square foot of floor space when the maximum enrichment is 2.0 percent U^{235}.

Limits on Fuel in Transit.--If the maximum enrichment of the fuel in transit is 1.6 percent U^{235}, it is always safe at a distance of $\geq$ 5.0 feet from the fenced-off area around the floor storage. When there is no water on the floor, the fuel in transit may approach 3.0 feet of the fenced-off area. Needless to say the fuel in transit must be in a configuration that is safe by itself.

For fuels of 2.0 percent U^{235} enrichment, the fuel in transit can pass the fenced-off area provided that the maximum floor area density of the fuel in transit and on the floor is no greater than 14 pounds uranium per square footof floor space.

At the request of the Experimental Reactors Operation (Nuclear Physics Research Operation) a study was made of the nuclear safety in the storage of TTR fuel. This fuel is made up of U^{235}-Al discs. The discs have an O.D. of 1.96 inches and an I.D. of 0.60 inch. The thickness is 0.075 inch. Each disc contains 2.23 grams of U^{235}. The following criteria can be used in the determination of safe storage conditions for this material.

Where there is no moderation whatsoever (no water, wood, carbon, etc.) an infinite slab 3.6 inches thick is safe.

For conditions where the exclusion of moderator cannot be guaranteed, the following criteria should be used.

(a) An infinite array 1.5 inches thick is safe.

(b) A storage container whose height is a maximum of two inches can have a cross sectional area ≤ 4.0 square feet.

(c) In wood blocks with holes for the stacks of discs in which there is physically no space for water other than in the inside holes of the discs, 1000 discs are safe in any geometry or spacing between stacks. If a center-to-center spacing between stacks of discs of ≥ 4.8 inches can be guaranteed, 2000 discs are safe.

Discussions are being held with members of the Chemical Engineering Development Operation (Chemical Development Operation) to develop nuclear safety specifications for the operation of the 321 Building. Critically safe parameters have been given to them and a rough draft of the nuclear safety specifications has been reviewed to determine whether nuclear safety controls have been incorporated which are consistent with good nuclear safety operating philosophy (i.e., double contingency philosophy). The suggestions and comments are being incorporated in the final specifications.

A talk was given to the Plutonium Metallurgy Research Operation (Reactor and Fuels Research and Development Operation) on the variables that affect nuclear safety. Emphasis was placed on nuclear safety in handling and processing of plutonium and its alloys. The operating personnel participated extensively in the discussion period with questions on nuclear safety relevant to their particular work. As a result of this discussion, questions on nuclear safety that require further clarifications are being assembled by the group and will be submitted to Critical Mass Physics for reply.

Nuclear Safety in 234-5 Building Processing

Discussions were continued with members of CFD on nuclear safety in the design of a plutonium melting furnace with a capacity of about three times the minimum critical mass for metal (under conditions of optimum geometry and water reflection). CFD is considering the use of a vacuum furnace assembly similar to that in use at Rocky Flats. The design of the melting crucible itself has not been selected. In situ measurements with plutonium metal in the slab crucible and furnace assembly at Rocky Flats indicated a minimum critical mass of about 22 Kg Pu (water cooled induction coils). It must be emphasized that these experiments were performed with δ-phase Pu. Had the experiments been performed with α-phase Pu, the critical mass would have been reduced to about 13 kg Pu. These experiments also showed the sensitivity of the critical mass to neutron reflectors outside the furnace. Water cooling or gas cooling in the furnace induction coils resulted in a difference of about 20 percent in critical mass! Therefore, in situ measurements are required, in a prototype crucible in its normal surroundings, if maximum furnace operating capacity is desired.

Based on the recommendation made last month, a new feed hopper was designed for use between the drum filter and the continuous calciner in the continuous Task I-II system in Hood 9. The nuclear safety of the new system was reviewed and the processing operation determined safe based on a "reflectors as-is" basis. Therefore, any water flooding of the feed hopper could result in an unsafe condition and is to be avoided.

The nuclear safety of an array of plutonium pieces (<2 kg/piece) surrounded by depleted uranium was reviewed. It is desired to radiograph a circular array of these pieces. The circle is 30 inches in diameter and the center-to-center distance between Pu metal pieces on this circle is 10.5 inches. It was

determined that such an array is safe with a maximum of nine pieces, provided there is no danger of water flooding or of obtaining moderation by some other method.

Power Fuels Processing

A new scheme for processing power fuels has been suggested by a member of the Programming Operation (HLO). The practicality of this scheme is dependent, to a large extent, on nuclear safety. Basically, it involves a single tray, spray type dissolver in which only part of the fuel is immersed in acid. The height of the tray determines the maximum solution height. The fuel height is greater than that of the tray. The critical mass physics problem is then to determine conditions for criticality when only part of the fuel core volume contains moderator. Where there is no moderator at all, no uranium fuel enrichment below 5.0 percent U^{235} can be made critical in any amount. Where the enrichment is 5.0 percent U^{235} the maximum safe core height (moderator and fuel) is 2.9 inches. Therefore, no fuel (moderated or unmoderated) is allowed above this height. The physics problem that must be solved is the maximum fuel height allowable when the moderator height is less than the maximum safe height for a moderated infinite slab and the fuel above the solution is covered by just a film of acid or water.

The same type physics problem must be solved for the interaction between two slabs when the height of the water reflector between the two slabs is less than the slab height. These problems require a theoretical study as well as an experimental one. The experimental study requires a critical mass facility for its inception.

Plutonium Critical Mass Laboratory

The Project Proposal for the Critical Mass Laboratory (Project CG-731, Revision No. 3), HW-58618, received all of the necessary approvals in HLO and in HAPO and was transmitted to HOO-AEC for consideration. This proposal requests funds for construction of Stage I of the laboratory.

Technical liaison was continued in support of the design work for the Plutonium Critical Mass Laboratory. The detailed design is now 91% complete; it is only 5% behind the schedule which calls for completion by February 24, 1959.

Experiments for Nuclear Safety Specifications

Exponential Measurements with 1.25% Enriched Uranium

Buckling measurements were continued with the 1.25% enriched uranium in water moderated heterogeneous systems. The fuel elements were 1.336 inches in O.D., with a 0.500-inch I.D. and 7.50 inches in length. Each fuel column consisted of six of these elements positioned in an aluminum tube of 1.420 inches in O.D. with a 0.028-inch wall thickness. In the "wet measurements" an aluminum tube of 0.492-inch O.D. and 0.020-inch wall thickness, which contained water, was inserted in the central core of the fuel elements; the central core was empty in the "dry measurements." The bucklings which were measured are listed below. The estimated number (N_c) of fuel tubes for

criticality in cylindrical geometry is also given. These values were calculated from the measured bucklings under the assumption of full water tamping.

Separation Between Rods in Inches (Hexagonal Lattice Pattern)	Condition of Fuel Rod Core	H_2O/U (by volume)	Buckling (10^{-6} cm^{-2})	Estimated Critical No. of 45-inch Fuel Tubes (Cylindrical Geometry)
2.0	Wet	1.69	5194	112.7
2.1	Wet	1.98	5089	106.6
2.2	Wet	2.29	4871	104.5
2.4	Wet	2.95	3755	129.0
2.0	Dry	1.56	4966	119.4

The smallest critical number of 104.4 fuel rods occurs at an H_2O/U volume ratio of about 2.25. A lattice framework is currently being fabricated to accommodate a rod separation of 1.85 inches in order to determine the maximum buckling.

A comparison of these measurements with previous results, in which the fuel elements contained minor indentations at each end for canning purposes, disclosed no discernible differences in the bucklings.

Measurement of k_{∞} for 2% Enriched UF_4-Paraffin Mixture

Experiments were completed for determining k_{∞} of the 2% enriched UF_4-paraffin mixture which was received from Oak Ridge in December. Two-shift operation of the PCTR was utilized in these measurements. The "green blocks" were positioned in the PCTR core forming a parallelopiped with nominal dimensions of 24 x 24 x 30 inches; the dimensions of the removable test section were 6 x 6 x 12 inches, which provided for a 9-inch thick buffer region. Both borated polyethylene and copper sheets were used to poison the "green blocks" to a multiplication constant of unity for insertion in the core. In the absence of this poison the above parallelopiped, which contained about 18 Kg of U^{235}, would have been supercritical when graphite reflected. The total amount of neutron absorber used in the core loading was equivalent to that of about 500 lbs. of copper.

Experiments were done to determine the effect on k_{∞} of changing the external reactor loading and of varying the amount of poison in the buffer region; also, two different methods were used for poisoning the test section. In one case the poison was distributed "homogeneously" by wrapping borated polyethylene sheets around the individual blocks composing the test section; in the second case the poison was distributed only over the outer surface of the removable test section, or at the boundary with the buffer region.

The analysis of the experimental results is underway; utilizing the current

data from this experiment a preliminary value of k_{∞} may be given as 1.21 with an estimated error being of the order of ± 0.02. The uranium enrichment of the paraffin has been given as 2.00 ± 0.02%, and the H/U^{235} atomic ratio of the mixture is 195.

Criticality Calculations for Correlating Theory with Experimental Data

A theoretical study of the criticality parameters for homogeneous systems of plutonium dioxide or plutonium nitrate in water has begun. The purpose of the study is to develop an age theory formulation for such systems so that the criticality parameters of homogeneous systems of plutonium in moderators of reduced hydrogen density can be estimated (i. e., plutonium in organic solution moderator).

Status of Critical Mass Experiments for E-Metal Dissolver

The most recent data on the criticality experiments for the E-Metal Dissolver were received by phone on January 23.

Dr. Callihan reported that 7100 of the 0.95 percent enriched I and E fuel elements had been placed in the mock-up of the Hanford dissolver without reaching criticality. All of the uranium on hand was used which amounted to 37,317 lbs., or about 18.7 tons.

The multiplication of the final loading was about three. The shape of the multiplication curve was consistent with, and similar to, that which was obtained previously when about 12 tons of uranium were used in the random array.

The H_2O/U volume ratio was reported to vary throughout the dissolver as follows:

Height of Loading	H_2O/U (by Volume)
7.5 inches	0.95
15.7	1.02
23.0	1.00
30.0	1.09
37.0	1.03
53.0	1.04

The H_2O/U volume ratio of the initial experiment with the random arrays was given as 1.11.

From the available data it was not possible to determine definitely whether criticality could have been reached had more uranium been available. This data may be used, however, to determine an upper limit for the critical buckling of the I and E fuel elements in the random array. This value is $\leq 1500 \times 10^{-6}$ cm^{-2} for the H_2O/U volume ratio of the experiment. No further work is planned with the fuel elements in random arrays.

The critical mass of a uniform array in cylindrical geometry was previously measured as about 5 tons for an H_2O/U volume ratio of 1.69. At the H_2O/U volume ratio typical of the most recent loading in the random array (1.04),

the critical mass even for the uniform array is calculated from theory to be about 9 tons for spherical geometry. At this low H_2O/U volume ratio the calculated critical mass is a rapidly varying function of the volume ratio. We do not recommend that the nuclear safety of the dissolver be based on the fact that in the Oak Ridge experiments the bulk loading density of the fuel elements was high. Therefore, in the absence of experimental data on the uniform array at a low H_2O/U volume ratio, a further increase in the critical mass limit, other than what has already been given, is not justified at this time. Unfortunately, the critical mass measurement for the uniform array at the H_2O/U volume ratio of 1.11 will not be made for about a month; this work is being further delayed. The Oak Ridge work schedule calls for the use of the large reflector tank which was being used in these experiments for other important critical mass work.

Neutron Age Measurements

The reduction and initial analysis of the final set of runs has been completed. Data taken with foils which were damaged by melting have been studied to determine when the damage occurred, and an individual history of each foil prepared. The irradiations made with bare indium foils have been analyzed to determine the activity induced by thermal neutrons alone.

The final activities have been averaged at each position, and their internal consistency studied. Most of the data were obtained with standard deviations, due to counting statistics alone, of about 1 percent. The observed scatter of successive determinations at the same position has proved to be of the order of 2 percent. In the run which was most severely affected by foil damage, 17 percent of the measurements were lost beyond recovery. The attrition due to experimental mishaps in the remaining runs averaged about 5 percent.

Mass Spectrometer for Plutonium Analyses

Efforts to fabricate successfully a kovar-to-glass seal for the source vacuum interlock are continuing in the Glass Shop. The electronic instrumentation is being altered to conform to the final design.

Critical Mass Theory

Attempts at adequate numerical evaluation of the solutions of the pile kinetic equations with linear time variation of reactivity, as given by Triplett, HW-32346, have been unsuccessful to date. The parameters describing possible geometries and fuel concentrations of interest to Critical Mass Physics lead to cancellation in the exponents of certain factors involved and result in uncertainty in the value of the multiplication versus time. In an effort to circumvent this difficulty, a simple FORTRAN program is being written to integrate the equations directly.

A re-examination of the reactor physics of the detection of potential chain reacting systems by neutron monitoring has also begun. The solution of the pile kinetic equations above will be applicable to this problem as well.

CROSS SECTION PROGRAM

Slow Neutron Scattering Cross Sections

The three-axis spectrometer at 105-KE was out of service from December 22, 1958, to January 13, 1959, because of operational problems. These problems were traced to faulty installation of the milling machine dividing head which controls rotation of the crystal about the third axis. The operation of this dividing head has never been satisfactory since the construction of the spectrometer on Project CG-672. When mounted as originally installed, excessive torque is required to rotate it. Because of this condition, the drive motor burned out and had to be replaced. The spectrometer has been returned to service, at least temporarily, by not tightening the mounting bolts for the dividing head, but it is not known how long this expedient will suffice.

The new boron neutron beam monitor has been placed in service. A slow deterioration in pulse height was observed initially, but repeated refillings of the chamber have steadily improved the stability.

Some progress has been made on the study of the scattering of 0.1 ev neutrons from water. The angular distribution of the elastic group has been measured from 4° to 76° in 2° increments. This group is fairly sharply defined at forward angles and strongly peaked in the forward direction. It drops by a factor of ten between 4° and 76°. Energy analyses of the scattered neutrons have been made at 10°, 20°, 30°, 45°, and 60°. The inelastic component varies much more slowly with angle than the elastic peak, and predominates at the larger scattering angles.

Slow Neutron Fission Cross Sections

A new absolute BF_3 chamber has been completed, but shows only slight improvement over its predecessor. The effect of changing the operating conditions is being studied.

The new aluminum fission chamber for the Pu^{240} and Pu^{241} cross-section measurements has been completed. Foils of Pu^{241} have been prepared, and their weights determined by alpha counting. These have been installed in the new chamber, which is now ready for use.

Subthreshold Fission

The planned experimental program on the low energy fission cross sections of Am^{241} and Np^{237} has been completed. The americium foil has been removed from the chamber and its weight redetermined by alpha counting in Analytical Laboratories. This new measurement gave an americium weight three times as large as the originally reported figure. The source of the error in the original alpha assay could not be determined. The new weight value gives a cross-section normalization consistent with that obtained using an earlier americium sample.

The analysis of the Am^{241} fission cross section has been completed. The low energy fission cross section extrapolates to a 2200 m/s value of 3.15 barns with an uncertainty of about 30 percent. This result agrees with the accepted

value obtained for thermal neutrons. The two lowest resonances at 0.307 ev and 0.579 ev are fitted to within the precision of the data of a few percent by single level resonance formulae. This is a very strange and disappointing result since it would be expected that large interference effects would exist because of the restriction of fission exit channels so far below threshold. It had been hoped that these data could be used to compare theoretical methods of calculation of interference effects. The level width obtained for the first two resonances was (41 ± 4) mv which agrees with values published from total cross-section results.

The comparison of the average fission widths obtained from the low energy resonances with the predictions based on the fast neutron fission threshold have been reported. Some evidence that the small widths obtained for Np^{237} are a local fluctuation in the distribution was obtained by measurements of effective fission cross section in filtered pile neutron spectra. These measurements indicated that the average fission width of Np^{237} in the region of 1000 ev may be 100 times as large as the value obtained near thermal energies.

Foils of 99.75 percent pure Pu^{240} have been prepared and measurements are being initiated to improve the low energy fission results on this nucleus concurrent with Pu^{241} fission cross-section measurements.

Foils of uranium samples enriched in U^{234} and in U^{236} are being prepared by Analytical Laboratories for subthreshold fission measurements.

Fast Neutron Spectra

Several improvements in instrumentation have been completed. The new RF generator for the beam sweeping system is in operation, and appears to be very satisfactory. It provides sweeping voltages from 3 kv to 35 kv peak-to-peak, together with a synchronous time mark pulse once per cycle. Construction has been completed on an oscilloscope for observing the target burst, to aid in aligning the chopped beam. A new detector assembly has been installed.

A new chronotron circuit has been built, using high-transconductance tetrodes (W. E. 436-A) instead of secondary-emission pentodes (EFP-60). In contrast to the old circuit, which suffered severe shift in channel width at large duty cycles, the new circuit has a duty-cycle dependence too small to measure by the technique currently in use.

Shielding Measurements

Further work on the NPR shielding measurements has given results significantly different from those reported previously. Systematic errors in the analyzer clock and resolving time are suspected. A 5-percent shift in energy calibration has been measured, but this change is too small to account for the observed discrepancies.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Correlation of Data on Heavy Water Moderated Cluster Lattices

In order to determine the effects of the moderator-containing cans on measured values of k_∞, it was decided to duplicate, via calculations, the steps used in a PCTR measurement. These calculations will determine the mass of copper, M_o, necessary to poison the central test cell to a multiplication factor of unity. M_o will be determined with and without the containing cans in the core. The fractional difference between the two values is directly related to the error in the measured k_∞ caused by the cans. The calculations assume a perfectly matched spectrum, so that the only effects found will be those due to the cans.

The three-group cross sections used were adjusted so that the calculated k_∞'s for the two (air-and D_2O-cooled) eight-inch cells agreed with measured values to within 1 mk (1×10^{-3} in k_∞). Using these same cross sections, k_∞ was calculated at the seven- and nine-inch spacings. The calculated values at the seven-inch spacing were within 2 mk of the measured values for both coolants. In the nine-inch lattice, the calculated and experimental values of k_∞ were 1.074 and 1.097 for D_2O coolant and 1.088 and 1.117 for air coolant, respectively. Thus, the change in k_∞ in going from the eight- to nine-inch lattice was reproduced to within 50%. It is felt that this degree of correlation is sufficient for investigating the small can effects.

As was mentioned in the last monthly report, the buffer fuel rods must be represented by an annular ring of multiplying material in order to use the VALPROD program on the IBM-650. The adequacy of any buffer model may be checked by noting the fact that k_∞ for any group of cells in a perfectly matched spectrum is identical to that for any of the cells taken singly. Calculations were run for the "supercell" consisting of one fuel column and its six nearest neighbors (buffers), without any containing can inserted. Using the best buffer model found, values of k_∞ ranged from 6 mk lower to 7.5 mk higher than those for the corresponding single cell cases. Calculations for the buffers alone yielded similar results.

k_∞ was also determined for the "supercell" and buffers alone with the containing cans inserted. The amounts of copper necessary to poison to $k_\infty = 1$ were determined for the single cell and buffer only cases. These results have not yet been analyzed or intercompared.

PCTR Experiments

Calculations have been completed which estimate the variation of the epithermal multiplication factor of Pu-Al fuel as a function of exposure. These calculations were made under the following assumptions: Constant power output per unit volume per unit flux, no self-shielding in Pu^{239}, Pu^{241}, Pu^{242}. Self-shielding in Pu^{240} was included.

Error estimates on an experimental program to measure the calculated variation indicate that the epithermal multiplication factors of Pu-Al fuel containing Pu of 6, 20, and 40% Pu^{240} can be resolved. Details of this experimental pro-

gram are under consideration.

Theoretical Physics Studies Related to the Plutonium Recycle Program

Since an estimate of the adjoint flux is needed in choosing variational trial functions, its physical interpretation has been studied. For a subcritical system, it was shown that the adjoint flux at a point is the response of a neutron detector whose sensitivity is given by the adjoint source, when a unit neutron source is introduced at the specified point. By taking a critical system as a limiting case, it was shown that the various adjoint functions corresponding to different possible detectors will coalesce (except for their relative amplitudes) as the reactor becomes critical, and agree with the iterated fission probability interpretation.

A general discussion of the analysis of multidimensional systems by means of variational principles has been written for the quarterly report. Besides the derivation of diffusion theory given in the previous monthly report, the following applications of the general method have been made:

(a) The two-dimensional, one-group diffusion equation has been reduced to a pair of coupled one-dimensional equations, in which the coefficients are obtained by weighting the material constants by the square of the flux associated with the other variable. The result is an improved version of current flux-synthesis methods for analyzing two-dimensional reactors.

(b) The few-group equations have been derived from the space- and energy-dependent diffusion equation. The resulting group constants are weighted by the product of the flux and its adjoint, and reduce to the usual flux-weighted constants only for the case of negligible absorption and leakage.

(c) The thermal group equations for a two-temperature system have been derived by using a superposition of maxwellian fluxes as a trial function. The resulting two-group equations are equivalent to the set previously derived on intuitive grounds when the average energy at which neutrons are produced or absorbed coincides with the equilibrium energy of the neutron groups.

Instrumentation

Purchase specifications for the profilometer have been written for all of the glass optical elements. The warp measuring section design was completed and a work order issued to Tech Shops for fabrication. The diameter measuring unit design was also completed. Fabrication cost estimates are being made at Tech Shops.

A purchase specification was written for the purchase of a Coleman Digitizer after a literature search of the available shaft position encoders had been made. The automatic printout system for the PRTR Profilometer using this digitizer should be ready for demonstration by the middle of March--barring purchase difficulties.

The design drawings for the wide-angle viewer are complete except for possible revisions arising from the comments of those who review the drawings.

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

Fabrication of the graphite for the PCTR core is about 70% complete. Fabrication of stainless steel components is in progress.

Control Rod Measurements

The control rod has been made and shipped to Hanford by Oak Ridge. Additional work on the method for interpretation of this experiment will be done in the next two months.

Doppler Coefficient Studies

Variation in the Doppler Coefficient with Surface-to-Mass Ratio

The design and procurement have begun for a mockup of the apparatus to be used in these studies.

Theoretical PCTR Studies

Work on the small source theory analysis of the GCR control rod problem has continued. The derived criticality condition is being examined for the very simple case of an infinite, uniform array of similar fuel rods. The methods required are similar to those necessary for the analysis of the actual problem but the complexity is greatly reduced since no off-site sums occur. A single equation thus serves as a critical condition rather than a four by four determinant.

As a sidelight, an analytical expression has been obtained for the slowing down flux as a function of position in a lattice cell. It shows very clearly the near spatial independence of this quantity.

Test Reactor Operations

Operation of the PCTR continued routinely during the first two weeks of the month. There were two unscheduled shutdowns, both due to electronic failure. Critical mass measurements were completed on the 2-percent enriched uranium fluoride in paraffin blocks.

The reactor was down for the last two weeks of the month for a scheduled maintenance outage. The moving face track was leveled so that the face again comes up flush against the fixed face. Play in the control rod actuators was removed and improvements were made to prevent this in the future. The 305-B Building Addition has made it possible to remove a large amount of the experimental equipment stored in the Reactor Room. This program was started.

During the enriched UF_4 in paraffin experiment, a radiation hazard was discovered. Small amounts of short-lived fission product were found to be escap-

ing from the blocks. Rubidium-88 was the principal isotope identified on air sample filters. Tellurium, Iodine, and Cesium isotopes were also found. Assault masks were worn while the hazard was being investigated. Work orders have been issued to improve the ventilation of the Reactor Room.

Experiments for the Lattice Neutron Temperature Study were conducted during the month.

There were four unscheduled TTR shutdowns, all due to electronic failure, in the log level amplifier (Ch. 3). Efforts are being made to locate and correct this trouble.

The TTR fuel piece out-of-reactor storage requirements were reviewed and revised for nuclear safety in fully water moderated condition. A special storage cabinet was designed and ordered. The small number in excess of the reactor loading cannot be hazardous.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Upon the recommendation of the Committee on Awards and with the approval of the Council of the American Meteorological Society, the Society's annual Award for Outstanding Contributions to Meteorology by a Corporation was presented to the General Electric Company's Hanford Atomic Products Operation on January 29, 1959. The citation accompanying the award was as follows:

> . . . "for early recognition of the importance of meteorological phenomena in the operation of nuclear energy facilities and for bold and imaginative action by the Company's Hanford Atomic Products Operation in developing a continuing meteorological program uniquely adapted to the nuclear energy industry. Through advanced research work in micro- and meso-meteorology, this program has contributed importantly to the clarification of atmospheric exchange and transport processes and to the proper incorporation of this knowledge into the solution of the multi-disciplined problems of airborne wastes. At the same time this program has provided a unique example of the possibilities for specialized weather services to a single industry and the incorporation of these services into the managerial and functional organization of that industry."

A novel method for measuring deposition of airborne materials on a snow surface was tested in the field. One of the greatest difficulties encountered in the measurement of deposited materials is in obtaining truly representative samples under natural field conditions. Vegetation and ground samples are unsuitable for the fluorescent pigment tracer system and attempts to substitute catch pans, gummed paper, etc., leads to highly abnormal surfaces and nonrepresentative sampling.

With fresh, undisturbed snow, it is very easy to obtain a representative sample, however, since a suitable area of the snow may be removed without

disturbing the sample deposited on its surface. The snow is then melted, the water-pigment solution filtered, and the particles retained on the filter. The results are, of course, applicable to deposition on snow only, but the sensitivity and accuracy of this technique probably far exceeds that possible for any other natural surface.

Comparisons of average airborne concentrations and deposited amounts were made at some 30 points, all contained in a 200-m polar gird.

The measurements were made quite readily. However, a very low and variable wind velocity prevented definitive results from this single experiment. Exploitation of this system for future testing of deposition hypothesis is planned.

The acquisition of materials and supplies for the dispersion experiments scheduled for this summer proceeded on or ahead of schedule. The Signal Corps approved the loan of fifteen towers and shipment of this equipment from their Sacramento depot was authorized. Plans for the analyses of data were continued.

DOSIMETRY

The Shielded Personnel Monitoring Station (body monitor) was completed and occupied.

Background in the iron room of the Station was measured after the flooring had been put down, lights and intercom installed, and the interior painted. No change was detectable from the background before these steps were started. Integral backgrounds measured in different parts of the room differed by 18% at the most. A background spectrum measured in the room was the same, within experimental error, as one taken earlier in a four-inch lead shield.

A 256-channel pulse analyzer and a 9-3/8-inch diameter by 4-inch thick NaI crystal were received for use in the Station. The analyzer works satisfactorily. Resolution of the crystal with a 14-inch photomultiplier tube was about 13% which is good for a large crystal. Use of a 2-inch lucite light-pipe gave no improvement in resolution.

Six subjects exposed to Ru^{106} were examined in the Station about two weeks after the exposure. Measurements were made with the large crystal in two different energy bands--one around 0.51 Mev, the other around 1.05 Mev. The low-energy band offers more sensitivity but suffers from interference by Cs^{137}. Results were

	mμc as determined in	
Subject No.	0.51-Mev band	1.05-Mev band
1	< 1	< 2
2	< 1	< 2
3	5 ± 1 *	4 ± 2
4	5 ± 1	7 ± 3
5	9 ± 1	3 ± 2
6	13 ± 2	5 ± 3

* Standard Deviations

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[redacted]

Subjects 5 and 6, where agreement is the poorest, drink a lot of milk. The lack of agreement is due to the uncertainty in their Cs^{137} content.

A subject exposed to fuel slug dust was examined and no unusual radioactivity found.

Pulse spectra produced in a large plastic scintillator were measured for Ba^{133} (0.66 Mev) and Co^{60} (1.17 and 1.33 Mev). The counting rate from a subject would be increased at the Compton peak by a factor of 2, 10, and 15, respectively, by 1 μc of these sources. This counter is being studied for possible use as an auxiliary personnel monitor.

The experiment designed to check the discrepancy between x-ray counting and alpha counting for plutonium must be repeated. The first attempt resulted in too small deposition of plutonium.

The operation of the positive ion Van de Graaff was improved considerably and is satisfactory for most work but not for the best time-of-flight work. The latter application requires much better than average performance.

The neutrons/gm-sec and the average energy of the neutrons emitted from plutonium chloride were measured with the double-moderator system to assist in planning protection measures in separations plants.

Measurements of the average neutron energy from small and from large neutron sources of the same kind were completed with the double moderator. There are measurable differences. The average energy from the smaller source is higher. The difference is greater for PuBe sources than it is for RaBe sources.

Studies aimed at improving low-dose pencil ion chamber techniques have reached the point where the performance of selected pencils is about adequate. The problem that now appears to be most important is that on insertion of the pencil into the reading device, there is a momentary reading in the wrong direction. This reading appears to be the same from one time to the next for a given pencil but is different for different pencils.

A general theory was constructed for dealing with problems of radiation dosimetry. Formulae can be derived from the general theory for the approximations usually used in dosimetry. The rigorously correct expressions can also be derived so that the nature of the approximations becomes evident. The theory gives the usual quantitative results from the approximations. No attempt has been made to use the rigorous expressions quantitatively. The theory can be shown to incorporate the transport theory of radiation so quantitative work can be done. The rigorous expressions can be manipulated at a qualitative level quite easily. This develops deeper understanding of such things as cavity chamber theory. On the latter topic, the theory shows that the delta-ray ef-

1. One is three inches and the other is 12 inches in length.
2. Each probe has a 5-mm diameter.
3. The diameter of the rod being used is 4 mm.

The probes are a scintillation type employing ZnS and bioplastic for alpha and beta-gamma detection, respectively. Tests already made show that these probes work very efficiently.

An estimate of the cost of providing Redox with some area monitors is being prepared. This estimate covers the use of (1) three alpha air monitors and one beta-gamma scintillation monitor, (2) a system using a central high voltage and central amplifier but with four inputs from area monitors (A recorder is to be central to the system also), (3) a G-M beta-gamma monitor instead of the scintillation monitor, and (4) change of present high-level alpha monitor to a dual channel alpha air monitor.

All of the radio telemetering network data station equipment was delivered and is being calibrated. Two representatives of the manufacturer (The Instrument Laboratory, Inc.) are presently at HAPO to correct minor wiring errors and to install the data station enclosures at the five locations not requiring wind generator power.

An experimental dose-rate integrator which employs a battery-operated miniature motor to turn a disk was fabricated and tested. The error introduced by the motor varied from +2 to -2%. The battery life of the instrument is greater than 100 hours.

One scintillation-type nuclear incident alarm was designed and two will be fabricated. The device employs a scintillation detector, low-gain transistor amplifier and a relay-type meter, presettable to any relay-close point from 1 to 20 μa. The transistor amplifier (2 transistors in a balanced circuit) need only be used for very low "alarm levels" such as 1.0 to 10.0 mr/hr. For alarm levels over 10 mr/hr, the phototube and crystal detector drive the relay meter directly. Any "alarm" point can be accommodated with this device from one mr/hr to two r/hr giving an excellent dynamic range. The "breadboard" laboratory assembly proved to be extremely stable. The crystal detector employed depends upon the "alarm" point requirements with NaI being used for "Alarm" levels below approximately 100 mr/hr and inexpensive terphenyl in polyvinyltoluene used above 100 mr/hr. Neutron alarming may be accommodated, either "fast" or slow by proper crystal and moderator selection. However, the neutron sensitive crystals are somewhat gamma sensitive. The estimated available neutron "alarm" levels are from 50 mrem/hr to 5 rem/hr. For all of the different "alarm" points, both gamma and neutron, the basic instrument is unchanged. The use of two "sensitivity" controls and a proper crystal selection are all that is necessary.

Work on the combined scintillation transistorized alpha-beta-gamma hand and shoe counter is progressing satisfactorily. Fabrication is now > 90% complete. Only the shoe probes remain to be assembled. Complete system "de-bugging" has started with this expected to require very little time since the basic components were tested after their original fabrication. This unit will be ready for operation by March 1, 1959.

The alpha scintillation transistorized hand counter has now been in continuous operation for one year and one month in the 329 Bldg., Purex, and 234-5 Bldg. with no maintenance, repair, or adjustment work necessary. In fact, it hasn't even been necessary to adjust the calibration or sensitivity controls in this time. The unit has performed much better than could have possibly been imagined. It still, reliably, detects and indicates above "warning level" which is 500 d/m in less than 15 seconds. In fact, the instrument will indicate about twice warning level for a 250 d/m Pu^{239} alpha source distributed over a 4" x 8" area in 15 seconds. This original "sensitivity" has been retained for the one year and one month operating period with no adjustments. The instrument is being ordered for 234-5 Bldg. (12 units) and for the PRTR project (4 units). It can replace the old four-fold alpha hand counters which average $100 per month maintenance costs each.

WASHINGTON DESIGNATED PROGRAM

The transistorized magnetic sweep circuit has been perfected, and construction of the final circuit has been started in the Electronics Shop.

The long-term temperature-sensitive drift in the ion accelerating potential has been reduced to an acceptable rate of less than one part in 2000 per day, by replacing the deposited-carbon resistors in the high voltage regulator and control circuit with precision wire-wound resistors.

A new electron multiplier has been installed in the ion counting system. It has a gain of 10^6, a factor of 10 to 16 greater than the original multiplier. The relative pulse-height distribution from the new multiplier, however, does not differ significantly from the old one, and under typical operating conditions only 10 percent of the incident ions are counted. This performance is unsatisfactory, and further investigation is necessary.

Work continued on the choice of wide-band amplifiers and the design of a pulse-height discriminator for the ion counting system.

CUSTOMER WORK

Analog Computing

For the PRTR, the xenon poisoning equations have been simulated successfully on the GEDA. Studies were made of the build-up and decay of xenon in the PRTR at power levels of 10 MW, 30 MW, and 70 MW. Studies were also made of xenon concentration when the reactor was taken up to full power at various time intervals after scram.

The D_2O-He system was studied using an analogous spring-mass system. The purpose of this study is to determine the transient response of the water level to changes in the gas pressure differential. Both step forces and sinusoidally varying forces were applied. These response characteristics have been determined by hand and also on the DDA. There is excellent correlation of results. Future studies of this type should use more refined and exact equations. Present results indicate that changes in the control valves may be necessary.

A problem has been accepted from FPD to determine the impedance as a function of frequency and parallel resistance for a suggested testing coil system. It

is expected that this problem will be completed in February.

The computer has essentially been out of service for the majority of the month. It was shut down on January 6 for replacement of bad contacts on the patch bay.

After all known defective contacts had been replaced, it was discovered that all the electronic multipliers were out of tolerance in accuracy and could not be calibrated. At the present time, only two of the multipliers are in satisfactory operating condition. The troubles with the remaining multipliers have not been resolved.

Both stabilizers are also giving trouble. One of these had been repaired and seems to be operating satisfactorily for the time being. Trouble-shooting is still in progress on the other. We hope to have it in operating condition within the next few days.

The electrical department has been contacted and asked for an estimate for installation of a positive ground system for the computer. We have received no word from them as yet. A good ground is a necessity for an analog computer and we do not understand why it was not installed at the time of installation.

A new power line installation will be necessary to supply the additional analog computing equipment which we anticipate receiving later this year. This power line will be required to handle approximately 75 amperes of 117 volt, 60 cycle, AC power.

Steps have been taken toward having an instrument technician assigned to full time work on the computer and supporting equipment. It is felt that this is necessary to maintain the equipment efficiently and to keep out-of-service time at a minimum. The amount of maintenance on the computer is rapidly reaching a point where this can be justified.

The specifications for a new computer have been completed and the purchase requisitions written.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	80.8
24-Hour General	62	85.3
Special	121	93.4

In spite of a cold wave early in the month, generally mild temperatures thereafter enabled January to become the 9th straight month of above-normal temperature. Precipitation totaling 2.05 inches was nearly 2½ times the monthly normal and was the second greatest amount of record for January. The 2.16-inch total of January 1953 stands as the 47-year record high for January.

Instrumentation

The alpha scintillation transistorized AC-operated poppy loud speaker output 110 VAC-operated device for "station" monitoring work has performed satisfactorily except where the gamma background where the probe is being used is greater than 200 to 300 mr/hr. This "level" of gamma background does cause some

additional background counts above the usual level of background of less than two c/m. Since there are very few places on the plant where such gamma levels are apparent where alpha counting is desired, this is not considered a problem.

On the zinc sulfide particle counter, a new source deposited on quartz glass was tested. Due to the poor optical properties of the source, the signal to noise ratio was poor as compared with the source deposited on the perifery of a flat disk with a hole in the center. Originally the glass source scintillated. We learned that the only difference between the new and the old source was that the new one had been coated with flexible (collodion). A conference with some chemists revealed that the flexible type collodion contains castor oil which probably causes these scintillations. The source was flamed again to remove the collodion and sprayed only with krylon. This eliminated most of the scintillations.

Final evaluation was completed on the portable, scintillation dose-rate meters.

Evaluation tests are being conducted on linear amplifiers, alpha, AC-operated poppy, and a commercial remote-area monitoring system.

Changes were recommended in the battery BF_3 univibrator circuit. These will give an instrument that has linear response.

Optical

Shop sketches were prepared outlining the modifications of the slit camera at the 105-C fuel examination facility. The modifications provide for taking either normal shots or for taking rolled cut pictures of the surface of fuel elements. Fabrication of this modified unit is fifty percent complete.

An informal report was written describing a profile microscope which was built in the Optical Shop for measuring scratch depths. Application of this technique to the 45-power underwater microscope at the 105-C fuel examination facility is being studied.

The routine Optical Shop work included the fabrication of six glass bearings, two lead glass windows, the lighting head for a Lenox Borescope, eight borescope lenses, two objective lens mounts, and several light pipes. Three microscope objectives and a theodolite were serviced. Work continued on the fabrication of 14 glass bearings, on the conversion of a Redox crane periscope, and on modifications to the 105-C slit camera.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

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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
J. L. Powell	1/12-16	Univ. of Oregon Eugene, Oregon	Consulting.	JE Faulkner	Yes	300:326,305-B 100:105 DR-KE
I. R. Compton	1/15	Hawthorne Electronics Seattle, Wash.	Discuss Donner Analog Computer.	WD Cameron HH Burley GR Taylor	No	300: 326
O. J. Judd M. C. Gilliland	1/19	Rush Drake Associates Boeing Aircraft Seattle, Wash.	Discuss Berkeley E.A.S.E. Analog Computer and Analog Computer techniques.	HH Burley WD Cameron PF Gast GR Taylor	No	300: 326
E. R. Wagner	1/19-23	Nuclear Products, ERCO ACF, Washington, D.C.	Discuss gas cooled reactor physics experiments.	RE Heineman TJ Oakes	No	300: 326, 305-B
Dale Johnson	1/19-23	Kaiser Engineers Oakland, Calif.	" " " "	RE Heineman TJ Oakes	No	300: 326, 305-B
Jack Lingafelter	1/21	General Electric Co. San Jose, Calif.	Discuss fuel elements for PCTR experiments on Gas Cooled Reactor Program.	RE Heineman TJ Oakes	No	---
J. E. Sperry	1/26	Brush Instruments Seattle, Wash.	Discuss recorders.	HH Burley WD Cameron GR Taylor	No	300: 326
J. B. Dee, Jr. E. K. Bjornerud	1/27-28	General Atomics La Jolla, Calif.	Discuss graphite critical experiments for gas cooled reactors.	RE Heineman	No	300: 326 700: 761
O. J. Judd	1/29	Rush Drake Associates Seattle, Wash.	Discuss Analog Computer techniques.	HH Burley WD Cameron GR Taylor	No	300: 326

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
H. H. Burley W. D. Cameron G. R. Taylor	1/7/	Boeing Aircraft Seattle, Wash.	Inspect computer installations.	Max Gilliland	No
		United Controls Seattle, Wash.	" "	---	No
G. R. Hilst	1/16	Univ. of Washington Seattle, Wash.	Confer with consultants.	P. E. Church F. I. Badgley	No
	1/17	Oregon Branch, AMS Portland, Oregon	Present talk on Hanford Meteorology Program.	J. Chapell	No
	1/20-21	Univ. of Chicago Chicago, Ill.	Discuss highly sensitive humidity instruments.	R. R. Braham	No
	1/22-23	AFCRC Bedford, Mass.	Discuss dispersion experiments.	M. L. Barad	No
	1/26-28	American Meteorological Society New York, N. Y.	Present paper and attend AMS meeting.	K. C. Spengler	No
	1/29	Joint Committee on Atomic Energy Washington, D. C.	Present testimony on Hanford meteorology program.	Rep. Holifield	No
	1/30	Army Chemical Corps Fort Detrick, Md.	Discuss meteorological dispersion experiment.	W. W. Dorell K. L. Calder	No
J. J. Fuquay	1/21-23	Air Force Cambridge Research Center Bedford, Mass.	Consultation on Atmospheric Diffusion Experiments.	M. L. Barad	No
	1/26-29	American Meteorological Society New York, N. Y.	Attendance at Annual Society Meeting.	K. C. Spengler	No
	1/30	Brookhaven Nat'l Lab. Upton, N. Y.	Consultation on Meteorological Instrumentation and Measurements.	Maynard Smith	No
	2/2	General Mills, Inc. Minneapolis, Minn.	Consultation on Aerosol Generation.	Sydney Stern	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. D. McCormick	1/26-30	High Voltage Engineering Corporation Burlington, Mass.	Discuss accelerator problems.	C. Ellison	No
B. R. Leonard, Jr.	1/28-31	American Physical Society New York, N. Y.	Present paper at APS meeting.	--	No
J. E. Faulkner	1/28-31	American Physical Society New York, N. Y.	Recruiting at APS meeting.	--	No

Chemical Research and Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIAL - 2000 PROGRAM

IRRADIATION PROCESSES

Uranium Oxidation and Fission Product Volatilization

The project proposal for the conversion of 292-T Building to a test facility for uranium oxidation and fission product release studies was completed. Estimated cost of the project is $75,000. It was estimated that construction could be complete eight months after project approval.

Small scale experimental measurements on the rate of fission product volatilization from heated uranium were continued. The principal aim of these studies was to measure the fraction of various isotopes volatilized as a function of time and to determine the activity associated with particles emitted. The specimens, eleven-gram bare uranium cylinders irradiated to 2×10^{14} nvt and cooled 1 to 3 days, were oxidized in air at a furnace temperature of 1200 C. Preliminary analytical results indicate that time at temperature is an important variable in the amount of fission products volatilized. Essentially 100 per cent of both iodine and tellurium was released in 80 minutes. Cesium volatilized linearly at a rate of about 0.025 per cent per minute. Strontium and ruthenium behaved anomalously, averaging about 0.15 per cent released for all cases tested.

Decontamination of Reactor Components

Removal of radioactive contamination from fission product-uranium dioxide contaminated carbon and stainless steel coupons by several cleaning procedures was studied. The contaminated samples were prepared by exposing prescaled carbon steel (Type A246) and stainless steel (Type 304-L) coupons together with irradiated uranium wire to pH 10 water at 195C in a stirred autoclave. The cleaning procedure studied most is a two-step process involving alkaline potassium permanganate followed by dibasic ammonium citrate-tetrasodium Versene solution (both solutions at 95C). Gross gamma decontamination factors from 2,000 to 3,000 were obtained. Corrosion of the carbon steel was undesirably severe. In procedures modified to reduce corrosion of carbon steel (reduced temperature and increased pH in the second step) decontamination factors lower by factors of about 10 were obtained. In another modification, ferrous ammonium sulfate-sulfamic acid solution was used in the second step. Decontamination factors in excess of 1,000 were obtained; corrosion of carbon steel, although less than with ammonium citrate-Versene, was still undesirably severe.

Several other procedures involving potassium permanganate, bromine, ammonium persulfate, and hydrogen peroxide in sodium carbonate-bicarbonate solutions were tried. Gross gamma decontamination factors of 50 or less were obtained.

[redacted]

Analytical Services

Regular reporting of Ga^{72} and Zn^{69} in the Columbia River and drinking water will start February 1. Gallium is purified by ether extraction and "256"-counted as a hydroxide slurry. Zinc is purified by ion exchange and "256"-counted as the diammonium phosphate slurry. Recoveries of both exceed 85 per cent.

IBM may soon be routinely calculating gamma energy spectra. In cooperation with Operations Research & Synthesis Component, matrix equations were calculated for a ten-component system and submitted to Data Processing. Its results on four 256-channel analyzer samples agreed well with manual values. Perfect agreement is anticipated.

Adaptation of a copper spark spectrographic method permits determination of aluminum in deionized water in the 0.025 ppm to 2 ppm range with a precision of ± 5 per cent at the 95 per cent confidence level. An aliquot of the sample with gallium added as an internal standard is mounted directly on a pair of copper electrodes, dried, and subjected to spark excitation. By using the line pair, Al 3961:Ga 4033, and triplicate analyses, needed precision was met.

A molecular leak and inlet system was fabricated and installed on the general mass spectrometer to permit routine analysis of 100 to 500 micron pressure gas samples. Recent water samples from in-pile loops had insufficient gas pressure, even after laboratory compression, for analysis on the (normal) viscous leak incorporated in the general mass spectrometer. The new installation circumvented an alternate method of building an extensive vacuum system hookup for the molecular ion resonance mass spectrometer.

The thermal mass spectrometer, routinely applied to high mass assay, was successfully used to determine the isotopic ratio of lithium contained in flux used to weld fuel elements. High mass techniques were used to mount 10 mg of sample from aqueous solution. Three lithium compounds (LiI, Li_2SO_4 and LiCl) were analyzed to evaluate the precision of the method. Mole ratios obtained at the 95 per cent confidence level on assumed natural materials were within the published limits of other sites.

The flexibility of activation analysis was expanded by reducing to seven minutes, the average time needed to get samples from the reactor to the counter. Thus, activation products of half lives as low as about two minutes may be assayed. The relatively short time lapse is due to three conditions. First, the 100-KE pneumatic charge-discharge facility is now in operation. Secondly, Marlex^R rabbits are used -- the high density linear polyethylene polymer exudes only one Rad, mostly beta, after a ten-minute exposure. Finally, nearby counting equipment has been arranged. To demonstrate, aluminum (half-life of product Al^{28} is 2.27 minutes) was used even though its < 0.2 barn cross section is poor. It is likely that about 50 elements in amounts above 0.00001 to 1 microgram, depending upon the element, may be assayed by activation analysis using the 100-KE reactor.

SEPARATION PROCESSES

PUREX

Anion Exchange Processing of Purex 1BP

Recent results indicate the efficiency of removal of fission products in the wash cycle decreases as the feed rate of the wash solution is increased. For example,

identical volumes of 7.2 M HNO_3, 0.01 M HF wash produced zirconium-niobium decontamination factors of 1.6×10^5, 2.4×10^4, and 1.8×10^4 when they were fed at rates of 5.4, 10.1, and 14.8 ml/(min)(cm^2), respectively.

Similarly, more efficient removal of fission products can be obtained by increasing the fluoride concentration in the wash solution. At a wash flow rate of 10.1 ml/(min)(cm^2), 10 column volumes of 7.2 M HNO_3, 0.1 M HF followed by 6 column volumes of 7.2 M HNO_3 yielded a zirconium-niobium decontamination factor of 3.7×10^4, somewhat greater than the value of 2.4×10^4 obtained with 30 column volumes of 7.2 M HNO_3, 0.01 M HF followed by 6 column volumes of 7.2 M HNO_3. The gain in fission product decontamination is somewhat offset by the greater elution of plutonium which occurs with a high fluoride wash. Use of a high fluoride wash would therefore require that the loading cycle be terminated at a lower average plutonium loading or that a "tailings" column be provided to recover plutonium from the wash cycle effluent.

The experimental study of the use of anion exchange to accomplish purification and concentration of plutonium in Purex 1BP has been concluded. The results indicate that a process consisting of a single cycle of anion exchange coupled to a single solvent extraction cycle such as the Purex 1A - HS - 1B cycle should be capable of routinely producing a 50 g Pu/l product well within present plutonium purity specifications. A single cycle of anion exchange designed to operate in remote equipment could, therefore, replace the 1BS, 2A, and 2B solvent extraction columns and the unshielded anion exchange contactor presently in use in the Purex plant.

Electrolytic Uranium(IV)

Construction of a pilot unit to electrolytically prepare tetravalent uranium has been initiated. The tetravalent uranium is potentially useful as an alternate plutonium reductant in lieu of ferrous iron in solvent extraction partitioning columns. Successful substitution will reduce the cation content of the wastes and thus potentially reduce the complexity of fission product recovery processes and/or alternate waste processing processes. The pilot plant will be used for engineering investigation of the process and for production of plant test quantities of product.

Tritium Processes

Studies have been initiated and directed towards improving the technology associated with tritium recovery.

To date, experiments have been performed on the dissolution of lithium-aluminum alloy by mercury as a means of liberating the contained gases. When the mercury was refluxed over the clad core, centers of corrosion occurred spontaneously and the whole slug became attacked. This approach is of promise since it offers the possibility of removing the lithium as a fluid, from which the mercury may be recovered for re-use by distillation.

Efforts to separate hydrogen isotopes have utilized the difference in their adsorption characteristics with respect to palladium black. Under isothermal conditions, the

equilibrium vapor pressure over the bed is considerably richer in the heavier isotopes. Several approaches to exploit this difference may be used: the bed (column) of palladium may be partially loaded with the mixture to be separated and the chromatogram then developed by the passage of hydrogen which eventually displaces, in almost pure form, the heavy isotopes from the leading edge of the band; alternately, the chromatogram may be developed by heating the partially loaded column starting from the end first loaded, thus using the hydrogen present in the original sample as the displacing medium.

Both of the above described methods (first experimentally verified by E. Glueckauf and G. P. Kott, Harwell, U.K.) have been examined using hydrogen-deuterium systems. The best enrichment so far obtained was by the self-displacement method. In this experiment a feed gas mixture consisting of H_2 - 13 a/o D_2 was recovered as 88 a/o D_2-H_2 in high yield.

Considerable difficulty has been encountered in the treatment of the palladium black both with respect to its initial activation and the subsequent preservation of its adsorption capacity. Some success has followed a cyclic oxidation-reduction treatment of palladium supported on asbestos or alumina.

Analytical Services

In response to questions about the use and accuracy of the coulometric uranium analysis method on completely quadrivalent uranium resulting from hydrochloric acid dissolution of Al-U alloy, comparative analyses show the following:

Sample	Ceric Sulfate Titration	Coulometric Titration
1	3.69 g U/l	3.65 g U/l
2	2.11	2.05
3	3.18	3.18

Perchloric acid is necessary to oxidize completely ruthenium in the analysis test well samples. To avoid hazards of that acid, tests were made of the substitution of periodic acid in the method. Periodic acid, however, proved not to have the needed oxidizing power for those samples.

WASTE TREATMENT

Nitrate Destruction

Pilot plant investigation of nitrate destruction by formaldehyde has been concluded with a few scouting experiments to determine the effects of packed tower height, methanol concentration in the feed, and the applicability of the process to nitrate destruction in Darex effluents.

Increasing the packed tower height from 2-1/2 to 5 feet increased formaldehyde utilization by about 10 per cent. Increasing the methanol content of the formaldehyde from 10 per cent (normal) to 20 per cent increased effective formaldehyde utilization by another 5 per cent.

Batch operations on Darex effluents showed no significant difference from similar operations on synthetic Purex 1WW. The free acid in solutions of either composition could be reduced to near zero with an overall formaldehyde utilization efficiency of about 1.8-1.9 mols nitrate per mol of formaldehyde.

Based on these observations it is believed that this process can be used for any application where it is desirable to reduce nitric acid concentration. It is particularly attractive when it is also undesirable to neutralize excess acid with caustic.

Fixation of Purex Waste

Some additional experiments have been run to complete the previously reported study of the effect of calcination and solution variables on fission product volatilization and leaching. A formal report, HW-57686, "Studies for the Storage of Purex High Level Waste, Part I - Evaluation and Calcination Volatility and Leachability," by G. B. Barton, is being issued describing this work.

Radiant Heat Spray Calcination

The eight-inch by ten-foot radiant heat spray calciner was put in operation during the month. The electrical resistance heating, the most novel feature of the design, was found to work well. The first run with simulated waste solution had to be terminated due to calcination of feed solution in the atomizing nozzle, which was located within the column. This arrangement has been altered by placing the nozzle outside the column with the end protruding through a hole in the center of the top flange. Subsequent operation has revealed leaks in the off-gas system which must be corrected.

The three-inch column was modified to test introduction of the feed at the bottom rather than the top. It was thought that this arrangement would provide a maximum residence time for the largest drops rather than a minimum time, as in the usual arrangement. Coalescence of the spray drops occurred, and the larger fraction either coated the walls or fell back to the bottom of the apparatus. These studies were discontinued. In other experiments in the three-inch unit (but with conventional feed location) addition of sucrose (for self-ignition) and phosphate gave a product with a bulk density of 1.8 g/cc. Analysis showed a residual nitrate content of only 0.06 per cent.

Argonne National Laboratories has agreed to perform scouting calcination studies on synthetic Purex 1WW in a 6-inch fluid bed waste calciner. These studies are planned to provide further data to aid the design of pilot plant equipment and experiments for the proposed fluid bed unit at Hanford. ANL experiments are expected to start in February.

NPR Waste Streams

Study on the disposal of NPR wastes continued. A tabulation of the streams, possible volumes and possible radioactive and chemical constituents was started. Although much of the data is speculative at this time, such study permits classification of the waste streams and assists in the evaluation of proposed disposal methods.

300 Area Waste

Preliminary consideration indicated that 300 Area laboratory wastes now being trucked to the Redox Laboratory crib may be acceptable for disposal in the Purex boiling tanks providing the salt content is negligible. Samples are being taken to characterize these wastes more fully. If they prove acceptable, there exists the possibility of savings in transportation expenses and further savings through prolonging the life of the 216-SL crib. Additional advantages would be reduced radiation exposure to the truck driver and of reduction in the activity (by about 100 curies/month) of the material going to ground disposal facilities.

Observation Wells

Since the cooling water discharge to the T-Plant swamp was discontinued in 1956 the ground water mound beneath that site has receded 25 feet. The ground water gradient developed a strong northerly component as a result, affecting the movement of ground water contaminants beneath the T-Plant. Radioactive material from that site was detected as far north as well 699-49-79. The concentrations were barely detectable and radiologically innocuous.

High plutonium concentrations were found in mud samples from the ditch to which cooling water from the 234-5 Building is discharged. Subsequent special mud samples revealed plutonium contamination ranging up to concentrations above 1.0 uc/g along the entire length of the ditch discharging into the U-swamp. Plutonium concentrations as great as 10^{-4} were found in mud samples from the edges of the swamp.

A test was performed to determine the effectiveness of knife-perforated conventional monitoring wells for measuring the concentration of radioactive material in the ground water. Three monitoring wells in the 216-BY crib area were sampled before and after they were reperforated with the shaped-charge perforator. The test was intended to determine to what extent corroded and plugged perforations affected the concentration of radioactive material in samples from these wells. After reperforating, samples were taken immediately after 2 days, after 5 days, and after 14 days. In none of the wells was an immediate significant concentration change detected, but a significant reduction in radioactive material concentration took place in all of the wells over the period of several days covered by the test. The reduction in concentration ranged from 60 per cent to 98 per cent in the three wells. It is believed that this test may indicate a monitoring problem in some older wells as a result of inadequate contact between the wells and the adjacent ground water.

Disposal to Ground

Laboratory results indicated that Sr^{90} would appear in detectable concentrations prior to Cs^{137} in wells monitoring the Purex 216-A-24 tank farm condensate crib. Therefore, future abandonment of this crib will have to be based on the appearance of Sr^{90} in ground water or on extrapolated laboratory data.

Laboratory study of resin column decontamination of Recuplex CAW waste with respect to plutonium was continued. An additional column test with Permutit SK at 28 C

[redacted]

confirmed the rather poor plutonium removal previously obtained with the resin. Column tests with Amberlite IRA 401 resin were not completed but equilibrium studies in which the plutonium uptake was determined after various contact times showed a great similarity between IRA 400 and IRA 401.

Three additional soil column tests of Purex boiling tank condensate waste gave Sr breakthrough after 3.5, 4.8, and 4.2 column volumes. The 4.2 column volume average is considered to be in good agreement with the 4.5 column volume estimate previously reported.

Special Geological Studies

The Bach Drilling Company completed the CA-794 drilling project with a total of 4011 feet. Eleven wells were completed as planned, ten to basalt. The original estimated footage was 4000 feet, the footage over-run was thus about 0.3 per cent.

A preliminary appraisal of the problems of determining the potential of damage to underground tanks by earthquake was completed by Frank Neumann, consultant to CPD. These problems, unique in the field of seismology, will require the collection of many data. In the field of geology this may require additional regional geologic studies and perhaps supplemented by geophysical seismic studies. The data should be integrated with those from special instrumentation and precise level surveys.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Neptunium Recovery

Recovery of Neptunium in Purex

Data obtained by Sidall and Dukes[1] on the kinetics of the oxidation of neptunium(V) to neptunium(VI) in the presence of nitrous acid have been used to calculate neptunium operating diagrams in the Purex HA column. These workers found that the rate limiting step in the oxidation process is approximately fourth order in hydrogen ion, zero order in nitrate and in nitrous acid (for nitrous acid concentrations greater than about 5×10^{-5} M) and has a heat of activation of about 12 kcal/mole. They also showed that the controlling equilibrium can be represented by the equation

$$NpO_2^+ + \frac{3}{2} H^+ + \frac{1}{2} NO_3^- \rightleftharpoons NpO_2^{++} + \frac{1}{2} HNO_2 + \frac{1}{2} H_2O$$

(1) Siddall, T. H., and Dukes, E. K., "Kinetics of Oxidation of Neptunium(V) by Nitrous Acid in Aqueous Solutions of Nitric Acid," a paper presented at ACS Meeting, San Francisco, California, April, 1958.

[redacted]

and measured equilibrium constants of about 5×10^{-4} at 25 C and 6×10^{-4} at 50 C for this reaction. Thus excess nitrous acid is unfavorable since it leads to reduction of the extractable neptunium(VI) to the inextractable neptunium(V) according to the above equation.

From these data, conditions most favorable for the recovery of neptunium in the HA column are: high acid, high nitrate, elevated temperature, the minimum aqueous phase nitrous acid concentration (e.g., ca. 5×10^{-5} M) necessary to catalyze the oxidation reaction, and high retention time for the aqueous phase in the extraction section.

Maintenance of appropriate aqueous phase concentrations of nitrous acid throughout the extraction section is complicated by the fact that nitrous acid is efficiently extracted by the organic phase. Thus, if nitrous acid is added to an appropriate concentration to the aqueous phase at a given point in the column it will have for practical purposes "disappeared" from the aqueous phase in a short section of column. For example, calculations indicate that presence of about 3×10^{-3} M nitrous acid in the aqueous feed (about the level normally present from radiolysis in the feed) will result in only about one-third of the extraction section being effective in recovering neptunium but none the less can result in recovery of about 95 per cent of the neptunium. This presumably accounts for the successful recovery of neptunium in the Purex plant during the December run period when the neptunium inventory plateaued at a level corresponding to a loss of between five and six per cent to the HAW. During this run period nitrous acid was added to 0.01 to 0.02 M in the feed but probably reverted to the equilibrium level of about 0.003 M under radiolysis (and, in fact, was found to be about 0.003 M by chemical analysis).

Neptunium recovery in the HA column can be improved by adding between 10^{-4} M and 10^{-3} M HNO_2 to the organic feed (HAX). This introduces sufficient nitrous acid into the aqueous phase at the bottom of the extraction section so that the entire extraction section is effective for recovering neptunium. However, under these conditions a near "pinch" exists for neptunium at the feed point and close control of flow ratios is necessary. Near-quantitative recovery of neptunium should be possible in the HA column by this approach, however.

Results of miniature mixer-settler runs made to test the feasibility of recovering neptunium through addition of nitrous acid to the HAX are shown in the accompanying table. It should be noted that no attempt was made to attain steady-state operation in runs in which early samples showed substantial losses. Thus it is probable that actual steady-state losses would be considerably greater than shown here except in the two runs which yielded low losses.

NEPTUNIUM RECOVERY IN HA MINI RUNS
(Synthetic Feeds)

Temperature, °C	M HNO_2 in HAF	M HNO_2 in HAX	HAW Np Loss, %
25	Nil	0.001	25
25	Nil	0.01	8
25	Nil	0.03	85
45	0.001	0.00046	0.25
45	0.001	0.0013	1
45	0.001	0.011	15

Purification of Neptunium by Anion Exchange

Experimental work in behalf of development of an anion exchange flowsheet for accomplishing purification of the Purex plant neptunium product has been concluded and a summary report is in preparation.

The recommended flowsheet is essentially that which was used successfully by the Process Chemistry Operation, CPD, for purification of the neptunium recovered in the Purex plant at the end of the December run period. It consists of the following steps (with Dowex-1, X-4 50-100 mesh, resin).

1. Loading of neptunium(IV) at ambient temperature out of feed containing 6 M HNO_3, ferrous sulfamate, and hydrazine to an average loading of ca. 25 g Np/l resin bed.

2. Washing at ambient temperature with 6 M HNO_3 containing ferrous sulfamate and hydrazine to remove plutonium. Laboratory results indicate plutonium decontamination factors of about 2000 with 15 column volumes and 6000 to 7000 with 20 column volumes of wash.

3. Washing at 60 C with 8 M HNO_3, 0.01 M HF to remove fission products and UX_1. Laboratory data indicate a zirconium-niobium decontamination factor of ca. 70,000 and a UX_1 decontamination factor of 500 to 1000 with 20 column volumes of wash.

4. Elution at ambient temperature with 0.35 M HNO_3. Elution in fractions is advantageous since it enables the product to be recovered at a concentration of ca. 25 g Np/l. Recycle of perhaps the first five per cent of the eluted neptunium would enable significant additional UX_1 decontamination to be obtained, also.

Work completed during the month demonstrated the feasibility of substituting the more convenient reagent, hydrazine, for the semicarbazide which had been used in earlier work and confirmed that Step 2 is indeed necessary if substantial plutonium decontamination must be obtained. Plutonium decontamination is poor in Step 3 while fission product decontamination is poor in Step 2.

Target Element Preparation

A casting procedure was developed for the preparation of neptunium-aluminum target material. The procedure makes use of a five-inch O.D., 1000 cm^3 capacity, bottom-pouring graphite crucible mounted above a multiple rod, removable bottom, graphite mold of the same diameter. In use, the crucible and mold assembly is heated inductively within an evacuated, inverted six-inch diameter quartz envelope. When the mold temperature has reached 700 C (and the melt about 850 C), the casting is made. Excellent results were obtained using this technique with stand-in aluminum - 10 w/o uranium alloy and a six place mold designed for 0.72 inch diameter by 4.3 inch long rods. With a five inch diameter mold at least ten double length rods could be cast in a single pour, the equivalent of 20 Savannah River target element cores (about 600 cm3 or 1800 grams of alloy).

Target-Core Temperatures

Expected core temperatures for aluminum-neptunium targets were calculated by J. Muraoka of Reactor Engineering Development Operation. For a typical Savannah River core, 0.72-inch in diameter, 4.3-inch long, clad in 0.070-inch thick aluminum, containing 33 w/o neptunium and exposed to a flux of 7.5×10^{13} n/sec,cm^2, the expected core temperature is 75 C greater than that of the cooling water. For these calculations a maximum specific heat generation of 1.58×10^4 BTU/hr,ft was used. A water film coefficient of 2000 BTU/(hr)(ft^2)(F), a contact coefficient of 1000 BTU/(hr)(ft^2)(F), and the thermal conductivity of aluminum were assumed. This calculation is also applicable to the NpO_2-Al core if it is assumed that the thermal conductivity is that of aluminum. If, however, the thermal conductivity is only five per cent of that of aluminum, the expected core temperature increases about 110 to 185 C greater than the cooling water temperature. Work in behalf of this program has been discontinued.

Fission Product Recovery

Multicurie Cell Investigations

Analytical results were obtained for the acid-side zinc ferricyanide cesium recovery run which was made in November. Cesium recovery (80 per cent) is lower than desired and can be attributed to a higher than expected cesium concentration. Cesium recovery could doubtless be improved by the use of slightly more precipitant.

The most recent batch of 1WW was filtered, acidified to 8 M HNO_3 (as received acidity was only 4.0 M), and passed through an anion exchange column for neptunium and plutonium recovery. An attempt to pass the solution through the column without prior filtration resulted in immediate plugging of the anion exchange column and indicates that feed clarification would be required for the Purex plant 1WW anion [illegible]

Strontium Recovery

Cold and tracer level experiments were carried out to firm up the dual pH strontium recovery process and to determine the effects of current high concentration of iron (0.5 M) and sulfate (0.75 M). Strontium loss to the iron precipitate was 60 per cent; however, this was reduced to 27 and 15 per cent by dilution with an equal volume and two volumes of water, respectively. Losses in other steps were nominal, about two per cent each in rare earth sulfate removal, the high pH strontium precipitation, and the final nitric acid product isolation steps. The final strontium nitrate contained less than 100 ppm barium and very little other radioactive contamination. Full-level experiments will be required to establish exact values.

Zirconium-Niobium Recovery

An informal document, HW-58970, "Composition of Solids from Purex 1WW," by H. H. Van Tuyl, was prepared and sets forth currently available information on the zirconium-niobium bearing solid which exists in Purex 1WW solution.

A precipitate similar in appearance and behavior to the solid in Purex 1WW solution was observed to form in synthetic 1WW solution. The solid was found to consist primarily of zirconium phosphate and barium sulfate. The centrifuged volume of this precipitate (14 per cent) coupled with analyses on the plant material, imply that the precipitate in the plant 1WW is more voluminous than previously thought from visual observation and that plant samples were probably non-representative.

Characteristics of Annular Anion Exchange Column

Experimental studies of the flow characteristics of the annular fixed-bed anion exchange column were concluded. The latter studies included the use of sodium ion as a tracer to determine the channeling and "hold-back" characteristics of the bed in both the presence and absence of sulfamate generated gas. Analysis of the data collected is in progress. Preliminary conclusions indicate variations in flow in the four quadrants of the column by as much as 50 per cent at effluent-to-feed concentration ratios of 0.20. No significant difference in the quadrant channeling was noted in the presence or absence of gas.

Fission Product Isolation and Packaging Prototype

The shop fabrication of the Fission Product Isolation and Packaging Prototype is approximately 70 per cent complete. Most of the vessels requiring intervessel and service piping have been installed on the base frame located in the 321-A Building and assembly and piping work have begun. The electromechanical components are not yet completely fabricated.

The initial flowsheets developed to recover cesium from plant waste streams were based upon the formation of cesium zinc ferrocyanide from a neutralized solution. Later studies showed that cesium could be recovered as cesium zinc ferricyanide from an unneutralized solution. Therefore, calcination and hydrolysis experiments were made to determine if any differences exist in the reaction rates of the ferro

and ferricyanides. In these experiments, cesium zinc ferrocyanide and potassium ferrocyanide were assumed to be characteristic of the ferrocyanide while potassium ferricyanide was used as a stand-in for the ferricyanides. The following conclusions were reached.

1. In calcination, the reaction rates of the ferro and ferricyanides are reasonably similar. The ferricyanides are slightly more reactive.

2. In hydrolysis, the reaction rate of the ferricyanide is about twice that for the ferrocyanide.

3. No adverse processing rates are expected if ferricyanides are used in the place of ferrocyanides.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Electroanalysis with the Tungsten Oxide Electrode

An informal report entitled, "Electroanalytical Studies of the Tungsten Hemipentoxide Electrode," has been issued as document HW-58406, giving the results of a limited study of this subject. The tungsten hemipentoxide electrode has been reported to have an unusually high oxygen overvoltage in acid, neutral and alkaline solutions. Since there are a number of Redox systems now outside the range of polarography and coulometery because of the formation of oxygen at the electrode, a high oxygen overvoltage has great potential usefulness. A study of ways to prepare the electrode, and of its polarographic and coulometeric behavior in various media, was made. The best preparation method for the W_2O_5 electrode seems to be heating tungsten in either air or oxygen for 30 minutes at 485 C. A bronze colored electrode results.

Polarographic oxidations and reductions were tested in sulfuric acid solutions with Fe(II), Fe(III), Cr(III), Cr(VI), Mn(II), Mn(VII), KIO_3, $KClO_3$, KBr + Br_2, $KBrO_3$, NaI + I_2, KIO_4, Ce(III), and Ce(IV). In addition, the $Fe(II)_2$-Fe(III) system was further studied in HCl solutions and several coulometric oxidation and reduction titrations were tried. The high oxygen overvoltage was confirmed, but the electrode is generally not capable of performing oxidations. Most electrode reactions are more or less irreversible at the electrode, and oxidation reactions are very slow. The only exception is the Fe(II)-Fe(III) system in HCl which gives normal anodic and cathodic polarographic curves. The W_2O_5 electrode appears to have no advantages over platinum in this system, and there is no evidence that it can be applied successfully to coulometry at high positive potentials.

EQUIPMENT AND MATERIALS

Pump Development

A HAPO designed metering pump employing an Archimedes Screw has been built and testing has begun. Basically, the rotating Archimedes screw dips into a constant head reservoir and delivers an accurately measured liquid increment from the reservoir and each rotation of the screw. Over a 10-fold variation in rotation speeds, delivery rates are very reproducible. Preliminary tests indicate that

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screws can be designed to give excellent flow measurement and reproducibility (reproduced within ± 0.5 per cent). To investigate its use for various flow ranges, tubes of three different diameters have been tested with results as indicated below:

Tube Size	Flow Range
1/4-inch O.D. Tube	0 to 126 ml/min
3/16-inch O.D. Tube	0 to 54 ml/min
1/16-inch O.D. Tube	0 to 4.3 ml/min

Although models built to date have been designed for small flows this type metering pump can be designed for larger service.

A small Pogo-stick pump (pneumatically actuated) has been built and is being tested for possible use in the Purex Ion Exchange System. The pump has been designed to fit a 2-inch diameter hole 4-feet long and to deliver 2 gal/min against a 25-foot head.

Titanium Fabrication

Technical assistance was given to the Technical Shops in the fabrication of a titanium tube heat exchanger to be used in the Plutonium Concentration System at Purex.

234-5 Powder Lock and Feeder

A powder lock has been designed, built, and "cold" tested for use in 234-5 Operations. The lock permits transfer of powder from one chamber to another but permits very little gas leakage. Operation of the lock has been trouble-free when tested using lead oxide as a stand-in for plutonium oxide or plutonium chloride. The "packing" and "bridging" characteristics of lead oxide are considerably worse than those for the plutonium compounds. The test unit has been given to CPD for "hot" testing with plutonium compounds.

Corrosion of Continuous Calciner Loop Headers

Samples taken from the loop header of one of the 224-U Building continuous calciners were examined to determine the extent of corrosion since start-up of the loop in October, 1956. The header is exposed to molten uranyl nitrate containing small amounts of nitric acid and sulfate salts. Some general corrosion of intergranular nature was evident; no preferential attack has occurred. Based on normal wall thickness for the pipe concerned, a corrosion rate of less than 0.5 mil/mo was estimated.

PROCESS CONTROL DEVELOPMENT

Assistance to Chemical Processing Department on Process Control Instrumentation

A linear polyethylene tube-type gamma-monitor cell is being tested on the Redox HCP stream. The empty cell (background) reading was less than 1 per cent of full cell

reading for about the first week of service. Subsequently, the background began to rise slowly. This may be due to softening of the polyethylene by the residual hexone in the HCP stream. The evaluation of tube type cells is continuing, with plans for testing a Teflon cell on the HCP when the background of the polyethylene cell becomes intolerable.

Tests with the mock-up of the Redox 1AFS dual jet sampler are continuing. The first (lower) stage jet delivers sample at the rate of 400 ml per minute, while the second jet delivers approximately 100 ml per minute of gas-free sample. The testing of this mock-up is to be concluded with collection of data concerning the amount of uranium that may be carried over in the vapor discharge to the vessel vent system.

1C Column Studies

A system to monitor the average density of the column contents in the extraction cartridge has been designed and tested. The system utilizes two electrical pressure transducers installed in the column immediately above and below the cartridge. The two transducers are connected in such a way as to indicate the solution density directly to ±0.01 g/cc. The instrument currently has a range of 0.80 to 1.20 g/cc., and can easily be changed to other ranges. Pulser induced pressure fluctuations from the lower transducer are filtered by a resistance-capacitance type filter, analogous to an electrical RC filter.

Magnetic Flowmeter Tests

The Fischer-Porter magnetic flowmeter which was used to measure 100 per cent UNH flow rates has been tested for possible use on Purex type organic solvents. In tests with a simulated HAX stream no indication of flow was observed. It is reported that oxygenated organic compounds such as acetone can be metered by this technique. However, the present work demonstrates that TBP solutions of acidified paraffin type hydrocarbons have electrical conductivities too low to allow flow measurement by this technique.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Processing - 40 Ton Hydraulic Shear Studies

High speed movies have been made to determine shear blade speeds and shearing characteristics in the 40-ton unit. These studies have indicated that the 7-1/2-inch shearing stroke is completed in 1/6 second. Peak blade velocities of approximately 70-inch/second are obtained. To obtain this blade movement, hydraulic oil flow rates of as high as 400 gal/min. are required.

Studies made with the shear equipped with a straight moving blade and a semicircular stationary blade have indicated that the shear forces required are approximately 10 per cent greater than the force required when both stationary and moving blades are straight. Although slightly greater shear forces are required, the straight-semicircular combination is considered the best yet tested since the tube bundles are less disturbed (not fanned-out) during shearing.

Life testing has begun with the above-mentioned straight-semicircular blade combination using blades fabricated from 420 stainless steel. With shearing conditions adjusted to accelerate blade wear, minor blade wear was noted after approximately 2000 square inches of steel (and stainless steel) had been cut. At that time the shearing force required had increased approximately 10 per cent.

Feed Preparation

Sulfex Process. Recent sulfex process studies employing UO_2 irradiated to ca. 460 MWD/T and cooled nine months generally confirmed previously reported results with somewhat "colder" material.

Exposure of this material to boiling 4 M H_2SO_4 resulted in dissolution of the UO_2 at a constant rate of 0.02 per cent per hour. A ferrous sulfate dosimeter measurement indicated a rate of energy absorption of ca. 1.2×10^{17} ev/(ml)(hr), about five-fold higher than with the colder material used in earlier work. The observed accelerated dissolution rate as compared with unirradiated UO_2 indicates an apparent G value for the process of ca. 76, based on an estimated surface area for the irradiated UO_2.

Further study of the inhibiting effect of dissolving stainless steel in reducing the rate of dissolution of the UO_2 showed that the accelerated UO_2 dissolution which occurs after the stainless steel is consumed is probably due to reaction of Fe(III) with the UO_2. Fe(III) was identified and followed spectrophotometrically in the solution. No Fe(III) forms while a sufficient heel of solid stainless steel is present. With no solid stainless steel present, Fe(III) formed at comparable rates over the irradiated UO_2 as over unirradiated UO_2, implying that the bulk of the Fe(II) oxidation occurred through simple chemical oxidation (e.g., by atmospheric oxygen) and that the rate was not significantly accelerated by radiation.

Experiments with cold UO_2 showed the rate of dissolution to be fairly well correlated by the simple expression,

$$\text{Dissolution Rate of } UO_2 \text{ (mg U/min,cm}^2\text{)} = 10\ M\ Fe(III)$$

It is of interest to note that this is the same relationship found for the reaction of metallic uranium with solutions of Fe(III) in dilute sulfuric acid.

Some previously reported experiments have been repeated with uranium metal wafers of more accurately known surface area. These indicate the rate of dissolution by boiling 4 M H_2SO_4 to be ca. 0.02 mg/(min)(cm^2) vice 0.05 mg/(min)(cm^2) previously reported and the rate of reduction of uranium(VI) in sulfuric acid solution to be 4×10^{-6} moles/(hr)(cm^2) vice 1.1×10^{-5} moles/(hr)(cm^2) previously reported.

Other experiments with cold uranium metal showed the rate of dissolution in boiling 4 M H_2SO_4 to be unaffected by the presence of dissolving stainless steel, in marked contrast to the behavior seen with UO_2.

Darex. One hundred pounds of stainless steel clad UO_2 rods were dissolved in the Darex pilot plant unit by the metered addition of 3 M HCl, 4 M HNO_3. The procedure

used permitted an approximate determination of the heat of dissolution for stainless steel. The measured value of 2700 Btu/lb. agrees fairly well with the 2300 Btu/lb. figure calculated from Thermodynamic data.

Studies were made to determine the effect of stainless steel concentration on chloride removal. Two solutions of the widely different stainless steel concentrations shown below were subjected to: concentration, continuous 60 per cent nitric acid addition, continuous water addition, and dilution. Starting with a solution 1.2 "M" stainless steel, 1.0 M UO_2^{++}, 2.7 M Cl^-, 5.1 M NO_3^- and 2.3 M H^+, final chloride concentration was 0.13 M (DF=21); starting with a solution only 0.12 "M" stainless steel, 2.0 M UO_2^{++}, 2.3 M Cl^-, 3.1 M NO_3^- and 1.0 M HNO_3, final chloride concentration was < 0.0007 M (DF >3200), indicating a liquid favoring chloride-stainless steel complex. With both solutions, the final free acid concentration was 0.3 to 0.4 molar.

Low carbon Hastelloy F, welded but unannealed, has shown good resistance to Darex solutions. After approximately 100 hours exposure to a variety of Darex conditions in the pilot plant dissolver, corrosion rates of 4 mils/month solution and 2 mils/month vapor were measured. The corrosion was general with a slight amount of intergranular attack. No preferential weld metal attack was observed.

Niflex. Installation of the Hastelloy F dissolver in 321 Building was completed and experimental work started. The first Niflex dissolution of 304-L stainless steel gave a terminal stainless steel concentration of 12.7 grams/liter after four hours' operation with a 1 M HNO_3 - 1 M NH_4HF_2 solution. Addition of more nitric acid was necessary before any further dissolution would occur to approach the normal laboratory saturation of some 22 grams/liter. Equipment operation was excellent.

Zirflex. Ammonia removal from the dissolver system in the Zirflex process has been one of the major difficulties in approaching maximum dissolution rates of Zircaloy. The boil-up rate, air rate, and refluxing condensate temperature all affect the rate removal of ammonia. Air sparging and water boil-off have been effective with cold condensate temperatures. By operating with a hot (85 C) condensate reflux, an air rate of 0.4 scfm/square foot of Zircaloy surface and a calculated boil-up rate of 11.7 pounds/(hour)(square foot) of Zircaloy, dissolution of 1/16-inch thick oxidized sheets of Zircaloy was complete in 2.7 hours. This rate exceeded those obtainable with cold condensate and approached the best values obtained under laboratory conditions.

Processing of Uranium-Molybdenum Alloy. The solids formed in the dissolution of uranium-3.0 w/o molybdenum alloy by nitric acid contain about 6 per cent of the uranium. Metathesis of these solids with sodium hydroxide is readily accomplished with small (< 0.1 per cent) loss of uranium to the supernatant liquid. The metathesis residue is readily soluble in nitric acid. In typical runs the combination of dissolver supernatant liquid and dissolved metathesis residue contained about 30 per cent of the molybdenum originally present in the alloy. The solution at 0.2 to 0.3 M free nitric acid and ca. 1 M in uranium can be made 0.2 M in sodium dichromate and boiled (plutonium oxidation step) without precipitation of solids. When plutonium(IV) is present during the dissolving of uranium-molybdenum alloy

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in nitric acid, the solids formed carry about 80 per cent of the plutonium. Metathesis of the solid with sodium hydroxide can be accomplished with negligible loss of plutonium to the metathesis supernatant liquid.

Attempts to prevent solids formation during nitric acid dissolution of uranium-molybdenum alloy by the addition of Versene (EDTA) have not been successful when the terminal acidity was low (< 2 M). Dissolution rates are reduced in the presence of Versene. Sucrose and glutamic acid appear to be more effective than Versene in preventing solids formation. However, low acid solutions completely stable to boiling have not been produced with either.

Further studies on the dissolution of uranium-molybdenum alloy in nitric acid - aluminum nitrate - ammonium fluoride were made. As stated previously, if the dissolution is made at boiling temperature a terminal acidity of about one molar can be achieved without appreciable solids formation if uranium concentration is no greater than 0.4 to 0.5 M, the F/Mo mole ratio is from 15 to 30 and the Al/F mole ratio is 0.5 or less. An Al/F mole ratio as high as one may be used if the dissolution is made at 80 C (other conditions the same) or when the dissolution is done at boiling if the terminal uranium concentration is 0.25 or less.

In all dissolution so far made with nitric acid - fluoride - aluminum solutions, a small amount (ca. 0.1 w/o of the initial alloy weight) of a brown solid was produced. This solid has not been characterized but has been shown spectroscopically to contain Al, B, Cu, Fe, Mg, Mo, Si, Sn, U, and Zr. When plutonium(IV) was present in the solution during the dissolution, about 0.2 per cent of the plutonium was carried on the brown solid. The solid is soluble in hot 10 M HNO_3.

Disengaging time studies simulating Redox extraction conditions were made comparing the behavior of a standard Redox feed with feed solutions prepared through nitric acid - fluoride dissolution of uranium-molybdenum alloy. No serious departure from standard Redox feed behavior was observed if the uranium-molybdenum feed preparation was done in Teflon or stainless steel equipment. Stable emulsions were formed with feeds prepared in glass equipment due, probably, to appreciable silica present. Batch extraction and mini-mixer-settler studies indicate that plutonium can be satisfactorily extracted from these feed solutions without a high temperature plutonium oxidation step. Dichromate must be added, as noted in a previous report, to prevent precipitation of what appears to be a plutonium molybdate, but it is not necessary to heat the solutions. As expected, increasing Al/F mole ratio and acidity favor plutonium extraction. Avoiding the high temperature oxidation step would materially reduce corrosion in the Redox oxidizer.

Solvent Extraction

Semiworks Redox Processing of Non-Production Fuels Feeds. A report, HW-58832, "Trip Report - Special Redox Runs at ORNL," by J. E. Mendel and K. J. Schneider, January 20, 1959, has been issued summarizing the currently available results of the experimental work performed by ORNL in October and November, 1958. ORNL has also agreed to perform a limited number of additional "cold" experiments. This work is in progress and will probably be completed in February.

Process Control Development

Combustible Gas Analyzer. The Davis combustible gas analyzer has been calibrated for hydrogen-air mixtures ranging from 0 to 3.5 per cent hydrogen. This unit is now being installed for use in the prototype Niflex dissolver.

Transient Pressure Measurements. Initial tests to compare the transient pressures produced when metallic sodium reacts with water or nitric acid have been carried out. Maximum pressures measured in the vapor phase above the reactants were about equal with nitric acid or water. However, the rise time of the pressure wave with nitric acid was about one-tenth of the time observed with water.

Boron Monitor. Development has started on a continuous monitor for boron concentration in the cold solution addition line to a Redox dissolver. Plans call for the development and use of a neutron absorptiometer for the detection of boron from 0.1 to 2.0 grams per liter. A control circuit will be supplied to stop further solution addition if the boron concentration falls below a predetermined level. Successful development and reliable demonstration of this monitor will permit approximately doubling the Redox capacity for dissolution of enriched materials.

Volumetric Calibration of a Process Vessel. A four line air purge dip tube system will be evaluated for precise measurement of liquid level in a vessel. Calculations indicate that such a system will provide an accuracy of 1 per cent or better. The read out of the system may be either manual with a precision manometer or automatic with a precision pressure transducer. A manual manometer read out should be satisfactory for the present application, and this method will be used in the pilot plant test.

Materials of Construction

A small vessel fabricated from one-eight inch thick Hastelloy F (vacuum melted) was exposed to failure in boiling 1 M HNO_3 - 2 M HF. Solution was changed twice a week to avoid excessive accumulation of corrosion products. Heat was supplied from the outside by a Glas-col mantle. Failure occurred after 1100 hours of operation at which time a pin-hole developed through a weld in the bottom of the vessel. General corrosion of the base metal in the vessel appears to have been considerably less than that observed in short term tests with coupons under similar conditions. The vessel was fabricated from a piece of four-inch pipe made by bending and welding a sheet of metal. The pipe was solution annealed (one hour at 2100 F - water quenched) before the bottom was welded on. The entire vessel was then solution annealed (2125 F - water quenched) before use. It is interesting to note that severe preferential weld metal attack occurred on the bottom weld but little if any preferential attack occurred on the seam weld.

A program of preparing special welding rod alloys for welding Hastelloy F is under way. The purpose is to find an alloy composition which will not suffer preferential weld metal attack in the "as welded" condition. Two alloys similar to Hastelloy F, both without niobium and one with nine instead of six per cent molydenum have been prepared. Weldments of vacuum melted Hastelloy F with these alloys as weld metal are being corrosion tested under Niflex, Sulfex, and Zirflex conditions.

Carpenter 20-Cb weldments with Carpenter 20-Cb weld rod suffered preferential weld metal attack in boiling dilute sulfuric acid. Similar results were observed previously when Carpenter 20 was used as the welding rod.

Corrosion of 304-L Stainless Steel and Titanium by Chloride-Containing Solutions Derived from Darex Feeds. Samples of stressed 304-L stainless steel and of unstressed A-55 titanium were exposed to boiling solutions simulating Redox oxidizer and waste concentrator conditions when processing Darex-derived feeds. Corrosion and tendency toward stress cracking in the stainless steel were determined as a function of the chloride content of the solutions. Free acid content in the oxidizer solution was 0.4 M while that in the waste concentrator solution was 0.0 M; chloride concentrations ranged from 0 to 50 grams/liter in the former and from 0 to 36 grams/liter in the latter. Samples were exposed for intervals of 24, 48, 72, and 96 hours; solutions were changed after each interval. All corrosion rates observed for titanium were less than 0.1 mil/month. Overall corrosion rates for 304-L were about 30 mils/month except at the high chloride concentrations where the rates dropped significantly in both solutions. Metallographic evaluation shows no evidence of stress cracking in these samples.

This spectrum is not typical of the spectra of fused salts reported in the literature which normally consist of opaque and transparent regions connected by steep transitions. It is believed that the transmission peak noted above is actually due to emission by uranium(III).

PRTR Fuels Processing

The great similarity of the proposed PRTR fuels and fuels which will be discharged from other power and propulsion reactors results in much of the experimental work already covered in this report under Non-Production Fuels Reprocessing being specifically applicable also to the PRTR interim processing program. This is particularly true on such work as mechanical processing, feed preparation, and materials of construction.

Plutonium Oxalate Filter

During the month satisfactory operating techniques have been developed for the oxalate disk filter being tested for possible 234-5 application. Efficiency tests have been conducted on 10 filter media and they indicate that 6 of the media tested are considered sufficiently efficient (greater than 99.5 per cent of slurry initially retained) to warrant additional testing. Filter media passing the preliminary efficiency testing include:

1. An aluminum oxide disc.

2. A sintered stainless steel wire mesh.

3. Two Dynel cloths of different weaves.

4. A Dynel felt.

5. A Polyethylene cloth.

On the basis of these encouraging initial studies a feasibility document is being prepared to assist 234-5 personnel in selecting the filter system to be used in the "Hot Button" Prototype.

PRTR Effluents

The plans for a 200 foot stack in the PRTR design prompted a recommendation to incorporate a stack sampler for particulates and gases in the exhaust air. A probe was designed which will provide adequately for sampling during anticipated release of contamination in the exhaust air.

Analytical and Instrumental Chemistry

X-Ray Photometry. Application of X-ray photometry to the non-destructive analysis of PRTR fuel cores was demonstrated. Using a 1/16-inch x 1/2-inch aperture and 75 PKV X-rays, a relative precision of less than 0.2 per cent was found for 0.5-inch diameter aluminum - 1.8 w/o plutonium rods.

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Application of this method to 0.5-inch diameter rods of plutonium impregnated graphite showed an absorption of 75 PKV X-ray equivalent to 5.93 mils of aluminum for each milligram of plutonium per cubic centimeter. The maximum error was estimated to be no greater than 0.3 mg Pu/cm^3 or 0.5 per cent relative on a typical piece containing 55 mg Pu/cm^3.

Analytical Services. UO_2, arc-fused between carbon and wolfram electrodes, was analyzed for electrode contamination. Carbon was determined within ± 50 ppm at 95 per cent confidence level by igniting in oxygen and absorbing evolved carbon dioxide on ascarite. Sensitivity for wolfram was 10 ppm - not lower because of dissolution uncertainties. Potassium hydroxide fusion demonstrated absence of wolfram metal.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Radionuclides in Reactor Cooling Water

Surface area measurements by gas adsorption techniques showed a reduction in surface area along the path of flow in the aluminum turnings used in studies of the removal of radioisotopes from reactor effluent water. The amount removed by a segment of the column was found to be an exponential function of the surface area of the turnings in the segment. This information is supporting evidence that greater removal is possible by this system than has yet been observed in the laboratory tests.

Reactor effluent radioisotope ratio measurements of $Zn^{69}:Zn^{69m}$ and $Zn^{65}:Zn^{69m}$ gave values between 7 and 85 hours as the average residence time in the reactor tube of the parent material from the time of entering until the activated products are released. Other isotope ratios including $Zr^{95}:Zr^{97}$, $Sb^{122}:Sb^{124}$, $Ce^{141}:Ce^{143}$, and $HF^{175}:Hf^{180}:Hf^{181}$ are being measured to provide further information regarding residence times of these various chemical elements in the reactor. Such measurements will aid in elucidating the processes responsible for radioisotope formation in reactor cooling water.

Geology and Hydrology

Silt and clay deposits, evidently correlatable to the Palouse eolian deposits beneath 200 West Area, were noted at depths of about 100 feet in wells flanking the Cold Creek anticline. These materials further define the land surface existing prior to erosion and subsequent deposition of the fluviatile gravels and Touchet sediments. An originally wide extent of the deposit is suggested and additionally that other uneroded areas might still exist. In 200 West Area this stratum effectively disperses and decontaminates wastes discharged to the ground above it.

Saturated samples of Touchet soil were subjected to centrifugal forces of 50, 100, 150, and 200 gravities for periods of up to 2 hours. The specific retention data obtained with these tests are in much better agreement when fitted to Terzaghi's gravity drainage equation than were similar data obtained at higher centrifugal forces. The results of two-hour centrifuge tests appear to be considerably affected by evaporation, as indicated by marked departure from the extrapolation of results from shorter runs.

Development of a suitable large-scale model for studying the movement of liquids beneath a crib was continued. A major problem is the development of an instrument for measuring moisture content at points across the model. Tests of electrical resistance probes showed some promise but a search for more satisfactory methods will continue.

Soil Chemistry and Geochemistry

Laboratory tests were performed to study the removal of strontium and rare earths from acidic sodium fluoride solutions by phosphorite rock. The dissolved material is incorporated in the fluorite (CaF_2) that results from this reaction. The reaction may have application for decontaminating acidic wastes. Final analytical data are not available but the preliminary results are not encouraging. A similar test with a column of gypsum also gave discouraging results.

Good removal of Cs^{137} from acidic solution was accomplished by the addition of sodium tetraphenylboron and passage of the solution through a bed of struvite ($MgNH_4PO_4$) or of potassium metaphosphate (KPO_3). This results in the formation of ammonium or potassium tetraphenylboron with cesium replacing the ammonium or potassium ion. The reaction proceeds satisfactorily from pH 1 to 9 and in the presence of molar concentrations of sodium, strontium, or aluminum. The resulting compounds float and are insoluble in aqueous solutions but can be dissolved in acetone.

A standard, homogeneous soil for laboratory soil chemistry work was prepared by compositing and wet screening samples taken during the construction of five test wells from depths ranging from 40 to 240 feet. Untreated carbonate, calcium-saturated carbonate, carbonate-free, and calcium-saturated, carbonate-free soils were prepared by chemical treatment of aliquots of the composited soil slurry. These soils will permit study of the influence of carbonate minerals on the removal of isotopes from waste solutions. Cation exchange capacities were measured for each of the four types of prepared soil; the measured values ranged from 10.4 to 13.0 meq/100g. The lower values were determined for carbonate-free soils, probably resulting from partial destruction of exchange material during the prolonged acid leaching required.

Ground Waste Investigations

Laboratory development work continued in an attempt to devise a technique for performing soil column adsorption experiments under conditions of unsaturated flow. To date no satisfactory method has been found.

Tests were made to measure the influence of strontium ion concentration on radio-strontium breakthrough curves. It was previously assumed that in the concentration range used in these tests (less than 1.0 ppm) the effect of strontium concentration variation would be negligible. Soil columns were run with solutions containing 1,000 ppm Mg ion and 1 ppm, 0.1 ppm and 0.002 ppm (tracer level) strontium. Breakthrough was found at 5.4, 7.3, and 7.7 column volumes, respectively. This degree of effect in the presence of 1,000 ppm Mg is more than can be explained by simple mass action and suggests the presence of some specific sorption sites for Sr.

Field Apparatus Development

A field test of the closed circuit TV camera was attempted; however, a break in the cable sheath allowed water to enter the camera and instrument failure resulted. The camera was repaired and waterproofed by using resin "potting" techniques.

A conductivity detection matrix was devised and assembled to follow the movement of dense electrolyte solutions in sand box models.

The seismic refraction equipment is being modified to improve stability in order to cope with the extreme temperature variations encountered in field operations.

Particle Studies

Microscopic sizing techniques were used to characterize the particle size of "cold" uranium abrasive wheel cuttings which pass through two-stage glass wool filters. The maximum particle size of the material not retained by the filters was 22 microns and 48 per cent by number was less than one micron. On a weight basis, 99.9 per cent of this material was greater than one micron and less than 22 microns in diameter.

Analytical Development

X-Ray-gamma ray coincidence counting techniques were successfully used to standardize solutions of K capture radioisotopes. Cr^{51} and Zn^{65} activities were determined to an accuracy estimated to be within one to two per cent. These standards are essential to proper evaluation of exposure measurements made for the Radiation Protection Operation.

Assistance was given to IPD, Equipment Development Operation, in formulating the tentative specifications for the development of a silver halide type ruture monitor.

L. P. Bupp

Manager,
Chemical Research & Development

LP Bupp:WOS:bp

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ORGANIZATION AND PERSONNEL

A. J. Scott, Engineer I, was transferred in from Fuels Preparation Department 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
P. Toback H. Barton	1/7-9/	Radiation Counter Lab Skokie, Illinois	Conduct training course on 256-channel analyzer and Hewlett-Packard Printer.	RJ Brouns	No
J. Peterson		Arva Corp. Seattle, Washington	" "		
E. Hilton		Hewlett-Packard Palo Alto, Calif.	" "		
P. Cohen	1/21/	Bettis Plant Westinghouse Pittsburgh, Pa.	Discuss corrosion contamination problems in reactor coolant system.	JM Nielsen LP Bupp	No
M. Cook R. Hoff	1/21/	Univ. of Calif. Radiation Counter Lab. Livermore, Calif.	Discuss Palm Program	WH Reas EE Voiland WL Lyon LL Burger LP Bupp	Yes
A. A. Garett M. J. Grolier	1/22/	USGS Ground Water Bureau Tacoma, Washington	Procure well data from Columbia Basin Irrigation Project wells adjacent to Hanford.	RE Brown WH Bierschenk	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. L. Moore	1/6-7/	Argonne National Laboratory Lemont, Illinois	Discuss separations chemistry.	S Lawroski	Yes
	1/8-9/	Brookhaven National Lab. Upton, L.I. New York	Present paper and attend conference on waste treatment.	B Manowitz	Yes
J. L. Nelson	1/6-10/	Brookhaven National Lab. Upton, L.I. New York	Conference on long-lived nuclide removal from wastes.	B Manowitz	Yes
L. C. Schwendiman	1/26/	Argonne National Lab. Lemont, Illinois	Discuss uranium melting equipment & technology.	S Lawroski JH Schraidt H Feder NR Chellew	No
	1/27/	Mine Safety Appliance Corp. Callery, Pa.	Discuss fuel element meltdown experiments.	S Rodgers JW Mausteller SI Winde	No
	1/29/	American Standards Assoc. New York, New York	Attend Meeting		
	1/30/	Brookhaven National Lab. Upton, L.I., New York	Discuss equipment for meltdown studies.	LG Stang CJ Raseman R Domish	No
D. W. Pearce	1/24-30/	Subcommittee on Radiation Washington, D.C.	Attend public hearings on waste disposal.		No
J. D. Ludwick	1/26-27/	Argonne National Lab. Lemont, Illinois	Discuss Washington Designated Programs.	MH Studier	Yes
	1/28-29/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss absolute calibration of radio-isotopes by coincidence techniques.	S Reynolds	Yes
	1/30/	Purdue University Lafayette, Indiana	Discuss X-ray proportional counting.	J Cobble	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
K. H. Hammill	1/28/	Flohr Company Seattle, Washington	Consultation with fabricators for cell liners.		No
D. L. Reid	1/26-29/	Savannah, Georgia	Attend ASTM Committee Meeting.		No
	1/30/	Savannah River Plant Aiken, South Carolina	Discuss hot laboratory facilities and analytical methods.	CH Ice	Yes

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

No significant changes occurred during the month.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Atmospheric Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits from the Prosser barricade were twice and from other stations about equal to values of one year ago. Values were as follow:

Collection Site	μc/g wet thyroid Average	Maximum	Trend factor
Prosser Barricade	2×10^{-3}	4×10^{-3}	+ 2
4 Miles SW of Redox	1×10^{-3}	3×10^{-3}	- 2
Wahluke Slope	9×10^{-4}	2×10^{-3}	-

Fission products occurred in rabbits in the following amounts:

Sample Type	μc/g wet material Average	Trend Factor
Feces	1×10^{-4}	-
Bone	5×10^{-5}	-
Liver	1×10^{-5}	- 2
Muscle	8×10^{-6}	- 2

Columbia River Contamination

Contamination levels of beta emitters in river organisms collected within and downstream from the Hanford Reservation were about twice those of one year ago for fish and comparable to one year ago for waterfowl. Values were as follow:

Sample Type	Location	μc/g wet wt. Average	Maximum	Trend Factor
Minnows (entire)	Hanford	2×10^{-3}	3×10^{-3}	- 2
Whitefish flesh	Ringold	9×10^{-4}	1×10^{-3}	-
Diving duck flesh	Hanford Reservation	3×10^{-3}	5×10^{-3}	
River duck flesh	Hanford Reservation	1×10^{-4}	1×10^{-3}	

Effect of Reactor Effluent on Aquatic Organisms

Monitoring of effluent from the 100-KE reactor continues not according to plan because of mechanical difficulties with the pump which supplies the effluent sample to our laboratory. The mortality of all lots held in dilute effluent (even at the 2.5 per cent strength) continues greater than in the control.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Strontium

The results from the 200-day animals of the retention experiment, and from the 146-day animals of the chronic study with weanling rats, agree well with earlier data and continue to follow established trends. The 200-day animals of the chronic study have been sacrificed, but samples are waiting equilibrium prior to radioactivity measurements.

The gastrointestinal absorption of Sr^{90} orally administered to mature swine essentially ceased within 10 hours after administration, with less than 10 per cent having been absorbed. Blood levels approached 50 per cent of maximum within an hour after administration.

The exponents of the power functions for the rate of urinary excretion of orally administered Sr^{90} in swine four months and two and one-half years old were found to be equal, although the percentage of retention by the four-month-old swine was more than four times that of the mature swine.

The third of a group of three miniature pigs intravenously injected with 24 Mc of $Sr^{90}Y^{90}$ died this month, 102 days after administration. It showed a generalized infection, to be expected from its lack of granulocytes.

A second cropping has been completed on soil previously contaminated with Sr^{90} in both soluble and insoluble forms. The second cropping is essentially no different from the first with the soluble forms of strontium (the nitrate and chloride) absorbed approximately 10-fold more readily than insoluble forms (CO_3, SO_4, HPO_4, F_2, C_2O_4, and $(OH)_2$). This difference persisted in the acidic Cinebar soil and this same general difference was also observed with Ephrata and Millville soils except that in these soils $SrCO_3$ and $Sr_3(PO_4)_2$ were much less available than were the other insoluble compounds. It is quite surprising that a soil with the large exchange capacity of Cinebar soil does not with time show movement of the Sr^{90} ion over to the soil complex. It appears that the forces by which the soil particles bind the strontium must be relatively slight. Otherwise the equilibrium of ions in solution should be in favor of movement of the Sr^{90} from the low concentration insoluble Sr^{90} precipitates over to the much greater exchange complex of the soil.

Iodine

The C/D (ratio of radioiodine in the thyroid to the quantity fed daily) of sheep increased slightly, a probable manifestation of cold weather. The only exception was the group fed 1.5 μc/day which shows some evidence of thyroid damage. (Due to electronic difficulties with the swine scintillation detector, no positive statement can be made on the C/D's in swine.)

Cesium

Bean plants cultured in nutrient solution containing from 0.05 to 30 meq. K/l were tested for their Cs^{137} content after 12 days' growth in the test solutions. Cs^{137} was present in all nutrient solutions during the growth period and potassium was added as the nitrate with total nitrogen balanced by addition of NH_4NO_3. The mean concentration of cesium in leaf tissue varied from 0.20 μc/g in the presence of 30 meq. potassium to 0.26 in the presence of 0.05 meq. potassium. This difference of 0.06 was not significant in the light of the standard errors (± 0.08). A somewhat greater difference was observed in cesium content of stems with concentrations of 0.9 and 0.2 μc Cs^{137}/g dry tissue, respectively, in the highest and lowest potassium concentrations. In both stems and leaves the values between the extremes are intermediate and consistent with the possibility of a very slight effect of potassium on cesium concentration. At the lowest potassium concentration, there was approximately a 25% reduction in dry weight of leaves.

Plutonium

Experiments were completed studying the therapeutic effect of intraperitoneally administered DTPA at dose levels ranging from 0.005 to 1.5 mM/kg. The lowest dose level was effective in reducing liver deposition to approximately 50% of the controls but had no significant effect on the skeletal deposition. A dose of 0.15 mM/kg reduced skeletal deposition to less than 20% of controls, and liver deposition to less than 10% of the controls. Higher dose levels produced only slightly increased therapeutic effect. Repeated treatment with a dose of 1.5 mM/kg at 1, 5 and 21 hours following plutonium injection was not superior to a single dose at 1 hour. A dose of 6.0 mM/kg administered intragastrically with calcium gluconate reduced skeletal deposition to 24% of the controls and liver deposition to 18% of the controls. This was roughly equivalent to the effect produced by 0.05 mM/kg administered intraperitoneally, suggesting that the absorption of DTPA may be of the order of 1%.

Conclusions made on data obtained from miniature swine injected over two years ago with Pu^{239}-IV citrate or nitrate intravenously (IV), intratracheally (IT) and intragastrically (IG) are as follow:

1. The percentages of the administered dose retained 15 to 18 months after plutonium administration was 70 per cent for IV, 0.01 per cent for IT and 0.0008 per cent for IG administration. These percentages of the administered dose retained following IG and IT administration represent about a 20 to 30 per cent decrease. (This may be partially explained by the comparatively low liver retention soon after administration by the intravenous route compared with the other two routes.)

2. The rate of urinary excretion of Pu^{239} following IV administration in the period from one day to 600 days can be described by a two-power function, the break being observed between 10 and 30 days, as other workers have found.

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3. The amounts of Pu^{239} excreted in the feces and urine during the first 40 days following IV administration were similar. After that time, the amount in feces was less than that in urine.

4. The urinary excretion rates following IT injection increased during the first ten days and then paralelled that following IG administration.

5. Following IT administration almost all of the Pu^{239} administered was excreted via the feces.

Radioactive Particles

Gross examination of mice for pathology after exposure to $Ru^{106}O_2$ and $Pu^{239}O_2$ aerosols is continuing. Lungs of mice killed 70 weeks after exposure to $Pu^{239}O_2$ retained two per cent of the Pu^{239} deposited.

Three sheep were exposed to I^{131} vapor and three to AgI^{131} aerosol. For both materials the I^{131} content of the thyroid attained a maximum value at 20 to 30 hours after exposure. The biological half-life was about five days. Tests on "insoluble" AgI^{131} particles show them to be two per cent soluble in water and 34 per cent soluble in Ringer's solution at 37 C.

Gastrointestinal Radiation Injury

In a new experiment, 50 rats are receiving 100 μc of Y^{90}/day, 50 are receiving 500 μc/day, and 50 are being exposed to the same external beta radiation dose as the other two groups and will serve as controls for these studies. This experiment is in the second week of an eight-week exposure period. Its purpose is to determine the aging effects of repeated intestinal irradiation. Longevity and pathologic damage are to be the principal criteria of effects.

Studies are continuing on the basic mechanisms involved in the actions of the DNase enzymes in the intestine. These include the effect of pH, time and intrinsic inhibitors. Normally the intestine is rich in DNase I which is held in check by an inhibitor thought to be protein in nature. The inhibition of activity decreases on being stored. The effect of radiation on this inhibitor is currently being studied. The results may be related to the sensitivity of the gut to radiation.

Microbiological Studies

Yeast strains, which by virtue of their low catalase content are unusually sensitive to radiation were not protected from X-ray damage by addition of catalase to the suspending medium during irradiation. These results coupled with those previously reported indicate that radiation protection to the cell derives from catalase within the membrane but not from catalase exterior to the cell. Thus indirect damage as measured here does not seem to originate exterior to the cell.

HA Kornberg

Manager
BIOLOGY OPERATION

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C. OFF-SITE VISITS AND HAPO VISITORS

Name	Dates of Visits	Company or Organization Represented/Visited	Reason for Visit	Personnel Contacted	Access to Rest'd.Data	Areas & Bldgs.
Dr.Ulrich Hagen	1/2/59	Heiligenberg Institute Germany	Discuss research	HA Kornberg and Staff	No	100-F, 108, 141,146
AFSWP personnel	1/6/59	Armed Forces	Tour facilities	DE Warner, RF Foster, LK Bustad	No	" "
A. S. Obermayer	1/19/59	Tracerlab, Inc.	Discuss research	JF Cline	No	" "
HP Singleton and 36 staff members	1/27/59	Prosser Irrigation Expt. Station	Discuss research	FP Hungate	No	" "
Dr. Norton Nelson	1/29/59	New York Univ rsity	Discuss inhalation studies.	WJ Bair	No	" "

VISITS TO OTHER INSTALLATIONS

H.A. Kornberg	1/7-10/59	Medical School, Portland	Seminar.	Goodman	-
		U. of Wash., Seattle	Discuss fellowships	Carlson	
W.J. Bair, R.T. O'Brien J.D. Stewart	1/13	WSC, Pullman	Address seminar. Discuss research.	-	-
W.J. Clarke	1/9-10	ORNL, Oak Ridge	Bone marrow conf.	Hollaender	-
L.K. Bustad	1/13-14	AEC Field Office and Nevada Test Site	ANP Committee	Barnes, et al	-
W.J. Clarke and JR McKenney	1/22-23	U. of Utah, Salt Lake City	Discuss studies on bone-seeking isotopes	Dougherty, Stover, Rehfeld	-
R.F. Foster	1/24-29	Wash. D.C. and Cleveland, Ohio	Congressional Hearings. USPHS meeting.	-	-
F.P. Hungate MP Fujihara PA Olson	1/30	U. of Wash., Seattle	Discuss radiobiological research.	Ordal	-
R.C. Pendleton	1/17	Lewiston, Idaho	Address Idaho State Radiological Society	McRoberts	-

D. Lectures

a. Papers presented at meetings

R.C. Pendleton, "Fallout in Perspective," Idaho State Radiological Society, Lewiston, Idaho, 1/17/59.

b. Off-site Seminars

H.A. Kornberg, "A General Survey of Biology at Hanford," University of Oregon Medical School, Portland, Oregon - January 8, 1959.

W. J. Bair, "Inhalation of Radioactive Particles," WSC, Pullman, Wash., January 13, 1959.

L. A. Temple, "Radiation Biology at Hanford," Marine Corps Reserve, Pasco, Washington, January 14, 1959.

K. F. Foster, "Research and Development Programs Associated with Disposal of Radioactive Liquid Wastes. B. Low and Intermediate Level Waste. 1. Surface Waterways," Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Washington, D.C., January 29, 1959.

c. Local Seminars (Biology)

B.J. McClanahan, "Some Analytical Applications of Ion Exchange Resin," January 14, 1959.

P. A. Olson, "Temperature Tolerance Studies on Chinook Salmon," January 14, 1959.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

January, 1959

ORGANIZATION AND PERSONNEL

There were no changes in personnel during January.

OPERATIONS RESEARCH ACTIVITIES

Input Output Simulation Model

Work with Procedures and Computing personnel on the programming of computational procedures and the processing of the first set of plant data was continued. In addition, a series of lectures are being presented to interested plant personnel on the use of this general method as a tool in the investigation of causal interrelationships.

Business Descriptions

Work continued on the effort to develop a scientific description of a business. In particular, efforts have been directed toward trying to separate those numbers used in the control of a business which represent experimental fact from those which are theoretical interpretations based on assumptions concerning the behavior of the enterprise.

OPERATIONS ANALYSIS STUDIES

NPR Spare Part Procurement

Work on a model for guiding the procurement of spare parts for the NPR was completed during the month and a report issued. Assistance in utilizing the method presented will be provided as required.

CPD Control Study

A final report on this study was issued during January (HW-58749, 1-5-59).

Z Plant Information Study

Due to the availability of Automatic Production Recording equipment belonging to the Research and Engineering Operation of CPD, effort during the month was directed toward the testing and implementation of previous analytical developments using this equipment. A detailed test program involving one segment of the Z plant production process is being prepared and incorporated into a proposal for review by production personnnel. If this test is approved, it will provide much valuable information concerning the practical problems involved in implementing the control principles previously developed.

FPD Process Control and Experimentation

Statistical consultation was provided in connection with an experiment to locate the optimum combination of preheat and submerge times in the canning cycle. Since several characteristics will be measured for the fuel elements prepared during this experiment, analysis will require a definition of fuel element quality as a whole unless the quality measurements under consideration all reach their respective optima at approximately the same combination of preheat and submerge times.

Data from two experiments concerned primarily with the porosity of fuel elements were analyzed. The first concerned the effect of the hydrogen content of the salt bath, and the second the effect of the method of quenching. Additional analysis of dimensional changes during the second test led to unexpected results, and plans have been made for further substantiating experimentation.

In connection with the acceptance sampling of uranium cores, extensive analysis relating reactivity of the cores to such variables as impurity content, weight, density, geometry, and rod position has been completed. Also sonic orientation resonance tester measurements on a shipment of dingot material were analyzed to obtain a statistical description of ingot differences and a comparison with previous shipments.

Evaluation of Fuel Element Performance

In connection with preparations for the Quality Certification Program, variables measurements were performed on selected samples representing three days production. The primary purpose of this work was to determine what sample sizes would be required for each of the measurements under consideration. The sample size requirements were computed from a process control standpoint, since information adequate from this standpoint would also be adequate from a quality certification standpoint.

A report was issued on the development of a quality index which appropriately combines the different measured characteristics of a fuel element. The index derived from a questionnnaire circulated to knowledgeable individuals throughout the plant was presented.

Analysis of Fuel Element Failure Data

In connection with the prediction of rupture rates for uniform corrosion ruptures, attention is being given to the variation of the reactor variables associated with a given fuel element around the nominal or maximum value. In view of the strong dependence of corrosion on these operating variables, the extent of these deviations from the average or maximum becomes an important consideration in predicting corrosion. A formula was derived expressing corrosion rate as a function of maximum power taking into account this variability, and work in this area is continuing.

Radiation Protection Precision and Accuracy Study

Work has started on the scoping phase of a study to evaluate the precision and accuracy of current whole body exposure estimates. The goal at this stage of the study is a detailed flow chart of the data generation mechanism used to obtain exposure estimates with an indication of those areas where further study of the precision and accuracy is needed. At the present time, emphasis is being placed on obtaining a better understanding of the many variables associated with film processing.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Separations

A statistical analysis of Zircaloy-2 high temperature rupture data was completed for the Fuels Development Operation. Correlation techniques were utilized to investigate the dependence of rupture time on temperature and transverse and longitudinal stress for annealed and cold-work material.

Discussions were held with Physical Metallurgy Operation concerning further analysis of data from an experiment to investigate uranium hardness as a function of irradiation time and certain annealing variables. The original analysis suggested that further experiments could profitably be done to fill out the experimental design so that more sophisticated statistical techniques could be used to investigate the functional dependencies. Data from these additional experimental runs are now being analyzed.

At the request of a member of Chemical Engineering Development Operation, a mathematical model for the kinematic behavior of isotopic gases in a Clusius-Dickel Thermal Diffusion Separation column was developed. The theory for binary mixtures has long been well known, but that for ternary and higher order mixtures is considerably more complex.

4000 Program - Swelling Studies

Further discussions were held with Fuels Development Operation concerning methods of estimating the distribution of diameters and centers of gas bubbles in irradiated uranium. Utilization of the method based upon measuring the rate by which gas escapes from a molten irradiated uranium sample and rises through a known depth of unirradiated molten uranium depends upon the knowledge of the relationship between rising time and bubble radius. Current efforts are directed toward solving a non-linear differential equation which expresses the functional dependency of bubble rising velocity on the parameters of the system.

6000 Program - Biology

A mathematical model has been deduced which gives promise of quite general applicability to problems involving description of organ or bone growth and of uptake and retention of radioactive materials. Preliminary deductions from the model yield, among other things, a modified form of the so-called "power law" which is in widespread use among radiobiological scientists to

mathematically describe excretion rates and retention curves. The result is that at least some theoretical support is now provided for the hitherto strictly empirical "power law." Attempts are currently being made to test the model using the data from past experiments.

Further consultations were held with Radioecology Operation concerning statistical analysis of data from an uptake and retention experiment within an aquatic community.

Further consultation was held with members of the Experimental Animal Farm Operation in connection with a proposed long term Sr-90 feeding experiment with swine, which is to begin in the near future. Among the objectives of current discussions is the determination of optimum numbers of animals to be placed at each dosage level of feeding.

Work continued on a life testing scheme for use in the statistical analysis of data from miscellaneous fish tests. The proposed scheme makes use of observed times of death which are available from daily pick-off records maintained during the normal course of the tests.

6000 Program - Atmospheric Physics

Work continued on a formal report jointly authored with the Atomospheric Physics Operation discussing the derivation and utilization of statistical techniques for analyzing data from next summer's Air Force-AEC diffusion and deposition study.

General

Discussions were held with personnel of the Analytical Laboratories Operation concerning the estimation of the precision of radiochemical analyses based on low-level counting statistics with appreciable background. Counting methods using fixed total count random time schemes were suggested which lend themselves to precise statistical analysis. The general area of resolving multi-channel analyzer counts was also discussed and a method suggested which possibly could be programmed as a digital computer routine to accomplish the allocation plus precision statements directly from a card punch of the multi-channel total count as read out from the analyzer.

Assistance was given in developing the theory and mathematical methods for a new experimental method of determining the thermal conductivity of materials. Unique to this method is the Stephan-Boltzman radiation of the sample into the interior of a black body.

A statistical analysis of spot sampling data from positive plutonium deposition cases was performed for the Bioassay Operation to determine the operational characteristics of a 24-hour deposition estimation procedure based on a spot sample and accompanying void time information. The results of the analysis were sent to interested persons.

[redacted]

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Analytical investigations continued on the electrical circuit analogue model of the eddy current testing method for fuel element defects. Further mathematical analysis was also conducted on the theory of wave propagation in elastic media.

Irradiation Processing Department

Data have been submitted by one of the vendors for the proposed high speed scanning nuclear monitoring system in support of its conformance to reliability specifications. These data have been analyzed in order to arrive at an estimate of the over-all system reliability.

A multiple regression is being computed relating prediction errors in connection with reactor start-ups to nine independent variables.

Chemical Processing Department

Calculations were performed in connection with the preparation of the tolerance statement necessary to demonstrate conformance to specifications for the final product parts shipped during the fourth quarter of calendar year 1958.

Relations and Utilities Operation

Work continued on the statistical analysis of age and sex specific mortality data from Richland during the ten year period ended December 31, 1957.

Further work is being done on the inventory and B-PID estimates described in HW-56536, "B-PID and Inventory Estimates with Minimum Variance." The properties of these estimates are being examined in more detail and the practical use of the method is being examined by applying it to over-all HAPO production data from January, 1952 through December, 1958.

Consultation was given SS Measurements personnel with regard to the amount of sampling necessary to obtain factor weight estimates having a given precision.

General

Assistance was provided salary administration personnel in devising a method to evaluate the new nonexempt position evaluation system.

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
None					

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
Carl A. Bennett	1/13-1/14	Amer. Soc. for Qual. Control Conference Los Angeles, Calif.	Presented paper	GE Ghormley	No

PROGRAMMING OPERATION
JANUARY 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. Nonproduction Fuels Dissolving Process Study

The complex processing chemistry and engineering involved in the establishment of a dissolution facility for the variety of nonproduction fuels encouraged consideration of many alternate proposals and unconventional techniques. As a result, a simplified, critically safe, total dissolution facility was scoped and submitted to appropriate Chemical Processing Department and Chemical Research and Development Operation personnel. This proposal involves the use of the circulating "spray-tray" type dissolution of integral (unsectioned), full length, fuel elements. Intermediate solution hold-up vessels in the dissolving circuit are small enough to assure critical safety for any of the anticipated low enrichment fuels. This proposal affords major simplifications over conventional head end processing involving mechanical chopping, leaching of cores, and separate chip disposal by mechanical or chemical means.

2. Uranium Value Study

Significant effort was devoted to consultation rendered to Irradiation Processing Department personnel concerning analytical treatment of diffusion plant economics basic to more elaborate studies of the interrelationship between irradiation, separation and diffusion plant costs and process variables.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

PRTR Fuel Burnout Computations

The final report on the first part of the study of PRTR fuel burnout, isotopic and fission product compositions was completed. ("Fission Yields, Compositions, and Activities of PRTR Fuels - Part I" by J. G. Bradley, 1/14/59.) This report describes variations in core composition of Pu-Al spike and natural UO_2 assemblies during irradiation at constant flux. Data are presented in tabular and graphic form. Effects of burnup rates and resultant compositions on scheduling and shielding are shown.

Characterization of Stainless Steel Cladding

Substantial progress was made in an economic analysis of stainless steel cladding for two types of fuel elements. Two fuel types were considered, tube and tube and seven-rod cluster, with uranium enriched to 0.85 wt % U-235. In the tube-tube case 27 mk decrease in thermal utilization

resulted, as compared to 21 mk for the cluster. The change in thermal utilization when replacing 20 mil zirconium with 7 mil stainless steel was calculated using the P_3 method. The GPR code was then used to calculate attainable exposure for plutonium recycle as well as single pass operation. For purposes of an economic evaluation, computation runs were made with 25 enrichment varying from 0.65 wt % to 2.00 wt %. A spectral index of r = 0.065 was used in all cases. Neutron temperature for the tube-tube element was calculated to be 560 C as compared to 400 C for the cluster. Results of the economic analysis are not yet available.

Fuel Cycle Analysis

IBM 650 calculations which compare the reactivity worth of reactor occurring plutonium with uranium-235 as a source of enrichment in uranium-238 were essentially completed. The calculated exposures for all cases are derived from one set of lattice constants (f_o = 0.899, p_o = 0.906 for a natural uranium loading). The effective reactor size was varied by the use of three values of $\bar{k}_\infty/\epsilon$; namely, 1.05, 1.15, and 1.30. The four plutonium compositions used in the study are as listed below.

	Weight %			
	1	2	3	4
Pu-239	100	75.2	52.95	31.35
Pu-240	0	19.5	30.12	33.59
Pu-241	0	4.92	14.28	24.96
Pu-242	0	0.38	2.65	10.10

Cases compared are those in which the weight of plutonium-239 plus plutonium-241 is set equal to a given weight of uranium-235, and both cases are then computed with the same value of $\bar{k}_\infty/\epsilon$.

As an example, 1.5% U-235 and 98.5% U-238 in a reactor requiring a $\bar{k}_\infty/\epsilon$ of 1.05 yielded an exposure of ≈ 20,950 MWD/T (1.62 fission pairs per initial fissile atom). This is directly compared to 1.18% Pu-239, 0.67% Pu-240, 0.32% Pu-241 and 0.06% Pu-242 and 97.77% U-238 which yielded about 23,500 MWD/T (1.86 fission pairs per initial fissile atom) at a $\bar{k}_\infty/\epsilon$ of 1.05. In this case plutonium enriching yielded a greater reactivity lifetime than did U-235 enriching. However, this is not always the case. Unlike U-235 enriching of U-238, the use of plutonium introduces the fertile material Pu-240 which absorbs neutrons to produce fissionable Pu-241. Pu-241 yields more neutrons per absorption than either Pu-239 or U-235 and is a superior source of enrichment. On the other hand Pu-241 also forms Pu-242 which is a neutron parasite similar in behavior to U-236. As a consequence, a complex interplay occurs which makes it difficult to state the relative value of various plutonium compositions as enrichment materials. Generally speaking, plutonium containing substantial amounts of Pu-240 and Pu-241 is superior to U-235 enrichment (from an attainable reactivity lifetime standpoint) for reactors having good neutron economics (low values of $\bar{k}_\infty/\epsilon$). On the other hand in reactors with poor neutron economy, where neutrons are not available for "banking" in Pu-239-Pu-240 to form Pu-241, U-235 enrichment yields a longer reactivity lifetime.

A more complete analysis appropriate to long range planning must include analysis of the U-235 and U-236 mixtures which will inevitably result with prolonged recovery and reuse of U-235 from thermal reactors. This effect has not been incorporated into studies performed to date.

Phoenix (Long Burning) Plutonium Fuel Studies

The Litton computer was employed for evaluating Pu-240 self-shielding and spectrum shift effects in plutonium-only fuel irradiations. With the lattice conditions used, the fuel compositions studied lost both reactivity and specific power generation more rapidly than the fixed-cross-section, fixed-spectrum cases run earlier on the IBM-650 computer. "Phoenix" or long-burning behavior is evidently associated with a different initial fuel composition in this type of cycle. Indications are that higher initial 240 content and lower fuel density are the main requirements. The results are also sensitive to the poorly-known Pu-242 cross-section, which also should be self-shielded to some extent. The Litton calculations will be continued for two or three weeks while FORTRAN programs are being written for the IBM-709 computer.

RBU Computer Code Development

Debugging of all major sections of the RBU computer code was completed. Linking sections, input-output routines, and the cross-section library have yet to be finished and this work will require considerable attention from Hanford personnel. American-Standard is somewhat behind schedule, but it appears the code will be usable for some types of problems within two months.

Methods for Measurement of Effective Cross-Sections

Study was devoted to possible experimental techniques for the direct measurement of absolute effective cross-sections. Most of the few methods used in the past are expensive in terms of time and effort, but some new techniques which rely on interpretation via the RBU or similar computing codes are being given further study.

PRTR Physics

Scope modifications of the shim rod design were studied at some length. The combined requirements of 2.2 lb. maximum weight, 70-75 mk total strength for the system, and a one year burnout life appear to restrict the poison material in the floating rod design to cobalt or a high-cobalt alloy. Alternatives using self-shielded high-cross-section materials exist but have not been considered because of their greater cost and complexity as compared to cobalt. The poison material in the screw-type rod design is less restricted because of the absence of limitation to 2 lb. maximum weight.

C. 6000 PROGRAM

Radiological Consultation

Consultation was provided on the evaluation of total body dose from mixtures of isotopes, selected aspects of recent recommendations of the ICRP, maximum permissible level for thorium, Columbia River emergency plans, and on potential methods for partially decontaminating present reactor effluent water. In conjunction with others, a report was prepared which elucidates the present level of knowledge on the release of fission products from heated, irradiated uranium.

D. OTHER ACTIVITIES

Lectures were given to members of the current AFSWP class. Arrangements for the next Science Colloquium, which features Dr. Hadley Cantril speaking on "The Nature of Perception" were finalized. The colloquium will be held on March 5.

Manager, Programming

LH McEwen:dl

VISITS TO HANFORD:

Name	Date of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
None						

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. W. Healy	1/6-7	General Electric Company San Jose, California	Attended meeting of GE Reactor Safeguards Council.	K. P. Cohen	Yes
	1/8	General Electric Company San Jose, California	Toured Vallecitos Atomic Laboratory.	J. M. Smith	No
	1/28-30	Joint Committee on Atomic Energy Washington, D.C.	Reviewed information available on waste disposal problems.	Dr. A. Wolman K. Z. Morgan F. L. Culler J. A. Lieberman	No
L. H. McEwen	1/26	General Electric Schenectady, N.Y.	Information exchange.	H. E. Stevens R. Erlich H. C. Towle F. C. Robertshaw	No
	1/27	General Electric Schenectady, N.Y.	Technical liaison	C. G. Fick (GERL) J. L. Michaelson (GEL)	
J. R. Triplett	1/29-30	American Standard Atomic Energy Division Mountain View, Calif.	Computing contract consultations.	E. J. Leshan	No

VISITS TO OTHER INSTALLATIONS (CONTINUED)

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. A. Eschbach	1/22-23	GE Defense Electronics Philadelphia, Pa.	Confer on plutonium fuel systems and fuel design.	E. Schmidt	No
	1/24	RCA Victor Division Lancaster, Pa.	Discuss high vacuum techniques.	W.N. Parker	No
	1/26	Oak Ridge National Lab. Oak Ridge, Tenn.	Confer on plutonium fuel systems and fuel design.	Paul Kasten	Yes
	1/27	AEC-Div. of Reactor Dev. Washington, D.C.	" "	W. N. Munster A. Giambusso D. B. Coburn	Yes
	1/28-29	Columbia University New York, N.Y.	International Fuels Symposium	H. Hausner	No
	1/30	MIT Boston, Mass.	Confer on plutonium fuel systems and fuel design.	M. Benedict	No

RADIATION PROTECTION OPERATION
MONTHLY REPORT - JANUARY 1959

A. ORGANIZATION AND PERSONNEL

G. L. Andersen was reactivated from military leave on January 12, 1959. Luese W. Powers was removed from the payroll on January 29, 1959. Shirilee H. Payne was placed on leave of absence effective January 30, 1959.

B. ACTIVITIES

No new cases of plutonium deposition were detected. The total number of plutonium deposition cases is 226.

Two Hanford employees who visited Oak Ridge reported that bioassay samples were collected from them at that site. Informal reports to them before returning to Hanford indicated that a positive indication of Sr^{90} deposition had been detected in the bioassay samples obtained at Oak Ridge. Subsequent sampling at Hanford confirmed a minor intake of Sr^{90}. The total amount of initial deposition was estimated to be approximately 0.04 μc (about 5 per cent of the maximum permissible body burden).

Difficulty with the burial of ruthenium-contaminated equipment from the Redox plant resulted in wide-spread particulate contamination down wind from the burial site both inside and outside of the 200-W Area. A number of private and government vehicles and equipment were contaminated. By month end the particle frequency had greatly diminished due to decontamination efforts and weather. The particulate deposition extended to a distance of several miles southeast of the 200-W Area. At the periphery of the affected area the particle frequency was about 30 particles per thousand square feet. Checks of six involved employees on prototype equipment in the Shielded Personnel Monitoring Station (SPMS) indicated no significant deposition of Ru^{106}. The residence of one employee was surveyed as a result of the spread of particulate contamination. No significant contamination was detected.

An attempt to make an aerial survey of and around the 200-W Area on the day following the burial difficulties was not successful. Further studies of aerial survey techniques are in progress.

The SPMS was accepted from the contractor for occupancy. Most of the equipment required for the facility is on site and under current test. Modification of an X-ray stand to permit positioning of the crystal detectors was completed. Several employees attended the RCL school on operation of the 256-channel analyzer for this facility.

One localized exposure above permissible limits occurred to a CPD employee as a result of glove contamination. The maximum estimated dose was 15.6 rads including 0.6 r.

The analysis of the exposure of employees to whole-body penetrating gamma radiation was completed for 1958. A comparison of the 1958 experience with previous years is contained in the following table:

	1956*	1957	1958 by Suffix						1958
			4000	5000	6000	7000	8000	9000	Const.	Total
≥1r, penetrating	695	729	3	647	219	73	1	7	23	973
≥2r,	221	238	0	319	67	23	0	1	0	410
≥3r,	11	23	0	1	3	0	0	0	0	4**
≥4r,	4	0	0	0	0	0	0	0	0	0
≥5r,	0	0	0	0	0	0	0	0	0	0

* For 1956 only, all of 17 kev X-ray component is included.
** Maximum: 4.19 rads including 3.21 roentgens.

An explosion in the hood of the cut-off box in "B" Cell, 327 To Building, caused skin and hair contamination up to one rad/hr on three employees. Prompt decontamination limited the maximum external exposure to 250 mrads. A check of the involved employees in the SPMS indicated less than 0.1 μc of gamma emitters was deposited in the employees.

The release of I^{131} to the atmosphere continued to fall well within working limits. The average emission rate was 3.5 curies per week. The fallout of nuclear debris occurred throughout the pacific northwest generally from January 20 through January 24. Gamma analysis of air samples showed an isotopic distribution equivalent to about 100-day old material which could correspond to the Nevada tests in late October 1958 and reported Russian tests during the first week of November 1958.

Several members of the RPO staff participated in a detailed training exercise involving the use of an X-ray spectrometer for the evaluation of film following its exposure to doses in excess of 50 r. Purchase of a simplified model of an X-ray spectrometer was authorized for the evaluation of film exposed to disaster level gamma doses.

The new ionization type finger ring which is based on a miniaturization concept, permitting direct application of the pulse reader technique, was tested in a prototype form and was found to be very sensitive. A sample ring was constructed of plexiglass tubing with a hollow, circular cavity containing two circular electrodes. Its design results in a smooth, comfortable device that gives promise in avoiding the discomfort features of existent film type dosimeter rings.

Preliminary guides were prepared for activating the Columbia River emergency contamination plan which is part of the AEC-HOO procedure for emergencies.

Consultation was provided to Legal and Financial personnel on suggested modifications to contracts involving the need for special considerations required by vendors in the handling of materials furnished by the Company.

Authorization for installation of a refrigeration system for the Van de Graaff electron accelerator was approved. This equipment will cost $3,000 and will eliminate the need for week end overtime.

C. EMPLOYEE RELATIONS

Material was gathered for Union Relations personnel for the Wonacott Case.

There were two medical treatment injuries for a frequency of 0.90. No security violations occurred during the month.

[redacted]

One suggestion was submitted by RPO personnel. One evaluation was completed. Three suggestions are pending in RPO for evaluation. No awards were made.

The RCL school on operation of the 256-channel analyzer was attended during the month by R. M. Bernard, G. D. Brown, and R. H. Wilson.

A twenty-four hour course sponsored by IBM was attended by W. V. Baumgartner.

D. SIGNIFICANT REPORTS

HW-59093 Waste Disposal Monitoring Activities Summary, January 1959, by K. F. Baldridge.

HW-59092 Regional Monitoring Activities, January 1959, by B. V. Andersen.

Undoc. Inventory of Radioactive Wastes to Active Disposal Sites, November 1958, by K. F. Baldridge.

HW-58312 Columbia River Flow-Time Calculations by J. K. Soldat

HW-59076 Monthly Report - January 1959, Radiation Monitoring Operation, by A. J. Stevens.

REGIONAL MONITORING - RESULTS (December 22, 1958 - January 25, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	2.7	% MPC_{GI}	--
Separations Areas	Total Beta	6.0×10^{-6}	µc/cc	--
Pasco	Isotopic	0.4	% MPC_{GI}	--
Kennewick	Isotopic	0.4	% MPC_{GI}	--
Richland	Total Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
Columbia River Water				
Above 100-B Area	Total Beta	4.3×10^{-8}	µc/cc	--
100-F Area	Isotopic	7.7	% MPC_{GI}	--
Hanford Ferry	Total Beta	9.4×10^{-5}	µc/cc	--
Pasco	Isotopic	3.2	% MPC_{GI}	--
McNary Dam	Total Beta	3.9×10^{-6}	µc/cc	--
Vancouver, Washington	Total Beta	1.3×10^{-6}	µc/cc	+3
Waste Water				
Outlying Test Wells	Total Beta	1.3×10^{-6} (Max)	µc/cc	--
Reactor Effluent Retention Basins to River	Total Beta	22,000	curies/day	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	0.6	mr /day	--
Environs	Gamma	0.6	mr /day	--
I-131 Separations Areas	I-131	3.4×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	3.7	curies/week	--
Active Particles - Project	--	15	ptle/100 m^3	+3
Active Particles - Environs	--	24	ptle/100 m^3	+3
Vegetation				
Separations	I-131	6.4×10^{-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	3.4×10^{-4}	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.

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
January	0	1
1959 to Date	0	1

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
January	32,208	55	4	1
1959 to Date	32,208	55	4	1

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)
January	10,742	896	85	0	53	2.75	18.37
1959 to Date	10,742	896	85	0	53	2.75	18.37

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
January	1,453	0	0	0	8
1959 to Date	1,453	0	0	0	8
Fast Neutron					
January	55	0	0	0	9
1959 to Date	55	0	0	0	9

Bioassay

	January	1959 to Date
Plutonium: Samples Assayed	847	847
Results above 2.2×10^{-8} μc/sample	24	24
Fission Products: Samples Assayed	774	774
Results above 3.1×10^{-5} μc FP/sample	3	3
Uranium: Samples Assayed	320	320
Confirmed Plutonium Deposition Cases	0	0 *

*Bringing all-time HAPO total to 226. This total includes all deposition cases which have occurred at Hanford and all deposition cases which occurred to present Hanford employees prior to employment at Hanford.

Uranium Analyses	Following Exposure Units of 10^{-9} µc U/cc			Following Period of No Exposure Units of 10^{-9} µc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	12	3.3	45	16	3.2	39
Hanford Laboratories	17	2.5	22	25	3.1	21
Chemical Processing	29	4.5	104	30	3.7	45
Chemical Processing*	24	10	7	27	4.5	9
Special Incidents	0	0	0	0	0	0
Random	4.3	1.3	32	0	0	0

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

Thyroid Checks	January	1959 to Date
Checks Taken	0	0
Checks Indicating 0.01 µc	0	0
Hand Checks		
Checks Taken - Alpha	28,513	28,513
- Beta-Gamma	18,656	18,656
Skin Contamination		
Plutonium	19	19
Uranium	3	3
Fission Products	58	58

CALIBRATIONS

Portable Instruments	Number of Units Calibrated January	1959 to Date
CP Meter	954	954
Juno	310	310
GM	1,357	1,357
Other	186	186
Total	2,807	2,807
Personnel Meters		
Badge Film	558	558
Pencils	---	---
Other	382	382
Total	940	940
Miscellaneous Special Services	196	196
Total Number of Calibrations	3,943	3,943

A R Keene
Manager
Radiation Protection

AR Keene:kc

1240944

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JANUARY, 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 1.80, which is considerably below average experience.

The absenteeism rate was 2.77 per cent, which is below average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 14,378 hours. The total shop work backlog is 18,253 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 7.2% (1270 hours) of the total available hours.

Distribution of time was as follows:	Man Hours	% of Total
Fuels Preparation Department	1913	13.3
Irradiation Processing Department	876	6.1
Chemical Processing Department	720	5.0
Hanford Laboratories Operation	10743	74.8
Construction Engineering Operation	6	
Miscellaneous	120	.8

The number of requests from customers for emergency shop service increased sharply necessitating a higher than normal overtime level. Other project shops were utilized to capacity in providing assistance to the Technical Shops. Work continued on setting up assistance type contracts with off-site shops, and the final drafts should be completed so that negotiations can be conducted in February.

The Knight No. 60 jig boring machine was received and placed in operation. Specifications for a small planer were compiled and a request for bids was issued by the Purchasing Operation.

RADIOGRAPHIC TESTING OPERATION

Activity for the Radiographic Testing Operation was normal for this month. A total of 5,724 tests were made, of which 1,357 were radiographic (including x-ray and gamma-ray) and 4,367 were supplementary tests. In man hours, out of a total of 914, 475 (52%) were employed in connection with radiographic tests, and 439 (48%) were employed on supplementary tests. The supplementary test work included dimensional measurements (micrometric), eddy current, leak detection, penetrant, and ultrasonic (thickness measurements and flaw detection) tests.

Continuing the trend of last month, a large number of pieces were handled this month, cutting down somewhat on the number of tests made. A total of 3,482 items were handled. The feet of material represented by this total amounted to 13,240 feet. Work was done for 21 different organizational components, representing all of the operating departments and service organizations. A total of 25 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 30 different occasions for advice and information regarding general testing theory and applications for other than the jobs tabulated in Part II.

The successful application of a portable leak detection unit for helium leaks is being continued in the reactor areas. The surveys being made have been extended to the reactors proper. Testing of the rear face of the reactors at 100-B, 100-KW, and 100-H has been started. The first work has been concentrated on the bellows and numerous leaks were found. This work has been requested at all reactor areas.

The major components of the ultrasonic test unit for examination of long tubular products has been installed and operated. A serious set-back was encountered with the discovery that the electronic flaw test instrument was seriously damaged in shipment. Provision is being made for immediate replacement. Tests with the ultrasonic thickness measurement instrument have been made and were successful. Tubular wall measurements were made on a 48-foot zirconium tube. The measurements were recorded continuously for the entire length of the tube. This data obtained will be invaluable in establishing fabrication variables.

Correlation tests of eddy current and radiographic inspection on stainless steel longitudinally welded tubing was evaluated at two vendors' plants. Preliminary results on 1" OD x 0.109" thick wall tubing indicated that the eddy current tester in use lacked sufficient sensitivity to test to our specification. At the second plant (working on 1/2" OD x 0.049" thick wall tubing) details of a standard were established and fabrication started. No tests were made. With the smaller size tube more successful results may be obtained.

The use of the 221-B pipe gallery as a pickling and autoclaving facility for zirconium tubes has been disapproved. Alternate locations have been investigated and work is proceeding toward utilizing the old automotive maintenance-heavy equipment shop at White Bluffs.

Testing Statistics

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
CPD	136	102	61	5" Sch. 10 SS pipe, concentrator boiler, TK 109 tube bundle coil welds, redox oxidizer, elec. aux. offgas heater.
CEO	1	1	1	SS weld coupon.
FPD	5	20	7	Thermocouple fuel element, Zr. clad I&E.

1240946

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
HLO	3550	9356	1856	1" O.D. x .078" wall ti tube; 1.3% Pu-Al cast billets; 8" long swaged Zr.-UO_2 fuel rods, 8" x 1.440" O.D. ash can element; extrusion dies 1.475" O.D. x .046" wall, 1" O.D. x .078" wall, .680" I.D. x .035" wall, 2.4" O.D. x .170" wall, 3" O.D. zircaloy tubing; 1-1/2" sch. 80; 14.3% Pu-Al cast cores and rolled fuel plates.
IPD	1582	3747	1552	Grooved Al tube, NPR loop high pressure piping; helium leak test systems in 105-KE, 105-KW, 105-H, 105-F, 105-B, and a high pressure heating element.
R&UO	450	14	5	Fork lift arm, vacuum tank circuit breakers.
TOTALS	5724	13240	3482	

FACILITIES ENGINEERING OPERATION

Projects

There were 12 authorized projects at month end with total authorized funds of $7,024,078. The total estimated cost of these projects is $7,690,078. Two projects were completed during the month. Two new projects are awaiting AEC approval. Project proposals for thirteen new projects are in preparation.

The attached monthly project report covers the status of individual projects.

Engineering Services

Title	Status
Modification of Elevator, 327 Bldg.	Work is complete.
Reroofing of 146-FR and 222-U Bldgs.	Inclement weather is delaying the progress of this job. Estimated completion is April, 1959.
Traveling Crane Improvements 314 Bldg.	Installation work is proceeding.
Noise Attenuation - 3760 Building	Q-duct was installed and a reduction of 5 to 6 decibels was noted. This application will be used in other ductwork of the building.

1240947

Title	Status
Additions to Room 123 146-FR Bldg.	Work is complete.
Vacuum Pump Problem - 325 Bldg.	Recent tests have indicated 50% savings in oil consumption.
Provide Additional Hoods, Room 7-2A, 325 Building	Installation work underway.
Decontamintation of the Interior of 314 Building	Work order has been issued for this job.
Renovate Room 30-C - 325 Building	New equipment is being procured for installation.
Alterations to 40' x 80' Army Mess Hall Building (Atmospheric Physics)	Finish work remains including connection to septic system and chlorination of sanitary water system.
306 Building Water Filter	Filter unit rework by vendor has not been received for installation.
Saw-Dust Storage Silo - Biology Operation	Work included a concrete pad, erection of metal silo, and interconnecting passage. Work is essentially complete.
Design & Install Fire Alarm System - 314 Building	Design work started for installation of a fire detector system in 314 Bldg. Work will include interconnection with ventilation system and add a civil defense alarm.
Air Balance - 108-F Building	An engineering study is being made of 108-F ventilation system.
Auxiliary L.P. Propane Gas Supply - 325 Building	Tank and valves are on plant. Plant Forces to perform installation work.
Building Modifications 146-FR Building	Work is underway to convert storage space into office rooms.
Lighting Study, Bindery Room, 3760 Building	Light levels have been checked and found to be inadequate. Corrective measures are being investigated.

Design and Drafting Service

Title	Status
Cesium Recovery	This job is essentially complete. A minor amount of work is expected to continue for changes and correction of deficiencies.

Title	Status
Draw Bench Chain Support	Test results are available and completion of work is estimated at 90%.
Equilibrium Chamber	A device to measure thermal conductivity of dense ceramics. Scope design 100% complete. Detail work remains.
Thermal Analysis Furnace	A vertical resistance furnace for determining the thermal properties of UO_2. Scope design 100% complete. Detail work started.
Creep Capsule	Measurement of Zirconium. A capsule to monitor stress, elongation, and temperature while being irradiated. 20% complete.
Wide Angle Viewer - PRTR Examination Cell	Work 90% complete. Rework of various elements was required during the month.
Wet Storage Transfer Mechanism, CA-749	Work 100% complete.
Wet Storage Basin Manipulators and Vacuum Cleaner	Work started.
Scope Drawing on Proposed Full Scale Test Reactor	Work is complete.
Full Size Layout PRTR Thermo Shield	Work is complete.

In addition to the above about 15 miscellaneous job items are being worked on in the Drafting Operation.

Maintenance and Building Engineering - Landlord Functions

Costs - December - $128,790
November - $101,665

FYTD Total: $565,830. 45% of Budget.
The predicted expenditure forecast cost over the same period was estimated to be 44.2%.

Planned Maintenance	December	Six Month Summary
Painting, Roofing, Heating, Ventilating, relamping, and miscellaneous items	$19,216	$69,862

Forecast expenditure to date $70,100.
Actual expenditure is 99.7% of forecast.

1240949

At the end of the first six months, we have spent 0.8% more than we forecast. The overexpenditure has been for steam which has exceeded our forecast by $5000 per month for the last two months. The unusual maintenance expenditures and other costs are very close to predicted costs.

TECHNICAL INFORMATION OPERATION

Some progress was made in the matter of obtaining a policy concerning participation by HAPO employees in the AEC's book publishing program. It has been agreed that Hanford authors should participate in the program, particularly in writing books on topics on which there is outstanding local competence. A list of books which the Commission would like to see written and published will be circulated to appropriate components in an effort to locate prospective Hanford authors who might undertake to write them.

A pre-publication draft of the AEC's Technical Progress Review on Power Reactor Technology was received for comment. This review, one of three now published by the Commission, is prepared by General Nuclear Engineering Corporation under the editorship of W. H. Zinn. The pre-publication review gives AEC contractors whose work is discussed in the publication an opportunity to object to specific items if they so desire. Regular pre-publication reviews of each of these publications will be standard in the future.

Two "Classification Information" bulletins were distributed to the field during the month. One bulletin contained instructions on classifying production reactor confinement information. The other presented some new criteria for classifying Hanford photographs. The new criteria on photographs supplement existing instruction and provide only limited relief from the strict interpretations. No word has been received on the status of the completely revised topics which were submitted by HAPO in December.

At the recent Ninth International Declassification Conference it was agreed that the chemistry and chemical technology in the field of chemical processing of irradiated normal or near-normal uranium fuel elements no longer warrants classification. It was also agreed, however, that the quantities and the critical specifications of materials that are produced primarily for military purposes should not be declassified. As an aftermath to the Conference, a meeting was held in Washington during the week of January 19 by the Divisions of Classification, Production and International Affairs to discuss the exchange of chemical processing information with the United Kingdom.

Considerable time was spent reviewing and verifying the unclassified nature of the material for the Public Hearings on Industrial Radioactive Waste Disposal. Classification difficulties were encountered with only one paper. The AEC Declassification Branch, Oak Ridge, confirmed the necessity for minor deletions in the paper.

The AEC Classification Officers met with Division of Classification personnel in Washington during the week of January 19 to discuss recent developments in the field of classification. Summarized below are the developments of special interest to Hanford:

1. The Commission has approved the downgrading of production rates.

Approval of the Military Liaison Committee, expected by mid-February is required before the change can be effected. This downgrading action should permit comparable downgrading of production rates of individual plants.

2. The AEC is now circulating a revised staff paper to fully declassify the NPR. The Division of Classification believes declassification is assured providing the NPR planning continues to include dual purpose features.

3. Distribution of the Ninth International Declassification Guide, successor to OC-DOC-44 "Declassification Guide for Responsible Reviewers" is expected in March.

4. Distribution of a revised version of OC-DOC-33, "Classification Guide for Source, Special Nuclear, and Other Materials and Shipping Forms for Source and Special Nuclear Materials," is expected in about six weeks.

5. A new weapons classification guide, "US-UK Weapons Classification Guide" has been prepared and is in the initial review stage.

6. Hanford has been authorized to use OC-DOC-54, "Classification Guide for Use in the Civilian Application Program" to replace AEC Chapter 3403, Unclassified Areas of Research. Use of the CAP Guide at Hanford permits the removal from the "born classified" category of certain information in the fields of chemistry and radiation effects. For the most part, this type of information originates in the Hanford Laboratories.

7. A revised version of AEC Chapter 2108, Atomic Weapons Data has been distributed for review and comments. It is understood that the revision incorporates most of the suggestions made by Hanford and when approved will allow the establishment of satisfactory procedures for handling this material.

8. The Director of the Division of Classification is tc meet with the Assistant Secretary of Defense to review Department of Defense policies on the classification of maps and photographs. The Division of Classification feels this meeting will provide the key to realistic resolution of the map and photograph problem.

9. AEC and AEC contractor budget and cost personnel are scheduled to meet in Washington sometime in February to develop classification guidance for budget and cost data.

Preparation of the "Testimony and Statements Prepared for Public Hearings on Industrial Radioactive Waste Disposal before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy" was handled by Technical Publications between December 31 and January 24. The final version consists of approximately 400 pages.

An annotated bibliography of approximately 250 references to Hanford literature on radioactive waste disposal was prepared for inclusion in the proceedings of the Congressional hearings on this topic. All reports referenced in this bibliography have been made available to the AEC's Civilian Application Program.

A field of interest register covering Hanford needs for both classified and unclassified publications of the National Aeronautics and Space Administration was completed and submitted through the AEC's Technical Information Service, Washington to NASA. Upon approval we will automatically receive NASA reports related to Hanford research and development activities.

The annual R&D and AWD Inventory started on schedule, January 2. The two Atomic Weapon Data reports inventory has been completed with all copies accounted for. The R&D inventory is progressing satisfactorily.

Working Volume Statistics

	December	January
Document Distribution and Files		
Documents routed and discharged (copies)	15,386	15,746
Documents issued (copies)	11,768	10,578
Documents sent offsite (copies)	1,595	3,453
Document reserves filled (copies)	516	886
Documents picked up and delivered	18,616	22,149
Document Accountability		
Holders of classified documents whose files were inventoried	444	577
Documents inventoried in Files (copies)	1,026	105
Documents destroyed or retired (copies)	3,274	4,675
Documents revised (copies)	1,317	2,061
Documents pulled and documents filed (copies)	7,140	11,359
Documents reclassified	697	582
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	204,029	204,878
Reference and Publication		
Books cataloged (new titles)	135	111
Books added to the collection (volumes)	277	252
Ready reference questions answered by professional staff	149	168
Literature searches by professional staff	102	119
Reports abstracted (titles)	182	205
Formal reports prepared (titles)	14	6
Offsite requests for HAPO reports (copies)	403	179
Reports released to CAP (titles)	25	29

Library Acquisitions and Circulation	December	January
Books ordered (volumes)	439	342
Periodicals ordered	69	30
Books circulated (volumes)	1,891	1,524
Periodicals circulated (issues)	2,300	2,520
Inter-Library loans	54	81
Films borrowed or rented	23	21
Industrial film showings	32	44
Bound periodicals added to the collection	72	153

Library collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Totals
No. of books	25,197	8,148	1,379	1,923	36,647
No. of bound periodicals	11,531	1	1,431	96	13,059
	36,728	8,149	2,810	2,019	49,706

Statistics	December	January
Documents, including drawings and photographs reviewed for downgrading or declassification	40	89
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	19	27
Documents submitted to Declassification Branch, Oak Ridge	48	30

LABORATORIES ADMINISTRATION

Two Assistance to Hanford authorizations are in the process of being approved. They are:

ATH-HLO-3-59 Corrosion Testing of Aluminum Cladding, to APED, in the amount of $15,000.

ATH-HLO-4-59 Processing of Aluminum Cermets, to MCRD, in the amount of $20,000.

A third Assistance to Hanford authorization to Chemical Materials Department, Pittsfield, Mass., for the fusion of uranium dioxide, is pending.

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

1240953

UNCLASSIFIED

BUDGET CLASSIFICATION
General Plant Projects - FY 1958 - AEC-2-23-58-L

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / CONST. SCHED.	DESIGN ACTUAL / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CG-779	Additions to Separations Development Facilities - 321 Building	$27,500	$27,900 5-22-58	100 100	100 100	5-26-58 6-19-58	- - - 1-31-59	9-26-58** 12-16-58*

USING COMPONENT: Chemical Research & Development
FEO ENGINEER: J. T. Lloyd

REMARKS:

The rectifier was received on site January 8, 1959 and delivered to the 321 Building on January 9, 1959. When uncrated one unit was found to have been damaged during shipping, the other unit was damaged being moved into the 321 Building. The unit damaged by GE forces was repaired by them. The AEC was advised of the shipping damage to the one unit; repair costs and a requisition for replacement parts were submitted. When an operating check was made on the unit, it was found to have incorrect internal wiring; the GE Apparatus representative was called and came out and made the correction. Construction Operation is painting the unit.

** Actual date.
* Project complete with exceptions.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / CONST. SCHED.	DESIGN ACTUAL / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CAH-794	Geological and Hydrological Wells - FY 1958	$49,000	$49,000 4-16-58	100 100	100 100	4-7-58 7-8-58	- - - 12-31-58	5-15-58* 1-29-59*

USING COMPONENT: Chemical Research & Development
FEO ENGINEER: H. E. Ralph

REMARKS:

An acceptance inspection was made with representatives of the Contractor, Commission and FEO on January 28, 1959. The project was considered physically complete, with the exception of establishing elevations on top of well casings on 3 wells, January 29, 1959.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / CONST. SCHED.	DESIGN ACTUAL / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-804	Ceramic Fuels Press Enclosure - 325 Building	$41,000	$41,000 6-2-58	100 100	100 100**	6-19-58 10-1-58	- - - 1-15-59	8-1-58* 1-15-59***

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: R. C. Ingersoll

REMARKS:

A final punch list of cleanup work was issued to the contractor January 14, 1959. Of 30 items listed, ten remain and five of these depend on fair weather. Work to be performed by Construction Operation is expected to be complete by February 15, 1959. Minor modifications are being made to the press, under the direction of the press vendor representative.

* Actual date.
** Exceptions are currently being completed.
*** Physical Completion Notice with exceptions was issued January 15, 1959.

AM-7300-019 (5-58)

UNCLASSIFIED

UNCLASSIFIED

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 1959

BUDGET CLASSIFICATION: General Plant Projects -- FY 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-829	Building 325 Basement Imporvements	$70,000	None*	None*	0	0	0	0	1**	3**	-- -- --	-- -- --	3**	7**

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: R. C. Ingersoll

REMARKS:

* The project proposal was approved by the AEC-HOO Review Board on January 29, 1959. To date the AEC Directive has not been issued.

** Months after authorization.

1R-242	Modify 303-J Building to Provide an Interim Test Facility for Fuel Elements	$19,000	None	None	0	0	0	0	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: H. E. Ralph

REMARKS:

The informal request was submitted to Contract Accounting on January 30, 1959.

New Construction FY 1960

CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None	None	0	0	0	0	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --

USING COMPONENT: Physics & Instruments R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:

A preliminary project proposal requesting funds for preliminary design was submitted to the General Manager for approval on January 23, 1959.

UNCLASSIFIED

AM-7300-019 (5-58)

BUDGET CLASSIFICATION: General Plant Projects - FY 1958 - AEC-2-23-58-L

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 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 COMP. DATE DESIGN / CONST.
CGH-809	Electrical Modifications -- 328 Building	$40,000	$40,000 6-30-58	100 100	26 25	7-30-58 1-9-59	- - - 3-1-59	12-15-58* 3-1-59

USING COMPONENT: Laboratory Auxiliaries
FEO ENGINEER: R. C. Ingersoll

REMARKS:

A work order was issued to Construction Operation, January 7, 1959, for modifications and additions to the lighting and receptacle circuits. Mezzanine floor receptacle circuits have been roughed-in. Lighting transformer and panel have been installed.

* Actual date.

General Plant Projects - FY 1959

CAH-827	Automatic Columbia River Monitoring Stations		None	0	0	- - -	- - -	- - -
		$50,000	None	0	0	- - -	- - -	- - -

USING COMPONENT: Radiation Protection
FEO ENGINEER: D. S. Jackson

REMARKS:

Informal discussion of the project, with the Commission, disclosed objections to the installation of two stations. A letter has been written to the Commission, requesting return of the project proposal for revision. To date the project proposal has not been received in Facilities Engineering.

CAH-828	Central Storage Facility - 300 Area			0	0	1**	- - -	2.5**
		$38,500	None*	0	0	4**	- - -	10**

USING COMPONENT: Property Accounting
FEO ENGINEER: R. C. Ingersoll

REMARKS:

* The project proposal was approved by the AEC-HOO Review Board on January 29, 1959. To date the AEC Directive has not been issued.

** Months after authorization.

UNCLASSIFIED

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 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 COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory	$1,000,000*	$175,000 / 5-12-58	96 / 91	0 / 0	5-22-58 / 4-1-59	- - - / - - -	2-24-59 / 5-31-60
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: D. S. Jackson		

REMARKS:

The project proposal requesting total Stage I funds was transmitted to the HOO-AEC on January 28, 1959. Detailed design is 5 percent behind schedule, less than one month prior to the scheduled completion date. It may be necessary to extend the schedule, for a week or two, dependent upon the solution to a couple of existing design problems.

*Stage I only.

CA-744	Metallurgical Development Facilities	$2,685,000*	$2,685,000* / 11-5-58	88 / 86	0 / 0	6-30-58 / N.S.	- - - / 9-1-60	9-1-59 / 9-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The bid package information has been transmitted to the AEC. A construction schedule of 9 months for the building and service, except for the fourth bay which will be included at a later date, has been requested from the Commission. Equipment specifications and requisitions are in preparation.

* Includes transferred capital property in the amount of $85,000.

CA-749	High Level Radiochemistry Facility	$960,000	$960,000 / 10-31-58	100 / 100	27 / 27	6-15-58 / 8-14-58	- - - / 6-30-59	11-21-58 / 7-15-59
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The following construction work was performed during this period: 1) 80% of Rebertson Company sidewall panels were erected. 2) Re-roofing of the existing building 60% completed. 3) Galvanized ventilation supply duct on the roof of the existing building erected and tie-in made to supply plenum. 4) Outside face of the structural steel was painted. 5) Electrical main service lines to tie-in to existing building panels was started. 6) Piping work in the basement continued and tie-ins were made to the existing building supply during building shut-down. 7) Concrete basement floor slab was poured and completed. 8) All structural steel was erected and wall panels replaced. 9) Concrete wainscote wall was poured on the main floor. 10) All concrete forms have been stripped. 11) Compacted backfill around building was started.

UNCLASSIFIED

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations 58 b 4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 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 COMP. DATE DESIGN / CONST.
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$325,000	$325,000 6-25-58	100 100	21 25	6-23-58 10-9-58	- - - 2-1-60	12-31-58* 2-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: A. W. Hervin		

REMARKS: The CPFF Construction Contractor has completed the concrete work on the retaining wall. The first lift on the walls, exclusive of the wet storage basin, have been poured. Work is progressing on forming the outside building and wet storage basin walls. The canal liner, without cover, has been placed in the existing building and concrete poured to near floor level. Work is in progress on the steam and condensate piping in the existing building basement. The stainless steel drainage piping which will be embedded in the concrete is being installed. Also, work on the drain line, in the basement of the existing building, is in progress. The bid package for the Fixed Price portion of the work is being assembled for transmittal to the Commission. The latest indications are that due to the radiation and contamination encountered, additional funds may be required. * Actual date.

CGH-819	Increased Laboratory Waste Facilities - 300 Area	$300,000	$30,000 11-24-58	0 0	0 0	3-1-59* 11-1-59*	- - - - - -	9-1-59 9-1-60
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: A. W. Hervin		

REMARKS: Work is continuing on the particulate problem. It is planned to put several different types of filters in the crib waste line in an endeavor to remove more particulates from the waste solutions.

* Estimated dates.

Equipment Not Included in Construction Projects - Program Class 2900

CG-661	Additional Heat Generation Facility - 189-D Building	$475,000	$664,000 9-18-57	100 100	15 22	12-6-56 12-3-58	- - - 8-31-59	10-15-58 8-31-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: A. W. Hervin		

REMARKS: Excavation has been completed. The base slabs for the equipment have been poured. Backfill around these slabs was started; however, in trying to compact the backfill the material became jelly-like due to the high water content. The contractor was instructed not to pour the floor slab until the material has dried sufficiently for compaction. The general condition of the soil in this area is normally very wet, probably due to leaks in the lines connecting the hot wells. The electrical sub-contractor has started work on the lights and cable trays.

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects -- Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 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 COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	$1,200,000*	$1,200,000 8-12-57	100 100	95 96	9-17-56 4-7-58	- - - 12-15-58#	9-2-58** 5-1-59*

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

Delivery of the 6 x 9 Loop is expected in early February; installation can start as soon as approval of the Hazard Survey Group is obtained. The refrigerated transportation cask has been cancelled. However, a revision to the project proposal for the proposed facility is being prepared for the development and evaluation of a rupture detection system and decontamination processes.

*Completion dates and estimated project costs will be affected by the revised project proposal.
**Some design to cover startup items is now underway on a work order basis.
Approval of requested extension to May 1, 1959 has not yet been received.

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 DESIGN / CONST.
CG-682	High Level Cut-Off and Examination Cell - 327 Building	$415,275*	$430,000 8-20-57	100 100	100 100	7-18-56 3-27-58	- - - 10-1-58	6-28-57* 9-30-58*

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: A. W. Hervin

REMARKS:

Status of exceptions: The slug positioner, HM chambers, and polisher-grinder have been completed. The seals for the cut-off saw have been received and reassembly of the saw has started; however, the drive assembly is being converted to a direct drive in lieu of V-belts. Testing the cutting mechanism on the saw is scheduled for February. Fabrication of the hood lifting mechanism is in progress. The cut-off saw gauge, for measuring thickness, has been essentially completed. One manipulator was assembled, tested and is being torn down again for minor modifications. During the test it was found that the wrist motion on the manipulator would handle 25 pounds, which is approximately twice the expected amount. Material for the can storage rack and exhaust alarm system have been ordered. Estimated exceptions completion, March, 1959. *Actual.

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 DESIGN / CONST.
CA-695	Radio Telemetering Network	$109,078*	$109,078* 9-23-58	100 100	100 80	2-22-57 7-25-57	4-15-57 2-1-59	5-27-57** 3-1-59

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: J. T. Lloyd

REMARKS:

The enclosures on the 100 Areas badgehouses are nearly complete. Installation of the twenty stations has started.

* Includes transferred capital property in the amount of $3,578.

** Actual date.

UNCLASSIFIED

AM-7300-019 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects -- Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59099
MONTH January, 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 COMP. DATE DESIGN / CONST.
CG-785	In-Reactor Studies Equipment -- 105-KW Building	$276,000	$276,000 / 12-3-58	2 / 2	0 / 0	1-5-59* / N.S.	-- -- -- / 12-31-60	12-8-59 / 12-31-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The Design Schedule has been prepared and detail design is in progress.

* Detail 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 COMP. DATE DESIGN / CONST.
CGH-801	X-Ray Diffraction Cell -- 327 Building	$170,000	$10,000 / 6-7-58	N.S. / 40	0 / 0	6-10-58 / N.S.	-- -- -- / -- -- --	3-15-59 / 10-30-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

A revised project proposal for the remainder of design and total construction funds was prepared and submitted to the AEC-HOO on November 19, 1958.

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 DESIGN / CONST.
CGH-805	High Temperature Tensile Testing Cell -- 327 Building	$150,000	$10,000 / 8-4-58	N.S. / 42	0 / 0	8-26-58 / N.S.	4-1-59 / 10-1-59	5-1-59 / 11-1-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

A revised project proposal for the remainder of design and total construction funds was prepared and submitted to the AEC-HOO on November 13, 1958.

AM-7300-019 (5-58)

UNCLASSIFIED

UNCLASSIFIED

BUDGET CLASSIFICATION: Equipment Not Included in Construction Projects -- Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 53099
MONTH: January, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT	AUTHORIZATION INFORMATION: DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED. ACTUAL	STARTING DATE: DESIGN	STARTING DATE: CONST.	DIRECTIVE COMP. DATE: DESIGN	DIRECTIVE COMP. DATE: CONST.	ESTIMATED COMP. DATE: DESIGN	ESTIMATED COMP. DATE: CONST.
	Dynamic Test Facilities -- 314 Building	$150,000	None None	0 0	0 0	1* 5*	- - -		- - -		4.5* 12	

USING COMPONENT: Reactor & Fuels R & D
FED ENGINEER: D. S. Jackson

REMARKS: The project proposal is being routed for HLO approval. It is currently being reviewed by members of Reactor & Fuels R & D management.

The General Electric Company Plant Forces will perform the physical work on this project.

* Months after authorization.

	Modifications and Additions to High Pressure Heat Apparatus -- 189-D Bldg.	$700,000	None None	0 0	0 0						

USING COMPONENT: Reactor & Fuels R & D
FED ENGINEER: H. Radow

REMARKS: Final approval signatures are being obtained on the project proposal.

	Fission Product Volatilization Studies Test Facility -- 292-T Building	$75,000	None None	0 0	0 0	0.5* 3*	- - -		3.5* 8*		

USING COMPONENT: Chemical Research & Development
FED ENGINEER: D. D. Wodrich

REMARKS: A project proposal has been prepared and is being circulated for General Electric Company approval and signatures.

* Months after authorization.

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 and Buildings Visited
Ernest W. Milburn & Dr. R. Hubbard	1-13-59 1-13 59	GE Co. X-ray Dept. San Francisco, Calif.	Technical Consultation & to introduce Dr. Hubbard.	R. B. Socky	No	300 - 326 & 328 2704-Z - 200-E
Wm.H. Hannah & J. N. Wessel	1-19-59	Puget Sound Naval Shipyard, Bremerton, Wn.	Study non-destructive testing methods.	R. B. Socky	No	300 - 325 & 224-B & 221-B 200-E
V. T. Burkett	1-21-59	G.E. X-ray Plant St.Petersburg, Fla.	Interview electronic technicians.	L. J. Lucas	No	300 - 328
W. Hamilton	1-21 59	Star Machinery Co. Seattle, Wash	Repair equipment	C. J. Lucas	No	300 - 328
J. D. Muir	1-22-59	DuBois Co. Spokane, Wash.	Advise on paint spray problems	J. H. Kelly	No	300 - 328

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
F.F.X. Dunigan	1-12 & 1-13-59	Brookhaven Nat.Lab. Long Island, N.Y.	Nat. Laboratories Comm. Mtee Meeting	L. G. Stang	No
R. B. Socky	1-26 & 1-27-59	Wallingford Steel Co. Wallingford, Conn.	Plan & coordinate correlation tests on SS tubing	D. Weise	No
R. B. Socky	1-29 & 1-30-59	Trent Tube Co. Troy, Wisconsin	" "	H. Bowman	No
R. W. Dascenzo	1-28-59	Flohr Company Seattle, Wash.	Inspect Materials	C. Flohr & J. Ward	No

EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

GENERAL

At month's end, the staff of the Hanford Laboratories Operation totalled 1203 employees, including 570 exempt and 633 nonexempt employees. There were 485 exempt employees possessing technical degrees, including 274 B.S., 106 M.S. and 105 Ph.D.

PERSONNEL DEVELOPMENT

The Armed Forces Special Weapons Project Training Program for medical officers commenced January 6th and is continuing on schedule. The Program will be completed February 13.

Two classes in PBM-I were initiated on January 15.

UNION RELATIONS

The Wonacott case pertaining to radiation monitoring jurisdiction is progressing toward arbitration. The arbitrator has been selected and a date of March 5th has been proposed to him for the hearing. No confirmation has been received up to this date.

The Arnold grievance pertaining to work assignments was discussed at Step II and an arbitration demand was received on January 30. George M. Brown has been named as the union's member on the panel and F. W. Woodfield will represent the company.

Twelve oral complaints were made by bargaining unit representatives during the month and were settled locally without formal grievances. The Arnold grievance was the only formal one submitted during January.

COMMUNICATIONS

A complete revision of a communications package dealing with the establishment of new HAPO exposure limits was prepared and submitted to Radiation Protection Operation for review.

HAPO Public Relations arranged for the APD Schenectady News Bureau representative to prepare a story on the American Meteorology Society's award to G.E. The story was released to Eastern and Northwest papers in accordance with the deadline requested by the AMS.

Tours were conducted for 15 science club members from Seattle Eckstein Junior High School and 30 Moxee High School science students.

EMPLOYEE COMPENSATION

Initial participation of managers and supervisors in completing one phase of a nonexempt compensation study was undertaken during the month. A major portion of nonexempt jobs will be rewritten on a new job description format which is compatible with the point score evaluation system.

HLO's salary review was completed during January.

1240963

PROFESSIONAL PERSONNEL PLACEMENT

Ph.D. recruiting continues to present most serious problems with extreme competition being encountered for Ph.D. physics candidates. Four offers were extended during the month and two acceptances were received, bringing the total acceptances for the recruiting year to six. Three offers are currently open.

Experienced BS/MS recruiting and recruiting for the Technical Graduate Program continues to be very favorable. Most serious difficulty is being encountered in the employment of new bachelor's candidates in physics. Spring recruiting commenced on January 12 with visits to WSC, Idaho, Gonzaga, Oregon State, Portland University, Washington and Seattle University and will continue during the coming two months with visits to 26 additional schools.

Twenty-three graduates are currently assigned to the Technical Graduate Program with three scheduled for placement on February 1. Requests for placement exceed Program members available and this will continue until June graduates report for assignment.

Employment for the Summer Program is underway with five graduates and four professors having submitted acceptances to date. Tentative goals are 10 juniors, 10 graduates, 6 high school teachers and 20 professors.

HEALTH, SAFETY AND SECURITY

Laboratories personnel worked a total of 197,040 man-hours during the month with no disabling injuries. Since September 1, 1956, a total of 5,475,100 man-hours have been completed with no disabling injuries. The medical treatment frequency for January was 1.13 as compared with 1.34 during December.

There were seven security violations during the month of January.

EMPLOYMENT

Twenty-six requisitions were received during the month, bringing the total nonexempt openings in the Laboratories to 45. There are 13 candidates currently in process and five transfers pending, leaving 34 candidates to be procured.

Manager,
Employee Relations

T.G. Marshall:tr

VISITS TO OTHER INSTALLATIONS

Name	Date of Visit	Company Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data
E.P. Galbraith	1/21 - 1/23	Western College Placement Ass'n. Meeting Los Angeles, Calif.	Establish contacts with industrial and institutional placement representatives to assist recruitment and placement efforts.		None
L. J. Kirby	1/28 - 1/31	American Physical Society Meeting New York City	To participate in recruiting physicists for General Electric Company		None
L. J. Kirby	1/28 - 1/31	Advanced Degree Personnel Office Schenectady, N. Y.	For discussions and to review papers of doctoral candidates interviewed last fall.	Jack Wolfe	None

TABLE II. NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	Dec.	Jan.
Requisitions		
At end of month	28	45
Cancelled	2	0
Received during month	18	26
Filled during month	12	9
Candidates Considered		
Total applications	48	41
Total transfer requests from other at HAPO	0	0

Nonexempt Transfer Requests	Dec.	Jan.
Transfer Requests		
Active cases at end of mo.	66	73
Cancelled	4	2
New	6	10
Transfers effected	1	1

TABLE III. UNION RELATIONS

Grievances Processed - January 1, 1959 to date

Total Processed	1
Step I	
Answered satisfactorily*	0
Step II	
Answered	
Satisfactorily**	0
Applied for arbitration	1
Pending arbitration decision	1

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

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

1240966

TABLE IV. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

	Visits to Richland				Offers*			
	Cases Considered	Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll
Ph.D.	486	161	25	65	17	6	3	6
Exp. BS/MS	241	40	26	4	39	30	2	24
Program BS/MS	222	-	-	-	95	21	56	7

*Offer totals include offers open on 9/1/58

Ph.D.	3
Exp. BS/MS	3
Program BS/MS	3

B - Technical Recruiting Activity - HLO - September 1, 1958 to Date

	Visits to Richland				Offers**			
	Cases Considered	Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll
Ph.D.	486	161	25	65	11	3	3	3
Exp. BS/MS	211	34	20	4	20	4	1	13
Program BS/MS	(Off Program Placement)				2	2	-	-

**Offer totals include offers open on 9/1/58

Ph.D.	2
Exp. BS/MS	2

In addition to the above activity, 17 exempt employees have transferred into HLO from other HAPO departments to date.

C - Technical Graduate and Technician Training Program
Month ending January 31, 1959

	TG Program	TT Program
Number Personnel on assignment	23	11
(HAPO Tech Grad Program.....23)		
(West. District E.P..... 0)		
Distribution of assignments by Depts.		
HLO	11	6
CEO	0	0
R&UO	0	0
FPD	0	0
IPD	12	5
CPD	0	0
Distribution of assignments by functions		
R&D or Engineering	19	11
Other	4	0

FINANCIAL OPERATION MONTHLY REPORT

JANUARY 1959

PERSONNEL

There were no changes in the personnel of the Financial Operation during January.

GENERAL ACCOUNTING OPERATION

A report of results was issued for the physical inventory of uninstalled cataloged equipment in the custody of Biology Operation. Seven hundred and twelve items were physically counted valued at $548,418. One item valued at $82 was not located during the inventory compared to 22 missing items valued at $8,112 in the FY 1957 inventory. Seven items valued at $1,822 were added to record as compared to 57 items valued at $24,700 in the FY 1957 inventory. Inventory results indicate good control over equipment and the use of proper procedures in transferring or retirement of equipment.

Reconciliation of the physical inventory of uninstalled cataloged equipment in the custody of Physics and Instruments Research and Development Operation is still in progress. A report of results will be issued in February.

The physical inventory of uninstalled equipment in the custody of Reactor and Fuels Research and Development Operation is currently being taken. Field work is expected to be completed by February 13, 1959. Equipment belonging to Project Whitney is also being physically inventoried.

A special report - Annual Industrial Fire Program and Experience - was prepared for Contract Accounting showing the replacement value assigned to HLO, excluding underground installations and open sided structures at December 1958. The replacement value of plant and equipment and government owned supplies on HLO records is $45,635,505. The index used in reflecting replacement value was furnished by Contract Accounting from the Building Cost Index published by Smith, Henckman, and Grylls.

The blank pass custody and issuance function was transferred from GE Security to Property Accounting during the month by assignment of a block of passes to HLO. A request was made of Laboratory Auxiliaries to revise HLO OFG's to reflect a revision in authorization to sign passes to Level 4 with redelegation by Level 3. This was necessary to strengthen controls and to simplify verifying authorization.

A resume of AEC Manual Chapters issued for compliance was received from Contract Administration. Each Level 3 Manager was furnished a copy of the resume for his use in examining his procedures.

Project Proposal for the Equipment Storage Area Building in the 300 Area was approved by the Commission on January 29. No directive to proceed has been received as yet.

Cash advance balances were reduced from $33,519 in December to $17,136 primarily due to settlement of Geneva Conference associated accounts and settlement of many other accounts in connection with calendar year-end closing.

Work continued on completing manual on travel, living and other reimbursable items handled by General Books.

Development of a new travel order form which will simplify office procedures concerning cash and check advances is about complete.

COST ACCOUNTING OPERATION

Instructions for preparing the Operating Cost Budget and supporting data for fiscal years 1960 and 1961 were transmitted to HLO management.

The Operating Cost Budget for FY 1959 was adjusted during January for the following changes in authorizations: (1) transfer of $175,000 from operating cost to the equipment category in the 4000 Program to reflect the reclassification by Washington-AEC of the GCPR Gas Loop, (2) transfer of $50,000 from operating cost to the equipment category in the 4000 Program to provide urgently needed funding of equipment items associated with the Swelling Studies and (3) reduction in CPD Process Technology authorization of $30,000.

Effective with January 1959 reporting, the distinction in classification of NPR costs between Metallurgy, Reactor and Separations was discontinued. This information was not required by management of Irradiations Processing Department and Hanford Laboratories. In the event this segregation is required at a later date, it can readily be obtained through analysis.

A "Cost Plus Commitment" report was issued for the first time showing the status of the Plutonium Inhalation Study contract with the U.S. Air Force as of December 31, 1958. Hereafter the report will be issued monthly to HLO management.

The second quarterly report of planned off-site R&D expenditures for the remainder of FY 1959 was submitted to Contract Accounting on January 26. Items listed totaled $2.2 million with $1.8 million expected to be costed in the remaining six months of the fiscal year.

A meeting was held with the Supervisor, Metallography Laboratories to discuss the advisability of adopting the work order system for the Metallography Laboratories. At the present time, there appears to be no problem of accounting for the cost of each job or of obtaining funds for work; therefore, it was felt that the advantages did not offset the disadvantages of the additional paper work involved under the work order system. It was agreed to continue with the present system of accounting for the present time and that another review may be made at a later date.

A revised schedule of the monthly depreciation allocation to programs was prepared for the last six months of FY 1959. The additional depreciation expense of approximately $41,000 associated with the removal of obsolete equipment from the 231-Z Building has been spread over the six months ending June 30, 1959.

PERSONNEL ACCOUNTING

Withholding Statements, W-2 Forms, for 1958 were delivered to employees on January 9, 1959; 1,412 forms were transmitted. Gross wages paid to these employees amounted to $8,651,829. Income tax withheld amounted to $1,234,080. Collector's copies of W-2 Forms and Reconciliation of Federal Income Tax Withheld for the year 1958 were mailed on January 19, 1959.

Annual Federal Tax Return of Employers under the Federal Unemployment Tax Act for the year 1958 was prepared and a check in the amount of $10,689 payable to the District Director of Internal Revenue, Albany, New York, was transmitted on January 22, 1959. Total taxable wages paid during 1958 under the Unemployment Compensation tax law amounted to $3,563,291. The state of Washington was paid a tax of $96,127 and the state of Idaho $60.

State Income Tax returns covering payments made by GE during the year of 1958 to employees transferred in from other General Electric components were prepared and transmitted to the various tax agencies within dates allotted. These reports were forwarded to Idaho, Oregon, New York and Wisconsin.

A pay raise of 2.5% for all employees participating in the Savings & Security Program became effective January 15, 1959. New rate to be included in pay checks received on January 23. Non-exempt payroll will be increased approximately $60,000 as a result of this increase. Shift differential was increased to .19 per hour, isolation pay to $10.35 per week in the case of non-exempt and area differential to exempt employees was increased to $45.00 per month.

PROCEDURES

Data Processing Operation has agreed to develop a program for accounting for off-site commitments placed by HLO for materials and services. It is planned that the record will include not only GE and AEC purchase orders but also contracts and procurement directives. The input to the tape record will be provided by HLO Financial Operation through punched cards prepared, for the present, by Classified Files Operation. The target date for implementation is the month of February 1959. The key to this procedure was obtaining additional information (complete or partial payment) on the payment voucher. Accounts Payable Operation has tentatively agreed to perform this service.

Data Processing Operation, upon our request, is studying the possibility of automatically updating the personnel source file for automatic increases for non-exempt employees. HLO Salary Administration Operation has tentatively agreed to this change which would eliminate not only the maintenance of a tickle file and supervisor notification by Salary Administration, but also the preparation and transmittal of rate change papers by Personnel Accounting. Tabulations of changes would be provided by Data Processing Operation for Wage Rates approval, salary control information, and auditable file document.

A study of card punching performed for HLO by Data Processing Operation is under way to determine desirability of performing part or all of this card punching in the 300 Area. Technical Information, Exposure Evaluation and Records and Calibrations Operations are presently doing their own card punching.

AUDITING

Contracting and Procurement Audit field work is complete, the report drafted, and work has started on the Work Order Audit. Issuance of the Material and Equipment Furnished AEC Construction Contractors report still awaits CEO clearance.

MEASUREMENTS

Work continued on the preparation of the Hanford Laboratories section of 1958 at HAPO. Interviews with Level 3 and 4 managers on the subject of measurement neared completion.

Payroll Statistics

Number of HLO Employees Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 204	568	636
Additions and Transfers In	18	9	9
Removals and Transfers Out	(19)	(7)	(12)
Employees on Payroll at End of Month	1 203	570	633

Overtime Payments During Month	January	December
Exempt	$1 829	$1 487
Non-Exempt	8 576	6 560
Total	$10 405	$8 047*

Gross Payroll Paid During Month		
Exempt	$471 812	$450 619
Non-Exempt	341 381	278 636
Total	$813 193	$729 255

Participation in Employee Benefit Plans at Month End	January Participation Number	January Participation Percent	December Participation Number	December Participation Percent
Pension Plan	1 161	98.9	1 174	98.7
Insurance Plan				
Personal Coverage	1 225	99.8	1 225	99.8
Dependent Coverage	822	-	815	-
U.S. Savings Bonds				
Stock Bonus Plan	78	40.0	78	50.3
Savings Plan	99	8.2	90	7.5
Savings & Security Plan	1 008	94.5	1 015*	95.0
Good Neighbor Fund	819	68.1	829	68.9

Insurance Claims	January Number	January Amount	December Number	December Amount
Employee Benefits				
Life Insurance	-	$	-	$
Weekly Sickness & Accident	12	1 253	12	1 511
Comprehensive Medical	94	8 195	33	4 118
Dependent Benefits				
Comprehensive Medical	146	12 134	61	5 369
Total	252	$21 582	106	$10 998

*Corrected Total

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
L. L. Ames, Jr.	Prevention of Deposition of Radioisotopes in Bone.
J. Dunn and R. J. Sloat	Adjustable Delivery Powder Transfer Feed and Powder Lock.
J. Dunn	A Pump for Metering Fluids.
D. R. Kalkwarf	Colorimetric Dosimeters for Ionizing Radiation. (HW-58923)
A. R. Keene	Radio Frequency Speed Indicator.
W. E. Roake and J. L. Bates	Fuel Element for Neutronic Reactors.
E. A. Evans, W. E. Roake and D. W. Brite	A Fuel Element for Neutronic Reactors and Method of Fuel Element Manufacture.
J. C. Tobin and D. R. Green	Null Balance Gas Thermometer.