DECLASSIFIED

REPOSITORY PNL
COLLECTION Atmospheric Release
BOX No. N/A
FOLDER N/A

HW-64108
COPY No. 18 A
HAN-75128

729370

HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

R

FEBRUARY, 1960

MARCH 15, 1960

THIS DOCUMENT IS PUBLICLY AVAILABLE

THIS DOCUMENT HAS BEEN SCANNED AND IS STORED ON THE OPTICAL DISK DRIVE

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

GENERAL ELECTRIC

DECLASSIFIED

A.E.C.-G.E.-RICHLAND, WASH.

1241918

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

1241919

AEC-GE RICHLAND, WASH.

DECLASSIFIED

[redacted]

HW-64108

This document consists of 163 pages. [redacted]

75128

HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
FEBRUARY, 1960

CLASSIFICATION R[redacted] FOR DECLASSIFICAT[redacted] LEFT UNCHANGED

By [redacted] Ruschke

D[redacted] 5/15/73

[redacted] Division of Classification

DECLASSIFIED

By Authority of CG-PR-2
DS Lewis 6-26-92
By J Tang 8-5-92
PM Eick 8-6-92

Compiled by
Operation Managers

March 15, 1960

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

PRELIMINARY REPORT

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

Route To:	P. R. No.	Location	Route Date	Signature and Date
HCC JE Evans				

THIS DOCUMENT IS PUBLICLY AVAILABLE

1241920

[redacted]

DECLASSIFIED

DISTRIBUTION

Copy Number	
1	W. E. Johnson
2	H. M. Parker
3	O. C. Schroeder
4	F. W. Albaugh
5	C. A. Bennett
6	J. L. Boyd
7	L. P. Bupp
8	F. E. Crever, GEAPD
9	W. E. Foust
10	P. F. Gast
11	A. R. Keene
12	H. A. Kornberg
13	T. G. Marshall
14	L. H. McEwen
15	W. Sale
16	J. W. Healy
17	H. P. Shaw - V. R. Cooper
18 - 21	Atomic Energy Commission, Hanford Operations Office, Attn: J. E. Travis
22 - 24	G. F. Quinn, Director, Division of Production, Washington 25, D. C.
25	Savannah River Operations Office, Aiken, South Carolina
26	300 Files
27	Record Center

1241921

TABLE OF CONTENTS

	Page
Staff	iv
Force Report and Personnel Status Changes	v
General Summary	vi through xv
Reactor and Fuels Research and Development Operation	A-1 through A-48
Physics and Instrument Research and Development Operation	B-1 through B-25
Chemical Research and Development Operation	C-1 through C-22
Biology Operation	D-1 through D-7
Operations Research and Synthesis Operation	E-1 through E-6
Programming	F-1 through F-4
Radiation Protection Operation	G-1 through G-6
Laboratory Auxiliaries Operation	H-1 through H-20
Professional Placement and Relations Practices	I-1 through I-5
Financial Operation	J-1 through J-4
Invention Report	K-1

1241922

STAFF

Manager, Hanford Laboratories	H. M. Parker
Manager, Biology	H. A. Kornberg
Manager, Chemical Research and Development	L. P. Bupp
Manager, Laboratory Auxiliaries	J. L. Boyd
Manager, Operations Research and Synthesis	C. A. Bennett
Manager, Physics and Instrument Research and Development	P. F. Gast
Manager, Programming	L. H. McEwen
Manager, Radiation Protection	A. R. Keene
Manager, Reactor and Fuels Research and Development	F. W. Albaugh
Manager, Professional Placement and Relations Practices	T. G. Marshall
Manager, Financial	W. Sale

1241923

TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE February 29, 1960

	At close of month			At beginning of month			Additions		Separations	
	Exempt	NonExempt	Total	Exempt	NonExempt	Total	Exempt	NonExempt	Exempt	NonExempt
Chemical Research and Development	127	101	228	128	101	229	1	2	2	2
Reactor & Fuels Research & Development	195	171	366	197	170	367	0	1	2	0
Physics & Instrument Research & Development	67	34	101	66	33	99	1	1	0	0
Biology Operation	35	46	81	35	46	81	0	2	0	2
Operation Res. & Syn.	16	4	20	17	4	21	0	0	1	0
Radiation Protection	34	100	134	33	100	133	1	0	0	0
Laboratory Auxiliaries	53	191	244	54	193	247	0	6	1	8
Financial	14	13	27	14	13	27	0	1	0	1
Prof Placmt & R.P.	62	20	82	55	19	74	8	1	1	0
Programming	15	4	19	15	4	19	0	0	0	0
General Totals	1 619	2 686	3 1305	1 615	2 685	3 1300	0 11	0 14	0 7	0 13
Totals excluding internal transfers	619	686	1305	615	685	1300	10	13	6	11

Composite Separation Rate _____ 1.5
Separation Rate (based on separations leaving G. E.) _____ .5
Controllable Separations Rate _____ .0

124 | 924

DECLASSIFIED

BUDGETS AND COSTS

Costs for February were $1,896,000, an increase of $76,000 from January. Fiscal year-to-date costs are 63% of the amounts currently authorized to Hanford Laboratories. Hanford Laboratories programs at February 29 have the following cost-budget relationship:

(Dollars in Thousands)	Cost	Budget	% Spent
2000 Program	$ 340	$ 616	55%
4000 Program	4 475	7 412	60
5000 Program	336	621	54
6000 Program	1 425	2 198	65
	$6 576	$10 847	61

Funds authorized to Hanford Laboratories for FY 1960 were increased during the month by $360,000 for Division of Reactor Development and $81,300 for Division of Research.

Costs of HLO research and development for Hanford Product Departments are in line with amounts authorized.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

The Phase III PRTR contract completion date has been changed from May 20 to June 24, 1960, to compensate for strikes and other delays. Placement of heavy aggregate concrete in the biological shield has been completed. The PRTR Final Safeguards Analysis was reviewed by the ACRS on January 28. No serious objections to the design or proposed operating procedures were raised by the Committee at the hearing. A written review has not yet been received.

A study of the compliance of the PRTR design with recently issued General Electric Reactor Safeguards Council Standards showed that full compliance could be achieved by making two minor changes.

About 90 per cent of the Critical Test outlines have been reviewed by the PRTR Startup Council. Writing of the Power Tests has started, and 35 per cent of the operating process specifications have been issued in rough draft form.

1241925

A Zircaloy process tube, which had not been pickled or autoclaved, was removed from the Single Tube Prototype Loop after 2329 hours of operation and found to contain wear depressions, 0.001 to 0.002 inch deep, adjacent to the fuel element supports and several randomly spaced blisters.

Thermal cycling tests at 1000 psig of Zircaloy-clad Al-Pu rods have shown no dimensional changes after 25 cycles and only slight changes on a few specimens after 50 cycles. Earlier testing at 1400 psig resulted in considerable distortion. Present tests are more comparable to PRTR conditions.

The 19-rod Al-Pu cluster irradiated to 60% burnup in the ETR is being examined. This element was prototypical of PRTR start-up spikes except for length. Considerable crud had formed on the element and the wire wraps had loosened, but circumferential bands were still tight, no failure had occurred, and no gross dimensional changes were evident. Exposure to a loop pressure of 2000 psi undoubtedly contributed to the observed thermal cycling damage.

The reduction of PuO_2 by carbon has been found to proceed at 1700 C with the formation of Pu_2C_3 rather than PuC possibly because of vaporization of PuO_2 from the stoichiometric mixture. A preliminary value for the melting point of Pu_2C_3 has been determined as 2110 C.

The 48th and last cold swaged, 19-rod cluster UO_2 fuel element required for the first loading of the PRTR was completed during the month. Manpower released from the fabrication work will permit acceleration of other fuel development work.

The 85 PRTR Zircaloy-2 process tubes have passed all non-destructive tests, meet all requirements, and are ready for reactor installation.

Analysis of the data of heat transfer experiments on the thermal hydraulic behavior of PRTR Mk I (19-rod cluster) and Mk II-b (rod and tube-in-tube) fuel elements confirms preliminary conclusions that self-induced flow reduction due to steam formation in the tube will not occur. The analysis does show, however, that if one of the three flow channels of the Mk II-b fuel element

DECLASSIFIED [redacted]

1241926

were completely plugged, the other two channels would increase in flow nearly equal to the loss in flow of the afflicted channel and a low flow trip would not occur.

Ninety-five per cent of the dissolved oxygen in filtered Columbia River water was removed by employing activated carbon to catalyze the reaction between oxygen and aqueous hydrazine. This is of interest for NPR shutdown conditions.

Retubing of the Hanford production reactors with ribbed Zircaloy replacement tubes is being de-emphasized in favor of accelerating the test installation of smooth bore (ribless) Zircaloy tubes to operate with self-supported fuel. Three vendors have developed the capability to produce NPR Zircaloy process tubes, as demonstrated by good progress on pilot orders. The use of Zyglo (fluorescent dye) and ultrasonic non-destructive tests on these tubes was demonstrated to vendors' representatives during the month.

Estimates of the fast neutron flux (above 1 Mev) of primary interest for graphite damage in the Hanford reactors are being significantly improved through a combination of Hanford nickel activation measurements and multi-group machine calculations performed at ORNL.

Measurements of radiation attenuation as functions of temperature and density are continuing on iron-serpentine concrete shielding. Recent data indicate that high density concrete (265 lb/ft^3) of this type retains about 45 per cent of its original water content after prolonged baking at 320 C.

It has been shown that thermal cycling produces appreciable creep in uranium metal under conditions which produce no creep in a steady state test.

Wear tests to evaluate the scratching characteristics of NPR fuel element support materials on the process tube have shown that a low chrome molybdenum alloy steel has remarkably good properties. Many hard materials investigated scratched the tube while the soft materials such as aluminum and copper smeared badly.

Post-irradiation annealing of highly irradiated uranium at 600 C for 100 hours produces as much as 20 per cent decrease in density. Further annealing at 880 C produced little further decrease in density. These data tend to establish that tempera-

tures between the irradiation temperature (500 C) and 600 C are critical insofar as swelling is concerned.

2. Chemical Research and Development

Plant tests showed neptunium can be caused to follow along with plutonium and uranium in the Redox process and recent laboratory results point the way for isolating neptunium from the 3A-3B columns.

Surprising stability and a ten per cent greater capacity was observed in pilot tests of pulsed column cartridges for graded nozzle plates with the nozzles pointing up rather than down. This finding is contrary to theoretical reasons behind the original nozzle plate design.

Remote maintenance features of the Fission Product Packaging Prototype were demonstrated to meet design expectations of accessibility with a General Mills manipulator. Converting salt brine to a free-flowing powder, though simple in concept, is proving to be a troublesome operation in the apparatus.

The simple process of mixing and aging the cleaning solutions contemplated for NPR decontamination may, in itself, prove to be an effective waste disposal step because a manganese precipitate forms and adsorbs most of the radionuclides expected to be present.

Corrosion properties of unannealed experimental alloys of the Hastelloy-F type were found to be superior when titanium was included in lieu of niobium. Better welding alloys should result. Additional experimental alloys will be provided by contract with Battelle Memorial Institute.

Salt cycle process work included elucidation of plutonium behavior in the system (as yet an anomaly), development of cathodic deposition of UO_2 with consistently desirable properties, and the development of needed analytical methods for salt cycle chemical species. A very sensitive and precise method of measuring O/U ratios in UO_2 by coulometric titration was reported.

Slow dissolution and emulsification difficulties were encountered on typical PRTR plutonium fuel alloys under conditions anticipated for Redox processing. Silicon in the alloy causes the difficulty and may require extended dissolution cycles.

1241928

[redacted] DECLASSIFIED

Purex formaldehyde-treated waste neutralized with aqueous ammonia (vice sodium hydroxide) resulted in a more compact product from the Radiant Heat Spray Calciner. Smooth operation with the simulated feed was observed without sugar or other additives.

Effluent water from a zircaloy tube with over four years residence in a HAPO reactor showed only Mn^{56} to be higher in concentration (ca. 25 per cent) than amounts in effluent water from aluminum tubes. Twenty of the most prominent radionuclide concentrations were measured in both effluent waters with values found to be equivalent or lower in the zircaloy system with the exception of manganese noted.

3. Physics and Instrument Research and Development

A preliminary study on the desirability and technical feasibility of automatic control of Hanford reactors was completed. Recommendations have been made to develop a system for the NPR.

Room temperature PCTR measurements on dry tube-in-tube fuel elements in an NPR-type core showed an interesting 54 C rise in "neutron temperature" in passing from the edge of the lattice cell to the center of the fuel. This effect is caused by preferential absorption of low energy neutrons.

Uranium rods were successfully heated to about 800°C in a mockup of an experiment to measure fuel temperature coefficients at high temperatures.

The Berkeley Electronic Analog Simulation Equipment (EASE) was delivered and installed, and calibration and testing are under way. Reactor speed-of-control and NPR startup calculations were completed with the GEDA analog computer.

In the Nuclear Safety Program, experimental studies on the poisoning of a 1% enriched uranium-water lattice showed that the addition of 3.2 g/l of boric acid to the water moderator would prevent a chain reaction for any quantity of 1% enriched uranium.

Improved computer codes were developed for criticality calculations.

The Neutron Cross-Section Program suffered a setback when a carefully calibrated detector on the DR spectrometer was damaged during operational reactor repair work.

Methods are being developed for measuring the PRTR prompt neutron lifetime by recording data at the recorder on magnetic tape and using laboratory computer equipment for analysis.

In the Nondestructive Testing Program, promising results are being obtained with infrared methods for determining the heat transfer characteristics of fuel core to cladding bonding layers.

PCTR measurements were completed on the effect of a stainless steel loop in the EGCR lattice.

Funds were received from the Air Force for support of additional basic studies on atmospheric diffusion and dispersion processes. The field sampling grid is being reactivated and plans are underway to add more samplers.

Calibrations for measuring K^{40} and Cs^{137} activity in people are now in good agreement with results of other laboratories. Zn^{65} activities for different subjects show definite variations dependent upon work and home location.

Work was completed on several activities related to the development of improved methods for neutron dosimetry.

4. Biology

Whereas a power function of time adequately describes retention of strontium and calcium in adult rats, in weanling rats, retention follows a function represented by the sum of two exponentials.

DTPA administered to pigs one hour after Pu injection caused nearly 90 per cent of the administered Pu to be excreted in the urine during the following six days. In controls, given no DTPA, only one to two per cent was excreted in the same period.

5. Programming

Extremely favorable results were obtained from a series of computer calculations made to evaluate and test an advanced statistical technique (Box-Wilson method) for determining optimum fuel

[redacted]
DECLASSIFIED

compositions in plutonium recycle reactors. Of special interest was the verification that only small interaction existed between the several plutonium isotopes in determining the reactivity lifetimes of fuels. It may thus be possible to estimate the fuel value of a wide variety of plutonium compositions, in a given reactor, by very simple formulas.

Preliminary calculations were made to explore the characteristics of mixed fuel cycles involving fast and thermal reactors and/or thermal systems using plutonium-thorium and U-233 - U-238 fuel cycles. Favorable conditions were uncovered. Especial advantages were evident for the Pu-Th cycles and arise from the higher Pu-241 content obtainable in the discharged fuel as compared with Pu-U-238 fuel cycles in which dilution of Pu-241 by newly formed Pu-239 is unavoidable.

TECHNICAL AND OTHER SERVICES

A letter summarizing the results of the K-reactors reliability study was issued. Further work has been done on the NPR reliability study. In this connection, a new and general technique for computing the reliability of a system of arbitrary complexity has been discovered and is undergoing further development.

Work on six operations analysis programs continued during the month. In addition, statistical and mathematical assistance on 26 problems was given within HLO and to other departments and operations.

Three minor plutonium deposition cases were confirmed during February. Preliminary estimates of the plutonium deposition cases indicated that all were equal to or less than 10% of the maximum permissible body burden (mpbb = 0.04 μc Pu). The total number of cases that have occurred at HAPO is 249 of which 180 are currently employed.

The status of radiation and plutonium work restrictions for Hanford employees did not change during 1959. Four employees, including one collateral contractor employee, are restricted from all radiation work and 10 employees are restricted from plutonium work.

Radiation controls were established throughout the Plutonium Fabrication Pilot Plant process areas coincident with startup operations in-

volving fabrication of plutonium fuel elements. No unusual radiological problems were encountered during startup activities.

There are 29 currently active HLO projects having combined authorized funds in the amount of $23,634,000. The total estimated cost of these projects is $29,796,000. Of the 29 projects, 19 are on or ahead of schedule, and 10 are behind. No projects are known to be in financial difficulty except CGH-805 on which a revised project proposal has been submitted.

Fluorescent penetrant testing and ultrasonic testing of NPR process tubing sections were successfully demonstrated to representatives of the Allegheny Ludlum Steel Corporation, Chase Brass and Copper Company, Harvey Aluminum Company, Tube Reducing Corporation, and the AEC-HOO. These companies are potential suppliers of the NPR production process tubes.

There were 36 existing J. A. Jones Company orders at the beginning of the month with a total unexpended balance of $348,902. Ten new orders, three supplements and adjustments for underruns amounted to $119,623; expenditures during the month on HLO work were $124,116 (Includes C.O. Cost). Total J. A. Jones backlog at month's end was $344,409.

SUPPORTING FUNCTIONS

A report of results was issued for the physical inventory of movable cataloged equipment in the custody of Physics and Instruments Research and Development Operation. Eighteen hundred and twenty-four items valued at $967,000 were physically counted. One item valued at $112 was not located during the inventory.

There are presently 168 items valued at $77,000 in the Laboratory Equipment Pool. A listing of items available for loan or transfer is being prepared for distribution in HLO.

A special request was received by Hanford Laboratories during February for the fabrication of unirradiated UO_2-PuO_2 pellets for ORNL with an authorized amount of $1,500. Costs will be billed to Union Carbide Nuclear Company.

Hanford Laboratories has been authorized $126,000 for miscellaneous capital work orders during FY 1960. This allocation will permit the

DECLASSIFIED [redacted]

DECLASSIFIED

completion of work already authorized plus the air conditioning of instrument rooms in the 329 Building, estimated to cost $15,500. Work on the animal farm waste disposal, estimated at $15,200, cannot be authorized until additional funds become available.

As of February 29, 1960, the staff of Hanford Laboratories totalled 1305 employees, including 619 exempt and 686 nonexempt. There were 530 employees possessing technical degrees, including 316 B.S., 114 M.S. and 100 Ph.D.

The medical treatment frequency for February was 1.44 as compared with 1.41 last month. There were 2 security violations during the month, bringing the total for the year to date to 4 as compared with 10 during the same period in 1959.

The HAPO-wide study of Pressure Systems continued during February. Dr. Plunkett of General Engineering Laboratory reviewed HAPO Pressure Systems and policies and practices associated with their design and use. An interim report was issued.

During February 60 offers were extended for the Technical Graduate Program. Eight acceptances were received, bringing the total to 16 for the recruiting year to date - 76 offers continue open.

During February 10 offers were extended to experienced BS/MS personnel and 4 acceptances were received.

Two offers were extended to Ph.D. candidates and one was accepted by a Doctor of Veterinary Medicine. There are currently 2 open HLO offers, both to Ph.D. chemists.

With the addition of 9 new Technical Graduates and the placement of one on permanent assignment, there were 51 Technical Graduates on the program at month's end.

A course in Applied Creativity and 2 classes of PBM-I were completed during February. The second class in Applied Creativity is scheduled for March 17.

Fourteen nonexempt requisitions were filled during February. With the receipt of 17 new requisitions and 3 cancellations, there are currently 5 openings for which 4 candidates are in process and one transfer is pending.

F. W. Albaugh
for Manager
Hanford Laboratories

FW Albaugh:pmg

[redacted]
DECLASSIFIED

[redacted] DECLASSIFIED

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Hydriding of Zircaloy in Simulated NPR Gas Atmosphere. Samples of Zircaloy-2 and Zircaloy-4 were exposed at 400 C in an atmosphere of 93% He, 4% H_2, and 3% CO. A second lot of samples was analyzed for hydrogen after 53 days of exposure. Examination of the results reveals all the samples were hydrided, and comparison of the 21-day and 53-day data indicates the hydriding rate is accelerating. The autoclave films offered only temporary protection, and there was little difference between Zircaloy-2 and Zircaloy-4. The hydriding was extremely localized as indicated by the hydrogen analyses. Detailed results and interpretation of this experiment are discussed in HW-63894, "Hydriding of Zircaloy in Simulated NPR Gas Atmosphere - Interim Report No. 1" by D. W. Shannon, published February 11, 1960.

Acid Staining of Coextruded Zircaloy-2 Uranium Core Fuel Elements. An investigation was conducted during the past month to determine the cause of acid staining which has been observed on recent coextruded Zircaloy-2 clad, uranium core prototype fuel elements after the etch-autoclave process. Several variables were investigated using short sections of similar coextruded material. In this study the etch bath temperature, the etch transfer times between the etch bath and the stop bath, the pH of the stop bath (from 3.0 to 0.4), and the amount of metal removed during etching were successively studied. In no case was the staining eliminated until the surface striations produced during coextrusion were considerably reduced in prominence by protracted etching. These striations apparently have prevented satisfactory rinsing of the etched surface and hence were the cause of acid staining during autoclaving. To minimize the pick-up of corrosion product hydrogen in the cladding, mechanical smoothing of the surface prior to etching would be desirable.

Jet Impingement Studies. Samples of X-8001 aluminum, electroless plated with 0.2 and 0.5 mil of nickel and heated for three and six hours at 300 C, were tested by direct impingement of a 10-mil stream of 100 C water at 140 feet per second for seven and one-half hours. Bare control samples of X-8001 aluminum were deeply pitted by this exposure. Resistance to attack improved with increased clad thickness and increased heating time. The 0.5 mil nickel-plated samples which had been heated at 300 C for six hours resisted attack.

Reactor Decontamination. The use of a decontamination sequence employing alkaline permanganate followed by an appropriate acid solution appears promising for application to the NPR. The reactor piping involves welded

1241935

[redacted]

stainless to carbon steel joints as well as a number of crevices. The corrosivity of the acid solution together with its high electrical conductivity enhance galvanic and crevice corrosion.

The effects of flow on galvanic currents were tested at 60 C for a proprietary acid decontaminant (Turco 55-8A, 12 oz/gal). The test apparatus consisted of a series of thick washers of stainless steel, carbon steel, and Zircaloy-2, alternately stacked with teflon insulators. The decontaminating solution is pumped through the center hole of the assembly at a known rate. Currents flowing between washers were measured on a recording milliammeter as a function of flow. Equal areas of stainless and carbon steel had current densities of 0.3 ma/cm^2 at 0.5 ft/sec, which rose to 0.7 ma/cm^2 at 11 ft/sec. Even though this solution was blanketed in argon, the possibility exists that a small amount of residual oxygen increased the current measured. Deliberate increase of dissolved oxygen increased the galvanic current. The apparatus is being improved, and similar measurements will be made on other acid decontaminants.

A welded 304-L stainless to a 212-B carbon steel couple and a similar pair mechanically coupled were hung in the above solution for two hours at low flow. The welded specimen exhibited about the same corrosion as the mechanically coupled specimen.

Radiometallurgy Laboratory Studies

Metallographic examination of one of the broken tensile samples of Zircaloy-2 process tubing from KER Loop 2 has shown partial recrystallization. Two unirradiated control samples were tested at 275 C to show an average ultimate tensile strength of 56,200 psi and a total elongation of 4.9% (RM-502). A transverse section made through a Zircaloy-2 clad uranium rod which was diametrically opposite to the split-rupture rod of a 7-rod cluster revealed a hydride concentration of less than 10 ppm (RM-555). Metallographic examination of the area around the defected jacket hole in the first ETR Rupture Test showed a pocket of UO_2, under the defect, about 40 mils in diameter and 15 mils deep (RM-557). Examination of the pre-defected rod from the second ETR Rupture Test revealed a spherical oxide pocket of 50 mils in diameter under the defect, with many cracks in the uranium emanating from the oxide pocket (RM-558). Diameter measurements of the exterior tube of the three-foot long tube-in-tube fuel element showed the maximum ellipticity of the OD to be nine mils and of the ID to be twelve mils. Many bumpy areas were observed (RM-550). The results and conclusions from these tests will be reported in connection with the respective programs of Fuel Design and Physical Metallurgy Operations.

Basic Metallurgy Studies

Radiation Effects in Structural Materials. A Zircaloy-2 tube which has been exposed to neutron radiation over a twenty-five-month period, and a similar unirradiated tube were removed from the KER facility. These tubes are being mechanically tested and examined metallographically to determine the effects of high neutron exposure at elevated temperatures on Zircaloy-2, and to establish testing methods for monitoring NPR tubing. Irradiated specimen 4-1 which exhibited unusually low yield strength and high ductility was examined metallographically during the month. Widespread partial recrystallization which could account for the observed deviations in tensile properties was observed in the transverse section. Two unirradiated control specimens were tested at 300 C. The average ultimate strength and total elongation of these specimens were 56,000 psi and 5.0 percent, respectively. Room temperature properties of this same material were yield strength 96,000 psi and total elongation 7.0 percent.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel material after irradiation is a direct way of detecting radiation damage in these materials. Thin films or foils offer advantages, since radioactivity restrictions are minimized. The preparation of suitable thin foils by various methods has continued. Irradiation and subsequent examination of films and foils prepared previously are in progress.

Three micron diameter particles of uranium dioxide dispersed in a thin evaporated film of aluminum have been irradiated in air filled and in evacuated aluminum capsules. After an exposure to 8×10^{18} nvt (thermal) the uranium dioxide particles in the air filled capsule had sublimed onto the aluminum and vanished from their original locations; in the evacuated capsule, however, the particles of uranium dioxide show no change up to an exposure of 8×10^{18} nvt. Presumably, a chemical reaction between the uranium dioxide and residual air occurs during the irradiation in the air filled capsules. No evidence of fission fragment paths in the aluminum was found. Films irradiated to higher exposures will be examined.

Sputtered films of Zircaloy-2 have been sprayed with polystyrene spheres and then shadowed with uranium dioxide as a source of fissionable material. The sputtered Zircaloy-2 film shows no crystallinity by transmission electron diffraction, but on heating in the microscope develops crystallites, approximately 1300 Å in diameter, which yield a diffraction pattern corresponding to ZrO_2. There is doubt, therefore, whether the zirconium is present as a metal or an oxide film. Sandwich films have been irradiated and fission fragment tracks in regions of the sputtered zirconium film on which no uranium dioxide is present have been found. Since no tracks were observed in the irradiated aluminum films containing uranium dioxide particles, two alternate considerations must apply. Since contrast in the electron microscope arises from differences in electron scattering power of regions in a specimen

DECLASSIFIED

DECLASSIFIED

and is a function of specimen thickness, density, as well as atomic number, it is possible that the fission fragment trajectories are observable in only the denser, higher atomic number metal films. On the other hand, the thermal conductance of the film, metallic versus oxide film, may be the prime factor responsible for the appearance or absence of the track.

Sputtered films of thorium oxide have also been irradiated in evacuated capsules and fission fragment trajectories have been observed after an exposure of 3.1×10^{17} nvt (thermal). These tracks resemble those present in uranium dioxide films, irradiated to lower exposures, and are approximately 150 Å in width and as long as two microns.

Metallic Fuel Development

Cluster Fuel Elements. One of the 7-rod clusters in KER Loop 1 ruptured on February 8. The ruptured cluster was a 20-mil clad cluster. There were four 20-mil clad clusters and two 30-mil clad clusters in the charge. Exposure at the time of the rupture was 2520 MWD/T. The rupture occurred in a peripheral rod of the cluster and is similar in appearance to the rupture which occurred in KER Loop 2 in October 1959. There is no evidence of gross crud formation or damage to the other elements. The original black autoclave film appears to be intact.

Tubular Fuel Elements. Enriched tube/tube fuel elements of Zircaloy-2 clad uranium are being tested in KER loops. One test is operating in Loop 2 with 272 C outlet temperature. The charge consists of two 18-inch long alloy elements, and two 18-inch unalloyed elements. Present exposure is 750 MWD/T with goal exposure 3500 MWD/T. Maximum core temperature is 440 C. Average specific power in the test is 133 kw/ft, the highest yet achieved in Hanford tests of NPR fuel.

One 36-inch long tube/tube two percent Zircaloy alloy element is now in Loop 4. This element should operate at temperatures similar to the Loop 2 charge.

An NPR size tube/tube element is being prepared for an ETR test. Zircaloy-2 end fittings on the top of the element are designed to allow interim measurements during the course of the irradiation. Both inner and outer tubes have been completed except for autoclave testing. Welding of the end fittings to the tubes should be complete by March 1. Operating conditions at the ETR 6x9 loop will equal or exceed forecasted NPR temperatures and test flux.

The projection welding of twenty hot headed KER inner tubes for irradiation testing has been completed. Ten of these inner tubes will be mated with ten TIG welded outer tubes to make up a charge for irradiation in a KER loop. These will be ready for charging the first week in March. The elements are twenty inches long and contain natural uranium.

The electrographic technique for detection and identification of surface contaminants has been used on the internal bore surfaces of tubular fuel

1241938

elements. An expanding aluminum mandrel on an electrically insulated shaft is used to apply the electrolyte moistened filter paper to the suspected location within the tube bore. The mandrel is then expanded, pressing the test paper firmly against the surface while electric current is passed through the system. After a suitable period of electrolysis, the paper is removed and processed in the usual manner to identify the specific contaminants. This device supplements the borescope and vectorscope in detecting, locating, and identifying flaws and blemishes in the cladding material which may serve as focal points for corrosion attack during autoclaving and irradiation.

A specially designed single component test of tubular geometry for KER loop irradiation is being prepared from coextruded Zircaloy-2 clad NPR inner tube stock. These fuel elements will have the following dimensions:

Inside diameter -	0.52 inch
Outside diameter -	1.43 inches
Cladding thickness -	0.020 inch
Length -	16.00 inches.

They are expected to operate at 60 kw per foot at a maximum bulk water temperature of 280 C. The maximum uranium temperature will be approximately 430 C and maximum heat flux will be 450,000 BTU/hr-ft^2. This test more closely approached NPR conditions than do elements previously tested. The fabrication and testing of these fuel elements is essentially complete except for welding on of supports and autoclaving. It is anticipated that five unalloyed and two uranium - 2 w/o zirconium elements will be available for in-reactor testing by the second week of March.

It was previously reported that out of a group of three, two 18-inch unalloyed KER size outer tubes, which were being prepared for a KER loop test, had bad welds and were being reworked. After new end caps were welded in place, the tubes were vapor blasted and reautoclaved. After autoclaving they were each found to have a ring of white oxide in the bore. They were vapor blasted again, the bores examined with a borescope, and the regions where the white oxide had formed were found to have a rough, granular appearance. It is likely that if they were autoclaved again, white oxide would form in that same area again. Two 18-inch elements, one alloyed and one unalloyed, were charged into KER Loop 4, along with a 36-inch alloyed tubular element.

KER inner and outer tubular Zircaloy-2 clad material received from FPD has been examined. Some zirconium hydride phase was observed metallographically in the zirconium cladding of both sizes in the inner and outer cladding. Hydrogen content is estimated to vary from 75 to 200 ppm. The hydride is preferentially located in the outer one-third of the cladding when present in smaller quantities. At higher concentrations hydride is observed throughout the entire cladding thickness.

DECLASSIFIED

Component Fabrication. Three stainless steel clad uranium billets were extruded for FPD to determine the feasibility of coextruding stainless clad uranium elements. These billets were canned in copper and just prior to extrusion were preheated to 640 C. The stainless cladding broke apart into approximately one inch long rings around the uranium core during extrusion and required 25 percent increase in extrusion force over a similar Zircaloy-2 clad billet.

Sixteen Zircaloy-2 clad uranium billets, canned in copper with part of the copper cans being outgassed, were extruded for FPD. These billets were for the purpose of determining the effect of copper outgassing on the Zircaloy-2 to uranium bond integrity. The uranium cores are not sealed in the Zircaloy-2 jackets.

Sections of KER size outer tube elements with brazed end caps produced by Nuclear Metals, Inc., have been studied to observe the effect of the braze cycle on the uranium-Zircaloy bond and to determine the heat treatment required for satisfactory grain size in the uranium. End sections having a 3-3/4 and 6-1/4 minute braze cycle were given one, two, and three beta heat treatments consisting of salt bath heating to 730 C for five minutes, quenching to 600 C salt, holding for five minutes and air cooling. Measurements of the bond zone width indicated a maximum thickness of 0.0005 inch for the 6-1/4 minute cycle and 0.0004 inch of the 3-3/4 minute cycle. The normal bond zone width after beta heat treatment is approximately 0.0002 inch. The zone affected by brazing extends to 1-1/4 - 1-1/2 inches below the cap uranium interface. One beta treatment appeared satisfactory for refining the large grain uranium structure produced by brazing. Unbonded areas were found in both sections between the cap and uranium, extending the full width of the cap.

Expanding tests were made on KER size coextruded inner tubes. The tubes were expanded by plug drawing from 0.498 inch ID to 0.536 inch ID in 0.005 inch steps. One tube was heat treated (730 C for 10 minutes, 600 C for five minutes, air cool) and sized, the other tube was expanded in the as-extruded condition. During the second sizing step the as-extruded tube cracked longitudinally for one inch from the exit end. The cracked end was cropped, and the next three steps gave the same result. The as-extruded tube split longitudinally full length on the seventh (0.535 inch die) step. The heat treated piece showed no visible macro cracking during expansion to 0.536 inch ID (0.540 inch die). This behavior is contrary to that observed in rod sizing where as-extruded material was more resistant to cracking; however, it is expected on the basis of extrusion orientation and sizing methods.

Closure and Joining. Uranium was removed simultaneously from both ends of Zircaloy-2 clad KER outer tube stock by acid machining which consisted of rolling the tubes while submerged in 5 M HCl. An average depth of removal of 0.150" ± 0.005" was selected. Actual depths for the ten elements, based on an average of four measurements from each end, varied from 0.146 inch to 0.156 inch with 85 percent of the ends lying

[redacted]

within ± 0.003 inch of the desired value. Variations between ends of individual pieces was nominal with the average less than ± 0.002 inch for all pieces except one which varied ± 0.004 inch. The uranium surface had a light, crinkly appearance with a gentle upward slope towards the ID wall estimated to be on the order of 0.005 inch. The concave meniscus effect was less than had been observed in the past with an estimated radius of curvature of approximately 0.003 inch. Etch rates varied from six to seven mils removed per minute with relatively fresh acid, decreasing to four to five mils per minute as the acid depleted. These rates are based on an acid temperature of 45 to 55 C, and with speeds of rotation of 20 to 30 rpm. The stock material used was heat treated ingot uranium.

Equipment to be used for hot heading KER outer tubes is presently being set up in the 400-ton press, previously used for hot press work. The 50-ton draw press proved to be too small to hot head the larger tubular elements. This equipment will be capable of heading 20-inch long elements.

Equipment is presently being fabricated to hot head NPR inner tubes, which will head 20-inch lengths and will also require use of the 400-ton press.

A projection welded end closure is being developed for tubular fuel elements. This utilizes hot headed tubes and a cap having a series of concentric ring projections. The tooling design was changed in the past month to permit successful gripping of the coextruded elements, after which a production test lot of KER inner size elements has been projection welded. Among the advantages of this process are the double welded almost fully bonded end and the very high rate of production possible. Similar type welds in industry are made at rates in excess of 500 per hour.

Work has continued on the vacuum braze closure of KER outer tubes by means of a 95 w/o zirconium - 5 w/o beryllium eutectic braze alloy. Although the braze alloy can be melted and formed into a smooth surface within 15 seconds, the braze does not wet the uranium. A minimum time of two minutes at a temperature of 1050 C is required to cause bonding to the uranium. The size of the braze alloy particles is important in reducing the melting time. The optimum particle size appears to be -14, +35 mesh (0.045 to 0.016 inch diameter) which melts in 30 seconds. A layer of -35 mesh (less than 0.016 inch diameter) alloy placed between the Zircaloy cap and the uranium, with a layer of -14, +35 mesh material on top of the cap, produces more consistent bonding and eliminates the requirement for a helium overpressure after the braze is molten. The present cycle consists of the following: final etch, one minute; HNO_3-$Al(NO_3)_3$ rinse, one minute; load with braze alloy, one minute; insert into vacuum chamber and pump down, 2-1/2 minutes; melt braze, one-half minute; hold for diffusion, two minutes; and cool five minutes. Approximately five grams of braze are required for each melt, of which 4-1/2 grams are -14, +35 mesh (0.045 to 0.016 inch diameter) and one-half gram is -35 mesh (less than 0.016 inch diameter). Preparation of the

DECLASSIFIED [redacted]

DECLASSIFIED

eutectic braze alloy is difficult because of the extreme hardness of the alloy, the possibility of a health hazard, and the need for exact composition. The braze alloy shows phenomenal wetting on Zircaloy. Either lap or butt joints can be made on Zircaloy with ease.

Allied Fuel Studies. The second deliberate failure of a Zircaloy clad coextruded cluster fuel element has been carried out in the ETR 3x3 loop. This test represents the first time that an element has been charged into a reactor, irradiated to goal exposure, discharged, subsequently charged into another reactor and deliberately failed under full power and high coolant temperature conditions. The element, with a prior exposure of 2400 MWD/T, was operated in the loop for three days, caused to fail, and operated in the defected condition for an additional fifteen hours. Very little activity was released from the element. During the fifteen-hour period the reactor was cycled from full to low power three times, and the power output of the element was deliberately increased to cause beta phase operation. Subsequent sectioning of the defected rod revealed a spherical pocket of oxide, perhaps sixty mils in diameter, under the defect. The uranium around the oxide pocket was cracked and macrocracks were seen at the center of the rod. The central macrocracks may well have occurred as a result of beta phase operation. The results of the two intentional rupture tests are in complete agreement and show that the induction period in-reactor required to blister and crack the Zircaloy-2 cladding is in excess of fifteen hours, as compared to a one-third to one hour induction period in ex-reactor autoclaves or loops. This gross difference in induction period probably arises because the oxide formed in-reactor is generating heat, thus tending to compact the oxide, increase its protective nature and decrease the chemical activity of the steam which can gain access to the metal surface. Both experiments are in agreement in indicating that the prototype NPR instruments installed on the loop are more sensitive than was originally believed and may well be capable of detecting a failure in the NPR during the initial induction period.

Reactor swelling experiments of Zircaloy clad uranium fuel rods with selected uranium temperatures, cladding thickness, and exposures are being conducted. Four swelling capsules, GEH-14-97, 14-101, 14-103, and 14-105 are presently being irradiated in the MTR. Exposures and average center uranium temperatures of these capsules are, respectively, 1900, 1500, 1700, 2200 MWD/T, and 700, 275, 310, 335 C. Goal exposures as high as 5000 MWD/T have been established for these capsules. Two additional capsules to compare the swelling characteristics of ingot and dingot uranium have been shipped to the MTR for irradiation. The six remaining swelling capsules in D Reactor were discharged at the end of January with 2100 MWD/T exposure. Examination of the Hanford swelling capsules will begin in March.

During cyclic temperature operation, polycrystalline uranium develops microstress distributions due to the anisotropic thermal expansion of the uranium crystals. Cyclic temperature, constant stress, creep tests are being conducted to determine the effect of these microstress

distributions on macroscopic creep rates. The first creep test was cycled between 150 C and 465 C, one cycle a day, and at a load of 2000 psi. Under steady temperature operation, this load gives negligible strain rates, but after nine temperature cycles the strain was ~9.6 percent. No necking was observed on the sample. The testing apparatus for adapting the standard creep machines for these tests was modified for easier reloading of specimens. The next sample is ready for testing.

Arbitrary standards for the metallographic rating of coextruded bonds have been issued by FPD. Some initial defect tests have been made of bonds with different ratings to relate the standards to the service or performance requirements of the bond. Bonds of numerical rating 8 (good plus) perform well in defect testing; bonds of numeral rating 1 (very poor) perform poorly in direct testing. Testing of other bond ratings is in progress.

A notch fracture test has been made in the Radiometallurgy facility on a wafer of irradiated (2250 MWD/T) coextruded fuel rods. The test indicated that the clad fuel bond was of high strength because separation at the clad fuel interface did not occur. This behavior is in marked contrast with the behavior observed at the site of an in-reactor failure on the same irradiated rod. Failure behavior indicated that the clad fuel bond strength had deteriorated as the clad was readily separated from the fuel by the forces of the accumulated fuel corrosion products. The behavior at the clad fuel bond during notch fracture testing of the irradiated wafer compares with the behavior of high bond strength unirradiated wafers and not with the behavior of lower bond strength unirradiated wafers. However, differences in the mechanical properties between irradiated and unirradiated uranium may invalidate direct comparison of notch fracture tests on irradiated and unirradiated coextruded fuel material.

Tests made ex-reactor show that severe scratching of the Zircaloy-2 process tube will occur when full sized NPR fuel elements with Zircaloy-2 supports are charged in them. In addition to the loss of metal and eventual thinning of the process tube after a number of charge-discharge operations, these scratches may lead to localized corrosion or act as regions of stress concentration. Wear tests against autoclaved Zircaloy-2 plates have been made using various metals that might serve as the bearing surface of the fuel element support. Two steels, one a low Cr-Mo alloy steel and the other a 0.8 percent C tool steel, showed excellent wear characteristics, and scratched the autoclaved Zircaloy plates only after wearing for distances of 60 to 190 feet. The scratches start where there are bad surface defects on the Zircaloy. One sample of the low alloy steel that had an oxidized surface from autoclaving in 300 C water did not scratch the Zircaloy plate after wearing for a distance of 180 feet. The one-half inch diameter metal samples used in the tests were pushed against the Zircaloy with a force of 27 pounds. Indications from the eleven metals and alloys tested in this series are that a

DECLASSIFIED

DECLASSIFIED

tough material gives the best performance as the bearing surface for the fuel element support. If this relation can be verified, a much larger selection of bearing surface materials may then be possible. Therefore, another series of metals with high impact strengths will be tested to verify this correlation of toughness and wear performance.

The in-reactor test, in which 15 Zircaloy-2 capsules simulating fuel element jackets were tested, was discharged. Post-irradiation examination will determine fracture strain in the seven capsules that burst and the amount of creep under constant internal pressure in the eight remaining unburst capsules.

Ferro-aluminum alloy billets were successfully extruded with the Dynapak. Cast billets, 7 w/o Al - 5 w/o Cr - 3 w/o Nb - 0.5 w/o Zr - remainder Fe, were extruded into 5/8-inch diameter by 14-inch long rods at a reduction ratio of 10:1 at 1200 C. The high resistance to oxidation of this alloy was apparent when it was compared with AISi 347 stainless steel extruded under the same conditions.

A coextruded Zircaloy-2 clad uranium tube 1.45 OD by 0.625 inch ID and five inches long was made with the Dynapak at a 2:1 reduction ratio. As expected, the outer jacket was not bonded at this reduction ratio. The effects of higher reduction ratios will be investigated.

Design Analyses and Computations. In order to establish a rational basis for end closure design, analytic solutions are being established for determining the mechanical, thermal, and hydraulic conditions encountered in the end closure region of a fuel element. Numerical evaluation of a method for determining the temperature at the center of the end cap in tubular or plate type elements with bonded end closures has been started. Evaluation of cases with end cap to fuel plate or tube thickness ratios of two and one are completed. The case of the one-fifth ratio is being evaluated. Convergence of the series for thicker end caps to tube thickness ratios is strong enough to use a one term approximation. Temperature on the surfaces are high enough in the end cap thickness to tube thickness ratio of one to cause a surface temperature limit to be reached under certain proposed operating conditions for the NPR. Thinner bonded end caps should definitely cause operational limits on surface temperature.

Facilities and Equipment. A stress analysis considering the creep deformation of the NPR process tube under combined pressure and lateral loadings is being made. A numerical method of analysis was developed and the numerical calculations are carried to the stage of determining a moment - curvature relation. An iteration procedure is used to find final deflection since the effect of the axial thrust on the moments is considered. No attempt was made to program the method of solution; hence, only one numerical case is considered.

2. REACTOR PROGRAM

Coolant Systems Development

Aluminum Corrosion in Process Water. Out-of-reactor testing of reactor grade nickel plated fuel elements at 80, 120, and 165 C is continuing. Inspection at eight weeks of exposure showed extremely good corrosion resistance. The scale on the pieces in the 165° test was somewhat brittle and had flaked off of several elements exposing the bright, shiny nickel plate.

Corrosion of Zircaloy by Turco 4306 B. Coupons of Zircaloy-2 exposed in the single pass mockup tubes for four months at 110 C were cleaned in Turco 4306 B. The coupons were cleaned for 15 minutes at 20 C and 30 C in a three oz/gal solution, resulting in corrosion penetrations of 0.15 mil and 0.25 mil, respectively. These penetrations were approximately the same as obtained with unexposed coupons indicating that the films on the coupons provided essentially no protection against corrosion by the Turco 4306 B solution.

KER Operation. A rupture of a 7-rod Zircaloy coextrusion clad uranium fuel element in KER Loop 1 on February 7 produced a characteristic chain of warnings, including: (a) a high delayed neutron activity (which scrammed the reactor), (b) strong sympathetic responses in the monitors of the other three KER Loops, and (c) high radiation levels at the rear nozzle and at other points in the loop. Water analyses confirmed the rupture, showing abnormally high I-131, total I, Cs-137, and Np-239 concentrations. Examination of the rupture in the water basin revealed a longitudinal split, about 3/4-inch long, in the cladding of an outer rod in the cluster. The fuel surfaces appeared clean and free of crud deposits.

Effect of Radiation on Dichromate. To test the behavior of dichromate when subjected to reactor radiation, a nominal 100 ppm of ammonium dichromate was added to the KER Loop 4 system for a 15-day test. The loop was operated with aluminum dummies at an average temperature of 155 C, provided by gamma heat and by heat from the graphite. Frequent addition of bombs of $(NH_4)_2Cr_2O_7$, was required to maintain concentration. This is probably the result of both radiation-induced decomposition of the dichromate and the adsorption of it on the loop surfaces. Average concentrations measured during the test were: pH 4.5, 80 ppm Cr_2O_7, 11 ppm NH_4^+, 124 ppm total solids, 4 ppm O_2, and 1.5 ppm Fe. The O_2 and Fe are very much higher than is typical in KER at pH 4.5.

Corrosion Evaluation of Bisulfate Decontaminating Agents. Cyclic testing of decontaminants is proceeding in CEP-4. During the past month, the loop completed three cycles of a test using H_2O_2-HCO_3^- solution, alkaline permanganate, and Wyandotte-112 (a sodium bisulfate cleaning compound). Serious pitting attack on corrosion coupons was observed along the heat-affected zone on carbon steel of a carbon steel to stainless steel weld. The H_2O_2-$CO_3^=$-HCO_3^- solution, a non-lubricating

[redacted]

DECLASSIFIED

solution to graphitar, caused overheating of the shaft bearing journals of the Chempump rotor. The loop will be out of service until the Chempump can be repaired.

Oxygen Scavenging Studies. A laboratory-scale system was constructed to obtain preliminary results on the feasibility of using activated carbon to catalyze the aqueous hydrazine-dissolved oxygen reaction. Three tests were run and excellent scavenging was obtained. Flow rates up to 98 gpm/ft^2 of oxygen-saturated, filtered water were used. The temperatures investigated were 39 F and 62 F. In each test at least 95% of the initial oxygen was removed. Hydrazine to oxygen ratios in the influent ranged from 2 to 2.3.

Single Pass Decontamination. Six tests were run in the 242-B single pass facility during the past month:

1. 10% Turco-4518 at eight gpm gave a decontamination factor of 63 on a present reactor pigtail. The temperature range was 38-65 C during this 24-minute test.

2. 10% citric acid at four gpm gave a D.F. of approximately two. The temperature range in this test was 78-85 C.

3. 10% Turco-4512 at eight gpm gave a D.F. of 14.3 on an H Reactor pigtail. The temperature range was 65-70 C during this 24-minute test.

4. 2.5% Turco-4518 at eight gpm gave a D.F. of 22. The temperature range was 67-70 C during this 24-minute test.

5. 10% Turco-4512 gave a D.F. of 27 during a five-minute test with a section of a KER-1 mockup tube pigtail. The temperature was 70 C during this test.

6. A cyclic process using 2.5% Turco-4512 and 2.5% Turco-4518 gave essentially complete decontamination of a section of a KER-1 mockup tube pigtail in 24 minutes. Three complete cycles were run at approximately 70 C.

Slug Rupture Experiments. An outer tube of an NPR tube-in-tube element has been exposed in an out-of-reactor loop for 11 hours at 300 C with essentially no rupturing. The tube was purposely tested with a zero clearance between the pinhole defect and the process tube. After the seventh hour the 24-mil hole was "reopened" with a 25-mil drill. This element had a small pimple (about 1/16" diameter) after the first hour exposure and which never increased in size or appearance during the next ten hours of exposure. The element was taken apart, inspected, and reassembled six times during the test.

1241946

Structural Materials Development

Zircaloy Retubing Program. A total of 26 smooth bore Zircaloy-2 tubes for C Reactor have been received from Bridgeport Brass and Harvey Aluminum. Delivery of the remaining 74 tubes on order should be nearly complete by mid-March. Two hundred additional C Reactor tubes are being ordered for complete delivery by June 15. Due to a change in plans and fuel design, contracts for development work and production of ribbed Zircaloy-2 tubes for the production reactors are being terminated, although an estimated 20 to 30 ribbed tubes should be delivered in the next few months from tubes already in process on these orders.

NPR Zircaloy Process Tubes. A three-day information meeting and workshop on fluorescent dye penetrant and ultrasonic testing was conducted during February for representatives of the four contractors for NPR Zircaloy process tubes. The theory and operation of the two test methods were explained in an illustrated lecture session. The actual testing operations were then demonstrated at the White Bluffs testing site of Radiographic Testing Operation, using short lengths (up to 15 feet) of experimental NPR tubing. In a final discussion session, results on testing and reclaiming other types of Zircaloy tubing were presented, and testing equipment costs were discussed.

Chase Brass and Copper Company has shipped eleven full length NPR tubes which are now at HAPO for final testing. Ten completed NPR process tubes produced by Allegheny Ludlum Steel Corporation have also been shipped. The fluorescent penetrant and other test results on these pilot tubes are of interest to the vendors as a measure of the problems they may face in application of these tests at their sites.

With the inclusion of Harvey Aluminum, capability has been developed on the part of each of three vendors to produce NPR process tubes to present HAPO specifications. Work will continue to improve these capabilities in line with the new more rigorous specifications.

Nonmetallic Materials Development

Hanford Irradiation of NPR Candidate Graphites. Samples have been discharged from the 2C test hole at KE Reactor with an accumulated exposure of 2500 MWD/AT at 550 to 600 C. These samples were thermally annealed at 650 C prior to irradiation. The results of length change measurements are tabulated below:

HANFORD IRRADIATIONS OF NPR CANDIDATE GRAPHITES
2500 MWD/AT at 550 to 600 C

Graphite Type	% Length Change Transverse	% Length Change Parallel
GL-10	+0.022	--
GL-11	+0.015	+0.003
		+0.001
VC	+0.006	-0.019
KC	+0.025	-0.017
CSF	-0.005	-0.022
TSGBF	-0.008	-0.012

DECLASSIFIED

1241947

[redacted]

The measurements show that all of the graphites made with needle cokes (GL-10, GL-11, VC and KC) exhibited expansion in the transverse direction, while those from other cokes (CSF and TSGBF) contracted.

Several high density graphites prepared by pressure forming and baking processes were included in this irradiation. Exceptionally large contractions were noted as follows:

HANFORD IRRADIATIONS OF HIGH DENSITY GRAPHITES
2500 MWD/AT at 550 to 600 C

Graphite Type	Apparent Density	% Length Change Transverse	% Length Change Parallel
NC-1 (unimpregnated)	1.81	-0.085	-0.091
NC-2 (impregnated)	1.90	-0.128	-0.120
NC-3 (unimpregnated)	1.83	-0.095	-0.092
NC-5 (impregnated)	1.92	-0.087	-0.087

These samples will be re-irradiated to determine whether the high initial contraction rates continue at higher exposures.

Flux Monitoring. Preliminary results from calculations of the fast neutron flux spectrum in the Y test hole at C Reactor were obtained from ORNL. The calculations were performed using a thirty-two group, diffusion-type code, the GNU-II, which had been modified to include twenty groups in the range 0.183 mev to 10 mev. The ratio of the flux above 1 mev to the flux above 5 mev, the reported Ni activation threshold, was calculated to be 21.2 compared to a value of 12.9 for a Watt fission spectrum, a change by a factor of 1.65. Thus, it appears that considerable modification occurs in the flux spectrum in the test position even in the region above 1 mev.

Similar calculations are being performed for the K Reactor lattice and the NPR lattice, and the results will be used in an effort to correlate damage rates in the two reactors.

Thermal Hydraulics Studies

Hydraulic Studies. Fourteen different combinations of rear fittings were examined in the hydraulics laboratory as part of the feasibility study for increased flow rates in the BDF type reactors by use of larger rear hydraulic fittings. Most of the fourteen cases examined consisted of reaming the existing header fittings (Parker fitting) and using larger J-type connectors. The data indicated that normal single tube flow rates could be increased up to 15 percent above present rates. The maximum flow rate corresponds to that attainable by using a complete K Reactor type rear assembly on a BDF tube. Attainment of such flow rate increases is based on an assumption of constant front header pressure; since reactor hydraulic supply curves probably show a decrease in front header pressure with flow increase, the total reactor flow increase would be less than

the single tube analysis would indicate. Mechanical problems may also limit the use of the largest reamed fittings which were tested (0.650" ID header fitting). The results were reported in HW-63756 1.

Heat Transfer Experiments Pertaining to Present Production Reactors. Three sets of experimental data concerning thermal hydraulic characteristics of BDF type reactor process tubes under various conditions were completed. These data, obtained from the full scale electrically heated low pressure heat transfer apparatus, were as follows:

1. Steady state hydraulic demand curves for enlarged rear fitting at standard rear header pressure.

2. Similar data with the same test section at rear header pressures of 150 psig.

3. Steady state hydraulic demand curves at very low tube powers with standard rear fittings.

For data set No. 1, flow instability would not occur due to plugging for tube powers less than about 1100 KW if the tube were supplied with flow from a front header at a pressure of 550 psi. Double protection for upstream plugging by a high trip would not be realized with tube powers less than 600 KW, with initial Panellit pressures equal to 180 psi.

For data set No. 2, the hydraulic demand curves align with similar curves for low rear header pressures in the boiling region. This is significant in that studies of hydraulic stability for reactor operation at high rear header pressures can be conducted with existing data.

For data set No. 3, the hydraulic demand curves obtained for tube powers of 50, 100, 200, and 300 KW were carried to flows sufficiently small that the pressure drop had reached a maximum and was decreasing with decreasing flow. This factor makes this data of particular value in analysis of shutdown cooling conditions.

Glass Heat Transfer Test Section. The test section using an electrically heated rod in a glass tube with annular cooling was modified. The thermocouples in the thermocouple plate at the outlet of the glass section were modified to obtain an averaging of the radial water temperature gradient across the annulus. This was done by soldering a copper fin to each of the nine thermocouples located around the annulus. A short run indicated that the lateral positioning of the glass tube with respect to the heater rod was more of a problem than at first realized. The positioning table is being modified to correct this situation.

Laboratory Equipment. The high pressure heat transfer apparatus remained shut down for modifications to allow greater flow and heat transfer rates as provided by Project CGH-834. The piping and instrument parts of the job were nearly finished and the first of two additional preheaters was installed. Progress was generally on schedule and

[redacted] DECLASSIFIED

DECLASSIFIED

operation of the apparatus was still planned for the second week in March 1960.

Design was completed for a short test section to be installed in a horizontal position in the high pressure heat transfer apparatus to allow boiling burnout experiments applicable to NPR conditions. Initial experiments were scheduled for this test section shortly after startup of the apparatus following completion of the second phase of Project CGH-834.

Considerable difficulty has been encountered in recording thermocouple readings from electrically heated test sections when using the new silicon rectifiers as a heat generating source. The a-c ripple imposed on the d-c output of the rectifiers induces an undesirable current in the thermocouples used to measure surface temperature in the heat transfer test sections. Suitable filters for the recording instruments were developed that would filter out the a-c components of the thermocouple signals without greatly affecting the response time of the instruments.

Shielding Studies

Neutron and Gamma Attenuation. The iron-serpentine concrete (265 lb/ft^3) test slabs were removed from the oven, where they were baked at 320 C, and placed in the shield facility for irradiation. The data indicated there was a 7.1 lb/ft^3 water loss after the concrete was baked at 100 C and 8.1 lb/ft^3 after the 320 C bake. This leaves a total of 6.4 lb/ft^3 of water retained in the concrete after the 320 C bake.

The lighter iron-serpentine concrete (210 lb/ft^3) test slabs were removed from the shield facility and placed in the oven where they will be baked at 320 C. After the foils have been counted and analyzed, this will complete the testing of this concrete in the "as-cured" condition.

An interim report on the results of the boron-steel thermal shield test has been issued as HW-63981, "NPR Design Test DT-1037, Boron Steel Thermal Shield Test." In this test the neutron attenuation of a one-inch plate of boron-loaded mild steel (approximately 1.0% boron by weight) has been studied experimentally using the 36" Shield Test Facility. Measurements to date indicate attenuation factors of 225 and 4.5 for thermal and resonance neutrons respectively.

Argonne National Laboratory has agreed to assemble the Perlow Neutron Recoil Counter with the exception of the two counter wires. An engineer from Hanford will install the wires and check the assembly. Fabrication of the final nine ion chambers for the C Reactor shielding work is complete.

1241950

[redacted]

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 Lawrence Radiation Laboratory (Project Whitney). Details of these activities are reported separately via distribution lists appropriate to weapons development work.

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. Studies have continued on the thermal expansion of plutonium dioxide in an effort to determine the cause for the discontinuity which exists on a plot of $\Delta L/L$ versus temperature. The discontinuity has been consistently observed between 600-700 C on curves from samples run in vacuo, while a specimen run in one atmosphere of helium showed no deviations from linearity up to 1000 C. A specimen which had been cycled three times in a vacuum of 10^{-4} mm Hg was subjected to x-ray diffraction analyses. The face centered cubic phase found had a lattice parameter of 5.396 ± 0.002 Å indicating pure plutonium dioxide. No evidence of a second phase was found. The diffractometer used in the x-ray work should detect a second phase if present in a quantity greater than 10%. A black ring was found on the dilatometer chamber about four inches above the sample and might possibly be the condensate of a volatile oxide. This effect has been observed before with copper. It would seem unlikely that a compound with a melting point near 2300 C would be volatile at such low temperatures. The cause for the discontinuity is presently being investigated by high temperature x-ray diffraction.

More determinations have been made on the UO_2-PuO_2 liquidus, and all the experimental data support a continuous liquidus curve between the two compounds. The phase diagram for this system has been calculated using the laws of ideal solutions and an approximation for the molal entropy of fusion. The theoretical diagram is of the simple Cu-Ni type, and good agreement between the theoretical and experimental liquidus curves was found. The maximum deviation was about 50 C which occurred at 2400 C (UO_2-90 PuO_2). The dendritic growth effect is still consistently seen at high temperatures and, as reported, is more severe for UO_2 at melting than for PuO_2. Extrapolated data indicate that the vapor pressure of UO_2 at its melting point is about eight times greater than that of PuO_2 at its melting point. However, at the melting point of PuO_2, the vapor pressure of PuO_2 is some 2000 times greater than that of UO_2 at this temperature.

The thermal conductivity apparatus has been completed and is being calibrated. Conductivity measurements to possibly 1000 C on ceramic materials containing plutonium will take place in a vacuum by the comparative method. Type 430 stainless steel, which has been calibrated

by the USBS, is used as a reference material. Initial experiments will be directed toward obtaining instrumental constants, thermal equilibrium over all temperatures, and an estimate of the accuracy which may be obtained from the apparatus.

Sintered pellets of UO_2, UO_2-25, 40, and 75 PuO_2, and pure PuO_2 were heated in saturated steam at 350 C - 2500 psi for 24 hours to determine the extent of attack as a function of composition. Two runs have been made -- one on a series of high density pellets (1500 C - 8-hour sinter) and one on a set of low density pieces (1100 C - 8-hour sinter). In both cases the pieces looked sound after autoclaving, and no evidences of heavy attack or disintegration were evident. The high density pieces gained weight with increasing PuO_2 content, except for pure PuO_2 which was 0.127 gm lighter after autoclaving. The low density pieces also gained weight; however, in this test both the UO_2-75 PuO_2 and the pure PuO_2 lost weight during autoclaving. These studies will be continued after the contaminated autoclave again becomes available.

A series of carbides of both Pu and U have been made by heating the respective oxides with graphite to 1800 C in vacuum. The resulting pellets have been repressed, using a paraffin benzene binder, at 37.5 tsi. These pellets have been resintered at 1900 C for two to six hours. The resulting bodies have had fair densities estimated at 80-90% from metallographic samples, but the time and temperature of sintering does not seem to be enough to achieve good homogeneity. Metallographic examination shows quite a bit of segregation; however, x-ray analysis shows almost pure UC in the UO_2 plus carbon samples. The lattice spacing of the sample made from 3% less carbon than the stoichiometric amount for UC shows a value of a_o of 4.940 Å as compared to the reported value of 4.951 Å. This reduced lattice parameter may be due to residual oxide in the system.

The plutonium carbide samples show strong lines of Pu_2C_3 on x-ray analysis. The a_o of the sample of PuO_2 plus 3% less than stoichiometric (for PuC) carbon is 8.129 Å as opposed to the reported value of 8.130 Å. This agreement is well within the limits of accuracy of the measurement. Two fairly prominent lines on the diffractometer trace were not indexed by the Pu_2C_3 structure. These might arise from a suboxide which was found in some of the other samples. Photomicrographs of these samples show a prominent second phase which has not been identified by etching techniques.

In an attempt to get more homogeneous samples the resintering was tried for longer times at maximum furnace temperature. This proved too much for the coil as its insulation broke down and arcing resulted. The coil was replaced, a new crucible was rammed, and the furnace is back in operation.

The consistent production of the sesqui-carbide of plutonium while producing the monocarbide of uranium under the same conditions prompted an investigation into the rate of the PuO_2 plus carbon reaction. The

reduction of PuO_2 by carbon was found to start (in the ribbon furnace) at 1700 C as determined by a sudden rise in the system pressure. This consistent production of Pu_2C_3 may be explained by a relatively high vapor pressure of PuO_2 as compared to UO_2. The top, cooler portions of crucibles always show signs of condensed PuO_2 on their sides. Any deficiency in Pu due to such a vaporization would encourage the formation of Pu_2C_3 instead of PuC. The vapor pressure of PuO_2 will be determined at these reaction temperatures to see if the formation of the monocarbide may not be promoted by a slightly lower reaction temperature. It may be necessary to compensate for the loss of PuO_2 by adding less carbon to the starting mixture.

A preliminary value for the melting point of Pu_2C_3 was obtained. The average of three determinations gave a value of 2110 C.

Fuel Fabrication. The evaluation of ultrasonic testing techniques for inspecting tube quality is continuing, and the reliability of the standards is being investigated. The testing of the first 100 rods indicates a high percentage have cladding defects. A total of 870 tubes are currently in process, and virtually all of these have been swage sized and final gauged. After swaging and straightening, the inside diameter of the tubes were treated with emery to remove burrs which created loading difficulties. First end caps have been welded into 637 tubes with virtually no rejects.

Four -hundred-ninety-six billets were cast yielding 992 fuel cores, and this completes requirements. The casting yield to date is as follows:

Fuel Cores	Percent	Rejects Attributed to Casting Process
992	100.0	
108	10.9	Rejected in development of corrosion-resistant alloy.
884	89.1	
12	1.2	Short billets rejects -- only one rod obtained from a billet.
872	87.9	
69	7.0	Blistered core rejects.
803	80.9	Preliminary Yield

Since all the billets have not been extruded, other rejects may occur for the above reasons. Additional rejects, attributable to the casting process, may occur from alloys which fall outside plutonium concentration limits, as well as in other steps of the fabrication process. Of the three causes for the tabulated rejects, only the blistered core problem has not been completely eliminated. Consistent corrosion resistance was developed in the alloy by casting into unheated graphite molds; short billet rejects were eliminated by increasing the melt size slightly.

1241953

Seven-hundred and twenty-seven cores have been extruded, and this effort is also about completed. Three-hundred and fifteen cores have been loaded, and only two have been lost because of sticking since graphite lubricant has been used. Eighty-nine final closures have been made. Each rod is helium leak checked immediately after the final closure is made and again after etching.

Fuel Evaluation. The four-foot long Zircaloy clad Al-Pu alloy 19-rod prototype cluster which was irradiated to a maximum of about 60 percent burnup of the Pu atoms is currently being examined in the Hanford radiometallurgical facilities. This element which employed the quick disconnect design was exposed in the ETR 6x9 high temperature loop for a total of 18 days at full power and 2000 psig pressure. It had received a total of about 15 thermal cycles. The stainless steel basket was easily removed in the basin at Hanford. Examination in the cell indicated that a considerable amount of "crud" had formed on the surface of the element and that all the wire wraps had loosened, but the circumferential stainless steel bands were still tight. The stainless steel ball lock pins in the end brackets could not be loosened with the manipulators and it was necessary to cut them off. The bottom end bracket was then easily removed, and the manipulators were used to disengage the quick-disconnect fittings on the top end bracket. Sixteen of the eighteen fittings operated satisfactorily, and the tips of the end caps broke on the remaining two. Preliminary examination indicates that some of the rods show signs of warping. A closer examination of the rods is continuing to determine warpage and change in length. Metallographic samples will also be obtained.

This element was fabricated by swage sizing the cladding onto the cores after canning. It was difficult to control the diametral gaps by this technique which may have aggravated the warp problem. Also, 2000 psig pressure would collapse the cladding and promote interaction between the core and the cladding. At the time this element was fabricated, the helical spacing wires were strained to their yield point or beyond as they were attached. It has been demonstrated since this time that loosening will occur under these conditions and the wires are now attached while under much less tension.

The 7-rod, Al - 1.8 w/o Pu alloy, PRTR prototype cluster with Zircaloy-2 cladding, stainless steel end fixtures, and quick-disconnect end caps was discharged from KER Loop 1. The cluster was scheduled for a longer exposure, but the rupture of another test element necessitated the charge removal. Cursory examination of the element in the reactor basin indicated that the cluster was in good condition and had suffered no gross deformation.

At the present time there are 24 irradiated UO_2-PuO_2 capsules in the Radiometallurgy Laboratory for examination. Eight specimens have been selected for complete evaluation. Of the remaining capsules, all will be photographed and measured and twelve sent back to the MTR for additional irradiation.

1241954

A comparison of the pre- and post-irradiated structures of GEH-14-19 co-precipitated high density oxide pellets (UO_2-0.026 w/o PuO_2) has been made. Both samples have been cathodically etched, and, as expected, a noticeable grain size difference is seen in the sample centers. The irradiated sample was held for two weeks in a thermal flux of 1.6×10^{14} nv and the calculated core temperature was 1900 C. The pellets were initially sintered for eight hours at 1500 C. The average central grain area was about four to five times greater for the irradiated specimen. At the edge of the pellets the average grain area was approximately the same for both samples.

Several additional experiments have been fabricated and are awaiting scheduling in the MTR and ETR. They are as follows:

1. A four-foot long Zircaloy clad 7-rod cluster prototype containing Pu-Al-Ni-Si-corrosion resistant alloy cores containing 1.4 w/o Pu. This element has diametral gaps as great as 0.007 inch between the core and cladding.

2. A four-foot long Zircaloy clad 7-rod cluster prototype containing UO_2-PuO_2 sintered and ground pellets as the fuel material. The rods contain UO_2-0.6 w/o PuO_2 cores in as-received Zircaloy tubing.

3. An 11-inch long Zircaloy clad 3-rod cluster containing Pu-Al-Ni-Si alloy cores with as much as 0.008 inch diametral clearance between the core and cladding.

4. An 11-inch long Zircaloy clad 3-rod cluster containing Pu-Al alloy cores with as much as 0.006 inch diametral gap between the core and cladding. These cores were slip fits in as-received tubing.

5. Injection cast Al-Pu core Zr clad bonded capsules.

Fabrication Development. Pu-Al fuel rods are being drawn to final size in a hooded draw bench. A cutter was designed and installed in the draw bench hood to reduce one end of the rods for insertion through the die to start the drawing operation. A commercial drawing lubricant, Oakite #12, is applied by a dipping operation and the rods are drawn through a tungsten carbide die. Very close diametral tolerances (± 0.002 inch) and excellent surface finish are obtained by the drawing operation.

A representative sample of PRTR fuel core material was autoclaved at 250 C for 24 hours in static deionized water with no signs of corrosion. The same sample was then autoclaved for 24 hours at 350 C in static deionized water with no signs of corrosion. The results from this test indicate that the alloy apparently does not have a minimum temperature limit for corrosion.

1241955

All parts have been machined for the Mark I-G Zircaloy-2 fuel element brackets. The projection welding fixtures for resistance welding the ring and sleeve sub-assemblies are complete, and several large and small rings have been welded to determine proper machine settings. The weld areas for different amperage ratings are being sectioned and photomicrographed before the full fabrication is begun.

A dummy Mark I-G was completed for charge-discharge testing in 314 Building. A second dummy 19-rod cluster of the Mark I-G design was fabricated using the same process as the first spike load for the PRTR. The only other deviation from the actual loading other than the core is the use of stainless steel end brackets instead of Zircaloy-2 end brackets. This cluster is needed for pressure drop and thermal cycle tests in the 314 loop. The cluster will be tested under specified PRTR water flow, pressure, and temperature.

Thermal cycling experiments on 30-inch long Zircaloy clad dummy elements are continuing. Recent tests indicated that the testing pressure was greatly affecting the cycling results. Ten rods were cycled 80 times at zero pressure, and no changes were observed in the specimens. Additional rods were fabricated by various techniques, and the cycling tests on these elements are continuing at 1000 psig. The results at the present time are as follows:

1. Six rods were fabricated using four-inch segmented cores. The segments were separated by indenting the can. All elements were wire wrapped. No dimensional changes occurred after 49 cycles at a pressure of 1000 psig.

2. A coat of graphite lubricant in the form of dag was applied to the outside of the cores and the inside surfaces of the cans on ten rods. There was a minimum diametral gap of 0.004 inch between the core and cladding. They were all wire wrapped. Five of these rods have received 25 cycles with no appreciable dimensional changes occurring. The length of the core seems to have shortened on one of the other five rods which have received 50 thermal cycles.

3. Six rods were fabricated with minimum diametral gaps of 0.004 inch. No graphite lubricant was applied and no wire wrap was attached. At the end of 25 cycles, no appreciable dimensional changes were observed.

4. Ten elements were fabricated with minimum diametral gaps of 0.004 inch and they were all wire wrapped. No graphite lubricant was applied. Essentially no dimensional changes had occurred in five of the elements after 25 cycles. The core showed signs of shortening in one of the remaining five rods at the end of 50 cycles.

1241956

Thermal cycling results are definitely dependent on the testing pressure. A marked improvement has resulted from lowering the pressure from 1400 psig to 1000 psig, which is closer to PRP conditions. The pressure range around 1000 psig seems to be a critical one for a nominal can wall thickness of 0.030 inch. An improvement in the cycling performance could be made by increasing the wall thickness of the tubing. The testing apparatus is being modified so that a constant pressure is applied to the specimens over all temperature ranges.

A method is being developed to fabricate irradiation capsules for evaluation of a new fuel design. Crushable MgO swaging tubing, 1/2-inch OD, 1/16-inch ID, 3-inch long, was filled with UO_2 powder to determine the density obtainable with loose powder filling. Apparently, bridging occurred in the 1/16-inch hole as the average density obtained with six samples was only 25% of theoretical. It is planned to insert the UO_2 and eventually PuO_2 filled MgO tubes into Zircaloy tubing and weld in swaging end caps. This will be followed by swaging to compact the MgO and enclosed PuO_2 to produce a self-shielded fuel rod resembling a "cal-rod" type sheathed heating element.

A major portion of the month was spent in leak checking the autoclave systems. The number 2 autoclave unit now appears to be leak tight. Dummy cluster #3 (Zircaloy-2 clad aluminum dummy rods) was autoclaved for 72 hours at 400 C and an initial pressure of 1300 psi. The final pressure was 1150 psi. A visual examination of the furnace cooled rods showed a uniform black oxide surface and no signs of warping. The over-temperature safety protection on the autoclave has been revised to operate on the internal thermocouples as well as the heater elements. Thus, a pressure leak, which produces extreme thermal gradient in the autoclave, will automatically cut the power to the heater before the fuel rod cores are melted.

The flipper type glove ports that were originally installed on the vacuum welding chamber would not meet requirements, and they were replaced by the original type glove port with covers. The vacuum system requires a maximum of five minutes to pump from atmospheric pressure to 1×10^{-4} mm Hg. It is felt that a minimum of 20 minutes pump down time should be allowed to evacuate the loaded fuel tubes before making the final closure. The welding chamber is now in operation, and back fill time is three seconds at 1000 psi.

UO_2 Fuel Development

PRTR Fuel Elements. The 48th Class I fuel element was completed this month. This fulfills the requirements for Class I UO_2 fuel elements for full power PRTR operation. Other fuel elements in process will provide spares, replacements, and extras needed for design and critical tests.

As reported last month, a total of 2180 rods were swaged. Because of constantly improving yields, the last 100 were diverted from the PRTR

1241957

fuel assembly, after swaging, and will be used for special irradiation tests.

Yields of Class I, swaged PRTR fuel elements approached 90 percent during the month (as compared with 19 percent for the April-June 1959 quarter) despite more rigid standards and more severe testing.

Seven autoclaved PRTR fuel rods randomly selected from six different autoclave batches were checked for uranium surface contamination by exposing nuclear track film to the surface of the rods. Surface contamination varied between 0.0 and 0.2 microgram/cm^2. The total uranium fuel element surface contamination in the PRTR core would be 0.06 gram, based on the average contamination found on the seven tested fuel rods.

Fabrication Development. Swaging experiments were performed during the month to determine the dependence of swaged density of -20 mesh fused UO_2 in Zircaloy-2 cladding on pre-swaged density and percent reduction in fuel rod cross-sectional area. For a given loaded density, there is an optimum swage reduction that produces maximum swaged density. Swaging beyond this point results in decreased swaged density. Work-hardening of the Zircaloy-2 cladding is presumably responsible for this behavior. As the swager dies open, after impact, the cladding will "spring-back" an amount dependent upon the amount of cold work present in the cladding, and the swaged UO_2 density will decrease accordingly. The swaged UO_2 density is a function of the pre-swaged density. Tubes of UO_2 loaded to a high density require less swage reduction to reach maximum density than do tubes loaded to lower densities. Because the amount of cold work introduced into cladding is accordingly less, less "spring-back" occurs, and higher swaged densities result.

A UO_2 density of 10.37 gm cm^{-3} (94.5% theoretical) was obtained by high energy impact forming of evacuated, stainless steel capsules of micronized UO_2 at 1200 C with the Dynapak machine. Coextruded UO_2 densities of 96.9 percent and 97.4 percent of theoretical were obtained in stainless steel at 1200 C, and in Zircaloy-2 at 750 C, respectively, with different dies. Extruded material was non-uniform in core diameter and wall thickness.

Lead-tin alloys are being investigated as gamma absorptometer density standards. An alloy having a composition correlated with the UO_2 density of interest may be cast into cladding of appropriate dimension. This method will eliminate the tedious and somewhat uncertain method presently used to obtain standards.

Fuel Evaluation. A three-foot long, prototypic swaged 19-rod (PRTR configuration) fuel element was completed for ETR critical facility tests. A similar test assembly is nearing completion for irradiation in the ETR 6x9 in-reactor loop.

Swaged UO_2 capsules have attained an estimated exposure in excess of 13,500 MWD/T during irradiation in ETR-MTR. No failures of swaged capsules or element have occurred.

Metallographic examination of the Zircaloy-2 cladding of an irradiated, purposely defected, swaged UO_2 fuel rod revealed a circumferential hydride concentration gradient at the defect. The hydride concentration at 90 and 270 degrees from the defect, 200 ppm, was twice the hydride concentration at 0 and 180 degrees. The average hydride concentration elsewhere in the cladding was approximately 100 ppm.

Four-hundred and thirty-seven feet of sintered UO_2 pellets in stainless steel tubing were delivered to Chemical Development Operation for fuel element dissolution and chemical reprocessing studies.

Basic Studies. Preliminary calculations based on classical radiation theory revealed the cause of a significant increase in the thermal conductivity of UO_2 which has been indicated in irradiation tests at temperatures above 1000 C. The thermal conductivity of UO_2, measured below about 1000 C, adheres to a $1/T$ law. However, the optical transmission properties of UO_2 indicates that radiation contributes significantly to heat transfer within solid UO_2, and radiation conductivity follows a T^3 law.

A shielded, remote facility for high temperature microscopic examination of irradiated UO_2 was completed.

Facilities. The Thermatool Rib Welder was installed in the 325 Building basement laboratory. The ability of this equipment to attach spiral ribs on Zircaloy-2 clad PRTR fuel rods and straight spacer ribs on nested tubular fuel element components will be determined. The equipment is essentially a drawbench with facilities for pulling the tube and rib stock through a set of rolls beneath a welding head. Heat is generated at the joint by 450 kc, 60 kw, resistance heating. The weld is performed at a speed of 90 feet per minute. The preliminary work performed on this equipment by the vendor was inconclusive.

1241959

Corrosion Studies

Need for Etching Zircaloy Prior to Autoclaving. It has been recognized that in order to obtain meaningful weight-gain data during autoclave corrosion tests, specimens must first be etched to prepare a reproducible surface. However, it was not known how necessary this etching was to actual long-term corrosion performance of the metal and how etching affected the time to breakaway and post-breakaway corrosion rates.

Six different zirconium alloy materials were corrosion tested in 400 C, 1500 psi steam in both the etched and "as received" condition. Comparison of the rate curves for the alloys out to about 1000 hours reveals conclusively that etching is required to obtain reproducible weight gains. A comparison of the weight gains at 800 hours of exposure illustrates the differences in weight gain etching produced:

Weight Gain, mg/dm^2, at 800-hr, 400 C, 1500 psi Steam

Alloy	Etched	Unetched
Zircaloy-2	38	36 (slopes similar)
Zircaloy-2*	75	65 " "
Zircaloy-4	36	68 " "
Zirconium	37	27 (slopes different)
Zircaloy-3	44	210 " "
Zircaloy-3*	54	340 " "

*Duplicates from different ingots.

Corrosion Testing of Zircaloy-2 from Columbia National Sponge. Samples of Zircaloy-2 made from Columbia National zirconium sponge were recently obtained from KAPL. These coupons were machined from 3/4" thick plate stock and hot rolled 0.200" thick strip. Many of the samples failed to meet the corrosion specification of 28 ± 10 mg/dm^2 weight gain after a

1241960

14-day 400 C, 1500 psi steam test. Weight gains up to 58 mg/dm^2 were observed together with mottled grey corrosion product films. Standard Zircaloy-2 coupons from KAPL, WAPD, and HAPO were included in the test and were satisfactory. Comparison of three-day and 14-day data indicates that the Columbia National material corroded rapidly for the first three days of test, but then the rate slowed to a normal Zircaloy-2 corrosion rate for the balance of the test. The end result was a high absolute weight gain, but a normal terminal corrosion rate, the change in weight from three days to 14 days being essentially the same for all of the alloys. This test is still in progress to determine whether parallel corrosion rates will continue.

Corrosion of Various Iron and Super Alloys. The corrosion rates of various iron and superalloys are being investigated for possible reactor application. The alloys are being tested in 360 C, 3200 psi deionized water and have received approximately two months of exposure to date. 406 stainless steel, 406 modified, and 430 stainless steel are exhibiting weight gains of approximately 5 mg/dm^2 and are similar to modified Ferral and a 6% aluminum, 24% chromium, iron alloy, which have weight gains of 8.4 and 6.1 mg/dm^2, respectively. 302 stainless steel, 410 stainless steel, Alfenol, and Ferral are exhibiting weight gains ranging from 18.3 to 26.2 mg/dm^2 with the 410 stainless steel being the highest and Ferral the lowest. The various Hastelloys and Inconels are varying from 11.6 to 24.2 mg/dm^2, with Hastelloy "F" showing the lowest weight gain and Inconel the highest. Two alloys, a 1% yttrium, 30% chromium, iron alloy and Allegheny-Ludlum iron-nickel base alloy D-979 have exhibited weight losses after only one month of exposure.

Structural Materials Development

PRTR Zircaloy Process Tubes. Eighty-five PRTR process tubes are ready for delivery to the PRTR contractor. These tubes meet the following criteria:

1. The minimum wall thickness is 0.146 inch or greater.

2. There are no metal flaws as measured by ultrasonics and compared to a 3-mil scratch standard.

3. (a) There are no surface flaws on the outer or inner surfaces as demonstrated by fluorescent penetrant testing, or

   (b) Where penetrant indications have been observed, radiographic and ultrasonic testing show no defect to be present.

4. The corrosion resistance is good as demonstrated by satisfactory autoclave films.

5. Tube bowing incurred during autoclaving has been corrected to within half the straightness tolerance specified to the vendor.

Of the remaining 12 tubes from the 97-tube order, two are considered unsuitable for reactor use but up to ten may be usable on a controlled basis, being scheduled for early removal and destructive testing as part of the tube monitoring program.

Radiometallurgy Laboratory Studies

A vibratory-compacted UO_2 fuel element was sectioned at midpoint and photographed. Partial sintering had occurred, but there was no central void (RM-600). Six samples from five various irradiation tests of UO_2 or PuO_2-UO_2 capsules were dissolved and sampled for burnup analyses. Burnup samples were also obtained from a 1.65 w/o Pu-Al and an 8.0 w/o Pu-Al alloy capsule. Examination of the defected UO_2 fuel rod (RM-603) was completed this month.

An unirradiated and a 0.4 a/o burnup irradiated sample of uranium were annealed for one hour at 880 C and cooled at 10 C/hr. Metallography, density and Fax-film replicas for electron microscopy were obtained (RM-265). The results and conclusions from these tests will be reported in connection with the respective programs of Ceramic Fuels, Physical Metallurgy, and Plutonium Metallurgy Operations.

Thermal Hydraulics Studies

Hydraulic Stability of Coolant Channels in the PRTR. The analysis of the conditions leading to possible hydraulic instability in the PRTR coolant channels was continued. Of particular concern in regard to hydraulic stability is the possibility that an increase in pressure drop in the coolant channel due to boiling would cause a self-induced flow reduction and excessive fuel temperatures.

The method of analysis consists of combining the hydraulic demand characteristics of the different portions of the coolant channels and comparing the result with the hydraulic supply characteristics under different conditions of normal and abnormal power and flow levels. The hydraulic demand characteristics for the portion of the coolant channels containing the fuel elements were obtained from full scale electrically heated mockups of the PRTR fuel elements in the heat transfer laboratory. The other demand characteristics were calculated and the supply characteristics were taken from the pumps curves.

For the coolant tubes containing Mark I type fuel elements, it was found that there was little chance of unstable flow conditions. For coolant tubes containing Mark II type fuel elements, it was found that the flow conditions in the individual channels within the fuel element were stable, but the margin of safety was not large. Furthermore, it was found that unstable flow in one flow channel would not be detected

1241962

since the decrease in tube flow with one channel in the fuel element completely blocked would not cause a reactor scram signal.

Protection Against Inadequate Cooling of a Fuel Element in the Event of a Small Leak in a PRTR Process Tube. The PRTR scram signal following rupture in a process tube or in the piping between the flow monitor and a process tube is by a high flow trip. If such a rupture should occur, the leak flow would be many times the normal tube flow and a high flow trip would occur. However, if a small leak should occur, the leak flow would come partially from an increase in total flow to the tube and partially from a robbing of the flow through the heated section. The question, then, is whether the total tube flow increase is sufficient to cause a high flow trip before the flow through the heated section is reduced to dangerous values. Preliminary calculations show that the reactor would be scrammed before the heated section flow were reduced to dangerous values if the high flow trip point is set no more than 105% of normal flow.

Effect of Wire Wrapping on Coolant Temperatures in the Mark I Fuel Elements. An electrically heated test section was constructed to determine the effect of wire wrap orientation on the coolant temperatures in the Mark I type fuel element. The test section will be run at prototypical flows and heat generation rates and data will be gathered concerning the water temperature distribution across the element for different orientations of the wire wraps.

PRTR Project Management and Design

Phase III PRTR Contract. The Phase III contract portion of the PRTR is 62% completed versus a scheduled 76% based on a May 20, 1960, completion date. However, the Phase III contractor has been awarded an additional 35 days, extending his contract to June 24, 1960, to compensate for strikes and other delays to his contract. Over-all PRTR Project is estimated to be 82% complete versus a scheduled 80.1%.

All pre-placed heavy aggregate concrete work on the biological shield was finished to the minus six-inch level. Conventionally mixed topping pour is being delayed to permit repair of the top flange on the inner liner.

The thermal shield blocks and cooling connections have been mocked up as required by the Phase III contract. Welds on cooling connections to inlet and outlet headers have been completed. Steel work on the rotating shields is complete except for minor cleanup work.

It is anticipated that the calandria and bottom primary shield will be delivered to contractor during the week of February 29.

PRTR Stack Addition. The PRTR stack contract is estimated to be 99% complete. The contractor was furnished backfilling and is completing installation of obstruction lights and painting.

1241963

Process Piping. Fabrication of modified pressurizer nozzles to accept safety relief valves was completed during the month.

Interim piping flexibility analyses reports covering deadweight and internal pressure stresses and stresses resulting from the failure of ring header supports to permit design movement were received from Electric Boat Division of General Dynamics Corporation. Thus far the analyses have shown piping flexibility to be within code except for cases of stuck header supports. The probability of such sticking is extremely remote and may be lessened by incorporating special provisions for lubrication, or totally avoided by monitoring piping movement during pipe expansion.

Eight sets of contractor submittal data on piping, pumps, and valves were reviewed.

Specification for PRTR ion exchange resins and portable disposable ion exchange units were written and distributed with bid invitation.

Instrumentation and Control. A rough draft report was completed summarizing a study on the compliance of the PRTR with General Electric Reactor Safeguards Council Standards. It was found that:

1. An interlock should be added to require that two neutron measuring channels be on-scale above a pre-set level in order for the gas balance compressor to run.

2. The temporary second channel of source level instrumentation should be made permanent if the first year of operating experience indicates that it will be needed routinely to meet recommendation 1.

With these changes, the existing PRTR nuclear control system is believed to comply fully with GE Safeguards Council Standards which have been adopted to date.

Purchase orders have been placed for all GE procured equipment for revisions of the PRTR safety and containment systems. The design change for revising the safety circuit to require coincident signals to shut down the reactor was negotiated with the Phase III contractor in the amount of about $45,000 plus several days extension of contract time.

The special silicone base compounds for "potting" the shim control cables into their connectors have been ordered. Because of the experimental nature of these compounds and the special techniques required, it is planned to have the "potting" done by plant personnel.

An invention report has been filed on a fusible contact temperature monitor for indicating temperature conditions above limits on the outlet of process tubes of a pressure tube reactor. The proposed temperature monitor would replace conventional thermocouples, resistance temperature

1241964

detectors, and their more complicated measuring circuits with a simple device which is clamped around the process tube outlet jumper, and a current detector. A contact made of a material chosen for its melting or softening point would be held against the outlet jumper and an electrical circuit broken when the material changed state or shape. Breaking of the circuit would cause a high temperature trip signal to be transmitted to the control room. The cost of such a device and its measuring circuitry would be significantly less than that of conventional temperature monitors currently in use.

Fuel Handler. Fuel handler testing was completed. The tests indicated that minor revisions be made to auxiliary equipment on the machine. The fuel handler is presently available for delivery to the construction contractor.

Process Tube Assembly. Nozzles have been delivered to the contractor, and tubes are ready for delivery. An interpretation of the acceptance test requirements has been given to the contractor and general procedure requirements outlined.

Fuel Transfer System. Installation of the fuel transfer system is in progress. Some trimming and adjustment of location is required to enable operation of the system.

High Pressure Loop. Analog studies are being initiated to evaluate control system transients and stability at equilibrium conditions.

Fuel Element Hangers. Bids for furnishing 140 fuel element hangers are due February 26.

Helium Gas System. The Phase III contractor was instructed to proceed with installation of piping of helium compressors in accordance with the revised drawings. The design change was consummated for about $15,000, and several days extension of contract completion date.

Fuel Element Examination Facility. The cast iron shielding blocks are now en route. The two sections of the control console which were made by Panellit have been received. Assembly and testing of the viewers was continued as parts were received.

Electrical. The scope design was completed for the emergency power tie-in from 384 Building to the PRTR to furnish backup power for critical drives in PRTR and the Gas Cooled Loop. A proposal was drawn up for supplying power to the PRTR primary coolant pump low speed windings if BPA and the diesel generator sources of power fail, but 384 power is available. The cost of such an installation is estimated at about $20,000.

PRP Critical Facility (Project CAH-842). The Project Proposal, HW-63069, was approved by General Electric Company and transmitted to the AEC on February 12, 1960.

The Design Criteria, HW-62117, has been revised to include a reactor moderator system capable of changing and controlling the reactor tank level at any point in the top four feet of the vessel. Additional equipment required for this change includes an 850-gallon storage tank, an adjustable weir overflow system, an addition pump, and associated piping and valving. The reactor cell was deepened from 26 to 32 feet to house the additional equipment.

Detailed design of the building addition has been completed. The fuel transfer lock design was withdrawn from the building design package and will be procured on a "design and build" basis. Rough draft specifications were completed during the report period.

Fuel Element Rupture Test Facility (Project CAH-867). Work on the design criteria is nearing completion with the criteria being assembled for publication of a comment issue. Scope drawings, to be included in the design criteria, are about 85% complete.

Work performed by Coolant Systems Development Operation indicates that the design flow rates for the cation and anion ion exchangers of the makeup system must be reduced from 50 gpm/ft^2 to 25 gpm/ft^2 to obtain adequate capacity utilization and to prevent bed leakage. It was also indicated that the mixed bed exchangers and the cation unit of the cleanup system can be designed for 50 gpm/ft^2.

Because the Rupture Loop will, on occasion, contain ruptured metallic uranium fuel elements, the possibility of uranium fire must be considered. Since the PRTR fuel handler is air cooled, it was apparent that some modification must be made to it or to the established handling methods. After reviewing a number of possibilities, it is proposed that the entire test section filled with water would be removed and transferred to the storage basin. In the storage basin the test section will be lowered into a metal thimble which extends down to the -38 foot elevation. The fuel hanger and fuel elements would be removed vertically. The thimble arrangement will also allow regular PRTR test sections to be vertically disassembled.

Design and Component Testing

PR-1 - Discharge Operation Mockup. Testing of the PRTR fueling vehicle components noted below continued during the month:

1241966

a. Position Indicator. The modified bridge and carriage position indicator systems were installed on the carriage, and operation was successful. The systems will position the carriage of the fuel handler within 0.045". Fuel elements were charged and discharged with displacements four times this amount.

b. Air Cooling System. The shrouds were installed but required hand grinding to allow the discharge cask plunger to pass by the shrouds. Compressor suction pressure with the shrouds and seat in position is 8.3" Hg and with a UO_2 prototype element in position with the shrouds, suction pressure is 8.6" Hg. Compressor suction pressure with a process tube in position on the seat (containing the UO_2 fuel element) is 10.5" Hg. The compressor will operate 9-1/2 minutes before overloading with the 10.5" Hg suction pressure.

c. Process Tube Discharge. Initial attempts to raise the process tube into the discharge cask and place the tube on the seat were unsuccessful. The process tube being used for this test is a reject with approximately 0.250 inch bow versus 0.100 inch specified. Guide rods in the seat drive air cylinder were bent when attempting to lower the tube on the seat at various discharge hook speeds. The air cylinder was repaired, and the seat is being modified to correct for more misalignment between tube and seat.

d. Charge-Discharge of Prototype UO_2 Fuel Element. It is possible to charge and discharge the fuel element with the centerline of the discharge hook offset 3/16" from the centerline of the nozzle. The discharge hoist motor failed with the fuel element approximately half way out of the process tube during one of the discharge attempts. Motor failure was caused by a "sticky" relay in the discharge hoist speed control unit. The fuel element has been discharged from a bowed process tube (maximum bow, approximately 2" located 9' from bottom of tube) with a discharge hook pull of approximately 300 pounds.

PR-10 - Primary Loop Mockup. The spare PRTR mechanical seal pump was disassembled after 1380 hours of operation with injection water to the seal chamber. Inspection of the high pressure seal revealed the same excessive wear pattern observed on the previous test run. Increased seal temperature, higher power consumption, and decreased flywheel coast down time all occur simultaneously and appear to be caused by the excessive seal wear. The pump has operated 300 hours with a new lower balance seal which allows higher leakage, 0.1 to 1 gph. The new seal is already showing evidence of excessive wear. The pump manufacturer has been contacted and is sending a representative for consultation and inspection of the pump, which will be disassembled at the end of this month.

Additional tests are being conducted to determine if vibration or pressure pulsation could be contributing to the excessive wear rate.

The high pressure seal of the prototype pump continues to operate at leakages less than 0.01 gph after 2600 hours of operation. A bearing failure in the drive unit caused this pump to be shut down during part of the month. The temperature has recently been cycled from 350 to 530 F, and the pump speed varied from 400 to 2200 RPM, routinely without noticeable effect on the seal performance.

Evidence of erratic leakage of the process tube high pressure closures has necessitated a renewed emphasis on evaluating the leakage problems. Operation each night as well as weekends, necessitated by the fueling vehicle tests during the day, have resulted in 230 hours of operation during the month with nine complete pressure and temperature cycles.

Severe process tube heating rates from cold to 350 F in five to ten minutes occur during these cycles with the temperature thereafter raised to 530 F in approximately 30 minutes. Several potential reactor operating problems were encountered during these cycles which resulted in increased leakage. These problems were fuel element damage to cap gasket seat during charging, insufficient bolt-up torque, and excessive shims in the process tube to nozzle flange. The leakage rates will be continually monitored and reported after more prototypical conditions are resumed.

The Zircaloy process tube installed in June 1959, before the pickling and autoclaving facilities were available, has been removed from the Single Tube Prototype Loop after 2329 hours of operation near PRTR conditions. The tube was cleaned by sandblasting, followed by pickling and autoclaving. Borescope examination revealed several suspected flaws which upon sectioning the tube showed wear depressions, 0.001 to 0.002-inch deep, adjacent to the fuel element supports and several randomly spaced blisters. The presently installed tube, which was pickled and autoclaved prior to installation, was examined after 963 hours of operation with a borescope. One suspected wear area was noted at the fuel element bottom support location and a blister near the top of the tube. Operation of the tube is continuing at PRTR conditions.

PRTR Primary Pump. Changes in power consumed by the prototypical PRTR primary pump during routine operation have been measured. The changes compare in magnitude to the friction losses as estimated in HW-63401, "PRTR Primary Pump Flywheel Analysis."

PR-40 - Shim Control Mockup. An aluminum test tank incorporating prototypical shim shroud tube extensions has been fabricated to investigate the possible corrosion problem between the shim assembly and the shroud extension.

A trip was made to GE-APED to observe the first and second production models of the shim control assembly in operation. The lead screws of the first assembly had an interference within the ball nut. The vendor is making corrections on site.

The other problem area encountered in production of the shim control assemblies is the drive motors which are being furnished by Glove Industries. The GE-APED is inspecting the motors upon arrival. Eight of the 23 motors inspected to date have been rejected because of defects.

PR-64 - Gas Sampling Technique. Testing of the prototype sampling system is complete, and a final report is being written.

PR-70 - Helium Compressor Test. The modified oil compensating pump with hardened steel piston and sleeve and chromed piston rings was removed from the test stand after 700 hours of satisfactory service. A modified piston and seal system received from the German manufacturer was removed from test after 10 hours when signs of scoring appeared on the piston. The teflon backup seal was removed, and the test restarted with a neoprene seal.

PR-80 - Air Cooling Duct Test. Fabrication of the second duct is 90% complete. A work order to remove the existing low pressure duct and install the new high pressure duct for testing has been issued.

Special Tools. The outlet nozzle core saw for use in removing the nozzle, process tube and fuel element into the fueling vehicle should the assembly become stuck has been tested. The saw successfully parted the nozzle outlet elbow and hold-down assembly. Improvements to the cutter edge and drive unit are planned before final testing.

Drawings on three of the special wrenches have been completed and are being checked prior to issuing for comment.

The cut-off saw has been fabricated and is being adapted to the fueling vehicle for testing.

The fuel element extractor is 80 percent complete.

Silicone Foam and Sealers. The second pouring was delayed pending delivery of an activator for the silicone. The pour has been made and leaks similar to the first pour. Two substitute sealers are to be tested as alternates.

PRTR Outlet Nozzle Fabrication. A total of 67 nozzles have been completed by J. A. Jones and delivered to the reactor site. The remaining 23 are scheduled for delivery by the end of the month. Considerable repair work on welds, threads, elbow alignment, flange thickness, bore eccentricity, etc., was required of parts received from the vendor.

PRTR Rupture Disc Assemblies. The rupture disc assemblies have been completed by J. A. Jones and are now being helium leak tested prior to delivery to the reactor site.

1241969

Cadmium-lined Shielding Cylinders. Ten of the shielding cylinders have been bored and lined with cadmium by J. A. Jones, and the remaining six are scheduled to be completed by the end of the month.

Inlet Orifice Flange. The revision to the inlet process tube flanges was started during the month and is now 45 percent complete.

Temperature Probe for Fuel Examination Facility. Testing of the second prototype (100-K) thermistor temperature probe using an arsenic trisulfide window has been completed. The output has increased 500% and the response time to 63% of a step temperature change has decreased 25% as compared with the same probe using a radiation stabilized glass window. The transmission efficiency of the arsenic trisulfide windows remained unchanged at accumulated doses of 10^6 and 10^7 R; however, at 10^8 R the following losses appeared:

1. 30% loss at one micron wavelength
2. 10% loss at four microns
3. Approximately 1% from five to 12 microns.

The 12-micron cutoff point remains unchanged. The average loss in the range utilized by the thermistor probe (four to 11 microns) is about 5%. The irradiation to 10^9 R is in process.

Design Analysis

Rupture Loop Temperature Transients. Following a reactor scram, loop components and the primary coolant are subjected to sharp temperature transients. The absolute magnitude of these changes and rates of change are dependent on the loop operating conditions. Thus, the necessity for automatic temperature control is also dependent on the operating conditions of the particular loop.

In order to determine the desirability of an automatic control system for the Rupture Facility, a temperature study was programmed for solution on the IBM-709. The conditions assumed were: (1) H_2O flow of 100,000 lb/hr, (2) electric heat capacity of 600 KW, and (3) maximum tube power of 1800 KW. The problem is to be solved assuming that following the scram, the primary coolant flow will remain constant, all coolant will flow through the regenerative heat exchanger and cooler, and the electric heater will deliver 600 KW. The 709 program is at present in the debug stage, and solutions are expected early next month.

Effect of Scram on Pressurizer D_2O Level. The liquid contraction following a scram in the PRTR was re-evaluated. The previous calculations were performed using the NPD reactor power decay curve. In the present study the more recent curve by Untermeyer and Weills was used.

The results indicate that the maximum rate of D_2O contraction is about 310 gpm. The total liquid contraction is estimated to be about 124 gallons, and this occurs in about 30 seconds. Since the maximum helium

flow required to maintain 1024 psig in the pressurizer is about 1900 scfm, the present system (capable of delivering 3000 scfm) appears adequate. The results are presented in HW-63861, "The Effects of a Scram on the Level of Heavy Water in the Pressurizer of the PRTR."

Instrumentation. A study report on a high speed data acquisition system for the PRTR has been published as HW-63789. The proposed system would scan 300 data points at speeds up to 100 points per second. Computing capability is included to perform such functions as continuous individual tube power calculation and on-demand evaluation of xenon and iodine concentrations.

Physics Analysis. Debugging of the SNG transport theory code for the IBM-709 is continuing. The calculation now yields the correct eigenvalue for the test case; however, the converged fluxes are in error by a large factor. Methods to accelerate the convergence are being investigated.

A study of 7-rod PuO_2-UO_2 fuel elements has been initiated in cooperation with Plutonium Metallurgy Operation. Both heat generation and reactivity are being calculated.

A brief study was made of the effect on reactivity of increasing the present Zircaloy cladding thickness on PRTR spike enrichment fuel elements. If the cladding on the Pu-Al elements is increased to 0.035" from the present 0.030", the loss in reactivity would be of the order of one milli-k.

Solutions are being obtained for control rod reactivity worths in a reflected core. The neutron transport model used is two-group diffusion theory. Rods being considered may have eccentric locations in the core. The calculational method has been programmed for the IBM-709 in FORTRAN language. The code (RECON-Reflected eccentric control) is compiled compatible with MONITOR operations. Debugging of the code is under way. An immediate application of the program will be to calculate rod strengths in the PRTR and PRCF where reactor flux distributions are affected considerably by the effective increase in core size due to a reflector.

Further employment of the F3 three-group diffusion theory cell and reactor sub-routine is being made using the FLUX-WEIGHT calling program written in FORTRAN language to perform a survey of the properties and behavior of several core configurations in the PRTR and PRCF. Output of the code consists of the following:

A. Cell Calculation

1. Three-group flux and fission density distribution in cell.
2. Infinite multiplication factor.
3. Average three-group fluxes in each cell region.
4. Cell average three-group cross sections, flux and volume weighted.

B. Reactor Calculation

1. Three-group flux and fission density distribution in reactor (core, reflector, shield, etc.)
2. Effective multiplication factor.
3. Three-group adjoint flux distribution in reactor.
4. Flux normalization factor (per watt of reactor power).
5. Relative statistical weight distributions given by products and cross products of the flux, the adjoint flux, and the volume weight. (Nine distributions are formed for three energy groups.)
6. Average three-group adjoint fluxes in each core region.
7. Average three-group cross sections for the core, obtained by weighting region cross-sections by the product of flux (i), the adjoint flux (i), and the volume weight, where i is the neutron energy group.

This code is currently being debugged. Cell cases are treated properly, but some facets of the reactor version require further modification.

PRTR Startup Activities. All but four of the Critical Test outlines have been presented to the Startup Council for review. Special foil-containing fuel assemblies to be used in obtaining thermal and epithermal flux distributions during startup testing have been designed, and fabrication has been requested. Planning of the Power Tests has been started.

Process Specifications. Writing of PRTR process specifications has continued. About 35 percent of the specifications have been issued in rough draft form.

PRTR Safeguards Analyses. The PRTR Final Safeguards Analysis, HW-61236, was reviewed by the Advisory Committee for Reactor Safeguards on January 28. All questions of the safety of the reactor raised by the Committee were apparently answered to their satisfaction. However, a written opinion is yet to be received.

Plutonium Fabrication Pilot Plant (PRoject CA-747)

Routine progress was made during the month in preparation of the second floor to receive the transferred equipment. The electrical and instrument cable trays were relocated, lighting re-arranged, power cable installed for the bus ducts, and the new lighting and receptacle power panel was installed. The hood exhaust and vacuum air sampling lines were extended into the second floor. Good progress was made with the installation of the zirconium etch facility; mechanical and electrical work is about 75% complete, and the facility will be ready for use as soon as plastering and painting are completed.

A complete schedule was agreed upon for the moving of equipment from 231-Z Building. It was ruled that the removal of the equipment, preparation for shipment, and transportation to 308 Building will be performed by 200 Area

Maintenance. A project proposal revision covering this change of method of performing work was approved during the month. The first pieces of transferred equipment, the experimental autoclave hoods, were received at 308 Building on February 25.

Work on the sintering furnaces continued in February. The furnace pressure control panel and the atmosphere control panel were received from the vendor in an incomplete condition. This work is being completed by construction forces. The cross-push mechanisms have still not been received though their shipment regardless of state of completion was ordered early in the month.

Fabrication of the cryolite furnace hood has been complete for some time, awaiting receipt of the furnaces. These have now been received, and work on mounting them is in progress. Delivery of the furnace hood to 308 Building is expected March 1.

PRTR Operations

Engineering Assistant training continued on schedule. The second phase of radiation training was organized and started at month-end. Six Engineering Assistants have completed their training with Mechanical Equipment Development Operation in the 314 Building. Another group of six Engineering Assistants was assigned to the 314 Building for a one-month training period. Three Technicians were assigned to 1706-KER for one month to gain experience in operation of high temperature-high pressure loops.

Pre-Startup Activities. Final operational and design review was completed on six tests during the month. All but two of the 53 tests have now been submitted for this review prior to presentation for approval by the Startup Council. Preparation of a list of special equipment items needed for the tests was completed, and a cost estimate of $22,000 was obtained.

All critical tests except number 35 have been presented to the Startup Council. Test 35 and the revised introduction to the tests will be presented in March. Equipment requirements for these tests were formulated. It is estimated that $35,000 will be necessary to procure and fabricate the required items.

The PRTR Power Test Sub-Council was organized during the month. Two PRTR engineers were appointed as PRTRO representatives. The Sub-Council met twice during the month to formulate a rough draft outline of the tests to be performed.

Seven operating procedures were issued during the month. In addition, several emergency procedures and operating procedures in rough draft form were circulated for comment. Answers to the written portion of the Qualification Test for personnel who will operate the reactor were compiled and will be issued next month. Comments were made on process specifications issued to date and were discussed with Reactor Technology Development Operation personnel.

A second communication system for PRTR was scoped and presented to Design Development Operation for their consideration. The second system would provide communications to the new facilities being added and would provide back-up for the present installation.

The PRTR Annunciator Manual was revised. Copies will be issued to interested personnel.

In cooperation with FPD Maintenance, the PRTR maintenance manpower requirements have been reviewed on the basis of the revised construction schedule. In addition to instrument calibration, maintenance activity during FY-1960 will be devoted to training and planning. Calibration activity will start in March on the reactor control room. Layouts of the temporary shop area in the PRTR Service Building basement were obtained, together with a cost estimate. These were forwarded to DDO for action. Spare parts have been ordered for PRTR components for which BPF data are available.

PRTRO completed definition of calculational requirements for the data handling system. This information was transmitted to EDPM to assist in their PRTR programming efforts.

PRTR Electrical Manual. Preparation of this manual which was begun in January is 20 percent complete. An additional forty percent is nearing completion. The remainder, except for test loops, will be finished by April 30.

PRTR Sampling Program. At a meeting held with representatives of the Analytical Laboratory Operation, the use of a Perkin-Elmer Infracord for determining isotopic purity of heavy water was demonstrated. This instrument was found to have the required range and sensitivity; purchase requisitions were prepared to obtain an Infracord for the PRTR Analytical Laboratory.

2. BASIC SWELLING STUDIES

Irradiation Program

Two types of capsules for irradiating uranium at a constant temperature are currently under construction: a metallographic specimen swelling capsule for insertion into either the MTR or the ETR, and a general swelling capsule for insertion into a HAPO reactor. Four assemblies of the metallographic specimen swelling capsule are in nearly completed stages of construction while four general swelling capsules have been completed and the fifth is in the final stages of assembly.

Several improvements were made in the design of the metallographic specimen swelling capsule during the construction period. The method of affixing the heaters and the thermocouples to the vacuum tight inner chamber was modified to include a welding sleeve. This improved the ease of welding and reduced the number of reject assemblies. Another set of heat transfer calculations have been made on the final design, and, with no additional changes, the capsule will be able to perform satisfactorily between the temperature limits of 450 C and 630 C in a neutron flux of 3×10^{13} nv to 1×10^{14} nv. One of the major problems in the design of the capsule was the large demand on the electrical heaters to keep the sample at a constant temperature at all times. The demand was such that there was not sufficient room to place the required heater in the capsule and still allow for some swelling of the uranium. The changes that have been made have decreased the power demand on the heaters by 18 percent at the highest temperature and by 34 percent at the lowest operating temperature. This was mainly accomplished by completely surrounding the heater with NaK, reducing the weight of gamma heat generating components and evenly distributing the heat removal. Sufficient room has now been provided to allow for a swelling of 40 percent in volume of the uranium specimen. Of the four capsules being constructed, one is being used to evaluate the heater and define operating limits, one will be used for an ex-reactor comparison to the in-reactor tests, and two are scheduled for irradiation in the ETR.

Assembly of the fourth general swelling capsule was completed and the capsule was successfully bench tested under simulated reactor coolant flow conditions. The Swagelok fittings that were used in the previous capsules as thermocouple seals to the inner chamber containing the NaK and uranium specimens were replaced by a welded sleeve arrangement. Short sleeves were welded to the thermocouple sheaths, and each sleeve on each thermocouple was then welded to a second sleeve which is part of the inner chamber cap. It was necessary to use sheathed MgO insulated thermocouples as the available Al_2O_3 insulated thermocouples could not be successfully welded.

The completely assembled capsule including the necessary electrical and thermocouple wiring and connections were shipped with the control instrumentation and capsule heater supply equipment to the reactor in the latter part of January for charging as soon as possible. The installation of control instrumentation and capsule power supply equipment for two capsules was completed and tested at the reactor site.

1241975

The fifth capsule is in the final stages of assembly but will not be completed until in-reactor operating experience is gained with the fourth capsule. Any modifications that become necessary will be made, and assembly will be completed so that this capsule can be charged at the earliest opportunity.

Pore Size and Distribution

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. A specimen irradiated at temperatures of less than 500 C to a burnup of 0.41 a/o and then annealed 100 hours at 600 C was subjected to an additional anneal of one hour at 880 C. An unirradiated control specimen of uranium was included during the one hour at 880 C. The object of this experiment was twofold: (1) to establish whether the absence of inclusions in a similar specimen annealed 100 hours at 880 C was a result of time at temperature, e.g., a resolution or "decarburizing" effect on the inclusions by the annealing treatment; and (2) to obtain a measure of the effect of time at temperature on the size and distribution of gas pores in the specimen. The inclusions in the irradiated specimen were again absent, but in the control non-irradiated specimen the inclusions were still present. These observations suggest either that: (1) the inclusions in the irradiated and annealed specimen, which has considerable gas porosity, fall out during specimen preparation steps; or that (2) the inclusions go into solution as a consequence of the high fission product concentration of the specimen. The density values for the specimen under study are: pre-irradiation - 18.7; post-irradiation - 18.7; after decladding and a 100-hour anneal at 600 C - 14.97; after an additional one hour anneal at 880 C - 14.13. Such low density values reflect considerable internal and external cracking, as well as open porosity, and must, therefore, be considered to be qualitative only. Studies of the replicas are in progress with the electron microscope to determine the pore size and distribution for purposes of comparison with the observations made previously with this specimen and the specimen annealed for 100 hours at 880 C. An as-irradiated specimen is currently being prepared for annealing at 880 C for one hour to more fully evaluate the observations.

The statistical analysis of synthetic specimens containing spherical pores with diameters of 1.17 microns has been completed. The analysis shows that distortion of the plastic replication medium occurs when it is stripped from pores cut above their center and that the extruded shape of the replica conforms to a cylinder with a spherical cap. A similar analysis is being made for pores with diameters of 0.56 micron to establish the effect, if any, of pore size on the magnitude of the distortion. If there is no size effect, the analysis shows that areal or lineal analysis can be applied in the measurement of pore void fractions and pore size distributions and that a precision can be ascribed to a given measurement.

A formal report, "Metallographic Studies of Swelling in Irradiated Uranium - Effect of Burnup, Irradiation Temperature, and Post-Irradiation Annealing," is being prepared.

Solid Surface Tension Measurements

Investigation of the formation of fission gas pores in irradiated uranium has brought about a need for solid surface tension values in uranium in the presence of inert gas at swelling temperatures. The solid surface tension data are to be obtained experimentally by a hanging wire technique.

Modifications of the annealing furnace to allow direct observations of the sample wires and continuous gettering of the krypton have been completed. High purity uranium chips were machined dry in argon and will be placed in both ends of the furnace tube to reduce specimen oxidation. Wires that are 0.003-inch in diameter are currently being prepared for loading. Efforts will be made to evaluate the solid surface tension of these specimens at 600 C.

3. IN-REACTOR MEASUREMENTS OF MECHANICAL PROPERTIES

This program has been initiated to establish the nature of changes caused in the properties of structural materials during irradiation. Currently, the study of the in-reactor creep properties of Zircaloy-2 is in progress.

The irradiation of an in-reactor creep capsule is in progress. The specimen is annealed Zircaloy-2, and a duplicate specimen is being tested in the laboratory to provide a direct comparison with the in-reactor test. No significant creep was measured on either specimen, at stress levels from 22,000 to 25,600 psi within the range of temperatures 525 F (274 C) to 600 F (315 C). The test conditions were then altered to a stress of 30,000 psi and a test temperature of 500 F (260 C).

During the month creep was measured on both specimens. The average in-reactor creep rate was 41×10^{-7} in/in/hr, while the ex-reactor specimen displayed a rate of 1.5×10^{-7} in/in/hr. Thus, there is an apparent 27-fold increase on creep rate due to irradiation. However, the in-reactor transducers are not as sensitive nor as accurate as the ex-reactor transducer, and an error of plus or minus 100 percent in the in-reactor measurement is possible. Also, ex-reactor creep data have shown that creep rates are not definitely established until at least 1000 hours of testing. These specimens have been under test for somewhat less than this. A statistical analysis is being made of the data so that confidence limits may be placed on the rates.

A second creep capsule has been ordered with specific changes made in specifications to eliminate the shortcomings of the prototype capsule and increase the precision of the creep measurements. A technical review of specifications is to be made with the vendor at the end of this month before construction begins. A prototype model of a capsule employing a direct reading, mechanical extensometer is being constructed on-site. The mechanical extensometer was designed to give high sensitivity and accuracy, as well as having a sufficient range to follow the specimen's elongation to fracture.

1241977

4. GAS COOLED POWER REACTOR PROGRAM

PRTR Gas Loop (Project CAH-822)

The delivery date for the Phase A package has been re-established as June 1, 1960, following a meeting with the vendor. This date is taken as 60 days following the revised delivery date of the main gas blowers. Considerable difficulty is being experienced in the fabrication of the gas blowers.

Final prints have been received and approved for fabrication of the top and bottom flexible connectors for the in-reactor test section. Additional requisitions were issued to fabricate these connectors from stainless steel (1200 F rather than 1500 F) to assure having connectors available at the time of loop installation.

Due to the complexity and number of factors affecting temperature transients of gas loop piping, transient analysis of the loop will be programmed on the new Berkeley analogue computer as soon as the instrument has been checked out.

In-Reactor Section. The nozzle closure assembly made of stainless steel which was tested at 1050 F and 500 psig was removed from the test furnace and disassembly of the unit was attempted. During disassembly, the tensioning nut galled the main stud and had to be machined out. During machining the pin which prevents rotation of the dome with respect to the rest of the assembly was sheared and the dome rotated, destroying the sealing faces.

Fabrication of a new nozzle closure assembly made of Hastelloy "X" was started. Leakage of the assembly will be determined under full pressure and temperature conditions.

The mechanical device which will be used to flex components in the furnace was completed. Operation of the device was started. Testing of the flexible hoses was continued. During the month the flexible hose was subjected to long term hydrostatic test at 200 psig at room temperature without leakage. Hot tests on this unit at 1200 F and 500 psig was started.

Additional Hastelloy "X" material for use as the pressure tube was ordered.

Material received for the in-reactor section is now 45% complete.

Fabrication of equipment to test the outlet helium bellows for the bottom face of the lower shield was completed. Testing of the bellows was started.

1241978

Gas-Graphite Studies

Hot Capsule Experiments. Results from twenty-two hot capsules irradiated up to 5000 MWD at 500 to 800 C in the MTR continue to indicate that the needle-coke graphites contract less in both the transverse and parallel directions (relative to the extrusion axis) than CSF. For all graphites tested, the parallel contraction was greater than the transverse.

Several capsules contained samples cut from a flat slab extrusion prepared by Great Lakes Carbon Corporation. The slab dimensions were 2.4 x 14.5 x 16 inches. With respect to dimensional stability, samples from the 2.4-inch direction (transverse to the extrusion) were the most stable followed by the 14.5-inch direction and the longitudinal 16-inch extrusion direction. Samples from the center of the slab contracted less than peripheral samples.

Gas Phase Oxidation Inhibitors. Experiments have shown that small amounts of chlorine effectively inhibit graphite oxidation in air and ozone. The chlorine appears to block active sites on the graphite surface, thereby reducing the oxidation rate. Experimental results obey the following rate law:

$$\frac{d\,CO}{dt} = k_3\,AB \left[\frac{1}{\left(\frac{Cl_2}{O_2}\right)^{1/2} + B} \right]$$

where: k_3 and B are rate constants

A is the total number of active sites

$\frac{d\,CO}{dt}$ is the rate of production of carbon monoxide.

Further experiments will study the effects of gamma rays and microwave discharge on these reaction rates.

Oxidation Studies -- Co-60 Facility. The reaction rate of carbon dioxide with graphite in the presence of cobalt-60 gamma radiation was measured at 700 C in the glass gas loop. The reaction rate decreased linearly from 1.63×10^{-3} g/g hr to 2.1×10^{-4} g/g hr, as the flow was increased from 140 cc/min to 280 cc/min. With further increase in flow from 400 to 900 cc/min, the reaction rate remained nearly constant at 5×10^{-5} g/g hr. The higher oxidation rates at low gas flow rates are attributed to the longer residence time of the gas in the radiation field. At higher gas flows the product of the interaction of carbon dioxide with gamma radiation is removed before chemical reaction with the graphite sample can take place. The effect of sample temperature will be investigated in the next series of experiments.

1241979

D. RADIATION EFFECTS ON METALS - 5000 PROGRAM

Radiation damage recovery is being studied for a number of metals; namely copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Tensile properties, microhardness, electrical resistance, and x-ray diffraction spectra are being studied to determine the characteristics of recovery mechanisms.

One hour isochronal annealing treatments at 25 C increments were extended from 350 to 425 C for irradiated and unirradiated specimens of molybdenum, zirconium, and nickel. Little change in the electrical resistance and hardness of the molybdenum specimens occurred in this temperature range. Complete recovery of the electrical resistance of zirconium irradiated to 4.7×10^{18} nvt occurred at 350 C. Above 400 C, zirconium irradiated to 4.7×10^{18} and 1.5×10^{20} nvt underwent extensive hardness recovery. A major drop in the electrical resistance of nickel irradiated to 1.0×10^{19} nvt occurred above 300 C; however, the hardness remained nearly constant between 300 and 425 C.

Seven irradiated molybdenum specimens were tested in tension during the month. The increase in flow stress with strain rate was measured for specimens in the unirradiated and 1×10^{17} nvt and 1×10^{18} nvt exposure conditions. The strain rates employed were 0.001, 0.01, and 1.0 in/min. The coefficient of rate sensitivity, which is defined as the change in log stress with change in log strain rate (at room temperature and approximately two percent total strain), did not appreciably change with exposure to 1×10^{17} nvt, but decreased from 0.038 to 0.025 with exposure to 1×10^{18} nvt. Specimens from the 1×10^{17} and 1×10^{18} nvt exposure groups were prestrained for strain aging studies.

Construction of temporary lead shielding for the Instron tensile instrument and electrical resistance apparatus was completed, and the remote tensile testing of irradiated specimens was successfully demonstrated.

Pre-annealing x-ray diffraction studies, metallography, electrical resistance measurements, and microhardness tests were completed for the unirradiated and irradiated specimens of copper and iron. The lattice parameter of copper showed a decrease after an exposure of 9×10^{18} nvt with no further change at 1.5×10^{20} nvt. Line broadening decreased continuously with exposure. The peak shifts with exposure observed for copper agree with theoretical calculations for stacking fault formation. The lattice parameter for iron first increased with an exposure of 4.6×10^{18} nvt then decreased with an exposure of 1.5×10^{20} nvt. The changes in parameter are similar to those for irradiated molybdenum which belongs to the same crystallographic system. The line shape for iron showed a marked sharpening with exposure to 4.6×10^{18} nvt, and only a small subsequent broadening with exposure to 1.5×10^{20} nvt.

1241980

D. CUSTOMER WORK

Radiometallurgical Examinations

Corroded DR Process Tube (RM-401). A sample of a badly corroded aluminum process tube from DR Reactor was examined. The metal quality of the process tube appeared good, and no intergranular attack was observed. There were no corrosion products present on the internal surface or in any of the pits. However, a uniform 0.002-inch thick oxide layer was observed on the outer tube surface. The profile of longitudinal and transverse sections of attacked areas was typical of erosion caused by turbulence in the cooling water.

1.47% Enriched I & E Fuel Elements (RM-404). Two enriched I & E elements clad in X-8001 aluminum alloy, which had developed severe hot spot corrosion attack, were received for examination. In the center of the hot spot areas the can wall had suffered an accelerated intergranular attack which in one of the elements had progressed to the AlSi layer and caused an incipient rupture. On the other element the corrosion attack had penetrated more than 50% of the residual can wall thickness.

Routine Slug Examination (RM-403). Two non-ruptured, internally and externally cooled, Hanford production fuel elements were given a cursory examination as part of a newly-instituted routine program. The two elements had been irradiated in the same tube and both exhibited evidence of hot spots on the surface. The fuel element with the more severe hot spot had warped approximately 50 mils, and approximately 10% of the can wall had been removed from the maximum-temperature area of the hot spot. The elements were sectioned transversely at the midpoints of the slugs, and the two halves of each slug were sectioned longitudinally. No unbonded areas were noted and the uranium metal was in good condition. The internal coolant annulus was in excellent condition in both slugs.

Metallography Laboratories

A small capacity spot welder has been adapted for attaching an electrical contact wire to metallographic samples when electropolishing or electroetching is required following a mechanical polish. Previously, contact to the sample was made by either drilling and tapping a hole through the mounting media (plastic or bakelite) or by soldering a contact wire to the specimen. With the welding unit, a Unitek Weldmatic of the condenser-discharge type, a length of small diameter copper wire can be spot welded to any sample quickly.

Samples Processed During the Month:

Total Samples	406
Carbon Replicas	37
Photographs	
Micrographs	431
Macrographs	70
Electron Micrographs	274
	775

DECLASSIFIED

1241981

[redacted]

Special Fabrications

Trans-Plutonium and High Exposure Plutonium Fuel Element Fabrication. Co-extrusion clad Pu-Al elements are being fabricated for irradiation in Savannah River reactors. For Campaign II of the Trans-plutonium Program 144 elements are required, and 272 elements of the same design are needed during FY-1960 to make high exposure plutonium for the Plutonium Recycle Program. At the present time there are 157 pieces in the following stages of fabrication:

25 cast billet cores, 14 machined fuel cores,
96 extruded and straightened fuel rods, and
22 machined fuel rods.

Development of casting techniques to give the end configuration to both ends of the billet is in progress to eliminate billet machining. Seven casting attempts were made, but solidification shrinkage and gas entrapment in the billets were extensive; however, segregation was not a problem. These studies will be continued.

Shipment of rod stock for the aluminum (X-8001 alloy) cladding components has been delayed for the second time and is currently scheduled to leave the vendor's plant on February 19, 1960. Use of aluminum (1100 alloy) cladding for a portion of the rods was approved, and fifty sets of components are being machined.

Plutonium-Aluminum Alloy Pins for SRP. Fabrication of 60 aluminum clad Pu-Al alloy pins for SR00 is continuing. The alloy containing 15.7 w/o Pu was cast into billets 0.375-inch, 0.125-inch, and 0.0937-inch in diameter. The 0.375-inch billets were hot extruded into two 24-inch wires ranging from 0.0315-inch to 0.033-inch in diameter. Extrusion was done with a flat face shear die in a vertical 20-ton hydraulic compacting press. The reduction ratio was 87 to one with extrusion temperatures of 450 C and 550 C requiring approximately the same pressure ranging up to 235,000 psi. Galling was observed on the extruded surface at both temperatures. The pins were cut to a 0.470-inch length by insertion in a lucite fixture and facing the ends with a file.

Earlier attempts to draw the 0.0937-inch diameter billets through several reductions to the final size of 0.0325-inch diameter were unsuccessful.

FW Albaugh

Manager, Reactor and Fuels Research
and Development

FW Albaugh:kb

[redacted]

1241982

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

FEBRUARY 1960

FISSIONABLE MATERIALS - 2000 PROGRAM

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Neutron Temperature Studies

The two manuscripts, "An Investigation of Effective Neutron Temperatures", and "Calibration of Lutetium for Measurements of Effective Neutron Temperatures", (Letter to the Editor) have been accepted for publication by the Journal of Nuclear Science and Engineering and will appear in the May issue.

A summary of a paper which is to be submitted to the American Nuclear Society for presentation at the Chicago Meeting in June has been written. The paper will present the results of the work which has been accomplished with lutetium since October, 1959. This paper, entitled "Lutetium as a Spectral Index Detector", will probably be the terminating report of the lutetium investigation and will be submitted to the Nuclear Science and Engineering journal.

In preparation for the paper, resonance integrals are being calculated for various energies of the effective "cutoffs" of epithermal neutrons and of cadmium covers. The sensitivity of the neutron temperature measurements to various assumptions about the "cutoff" energies will be obtained from the calculations. Several experiments which exemplify the use of lutetium as a spectral index detector are being analyzed. These experiments are a lutetium traverse obtained in the Thermal Test Reactor and measurements made in the geometries used for the Pu-U experiments. The latter experiments were reported in HW-60778.

The double focusing beta-ray spectrometer is being set up for measurements on the lutetium isotopes used in making neutron temperature measurements. Difficulties with the GM counter detector were eliminated and calibration runs were completed.

The nuclear data tape code on neutron temperature coefficients has been operated successfully on a number of debug runs. The difficulties reported last month were circumvented by dividing the main program into a smaller main program and a subroutine. Since no known restrictions were exceeded in the original main program, the explanation of the failure of the MONITOR system to handle this code is still unknown. Debugging of this code has progressed quite rapidly. Several features still remain unchecked and debugging of them continues.

Multimaxwellian Group Analysis

FIT-1 computer code was operated successfully. The input error in the test case data, mentioned last month, was found to be causing most of the troubles experienced in debugging. A three-group modification of FIT-1 was coded and debugged this month. The program reads-in experimental foil traverse data, and a

DECLASSIFIED

DECLASSIFIED

description of the conditions (nuclear and geometric) under which the traverse was taken. It then calculates a series of theoretical traverses using group diffusion theory by adjusting a specified cross section between calculations. This process continues until the sum of the squares of the differences between the experimental and theoretical traverses is minimized. The normal two or three-group models, or the two thermal and one fast-group approximation, may be used to get theoretical traverses. Up to ten regions, in slab or cylindrical geometry, may be included in the calculation. Any cross section, except $\nu\Sigma_f$, in any region may be adjusted in the fitting process. $\nu\Sigma_f$ will, in general, affect only k, not the flux shape. The first data from the neutron rethermalization experiments have been submitted for analysis.

Neutron Rethermalization

The primary objectives of these recent experiments is to define the temperature dependence of the rethermalization cross section, for use in reactor calculations. The analysis of the experimental data obtained in these experiments has continued through February. Traverses of the thermal activity of a "1/v" detector and of the thermal source function have been analyzed and plotted. The analysis of lutetium activity data for the determination of neutron temperatures is approximately 50% complete. None of the final analysis has been completed; however, some preliminary calculations of the relaxation lengths have been made.

Under the assumption of no absorption in the graphite and no source of thermal neutrons one can make fairly good estimates of relaxation lengths. These estimates are determined from the ratio of activities at the center of the hot region to the activity at the same point at room temperature. This technique was described earlier. The results of these calculations are shown below together with earlier results obtained in the plane geometry experiments.

NEUTRON RETHERMALIZATION
RELAXATION LENGTHS (cm)

Plane Geometry				Cylindrical Geometry
Graphite Temp.	Preliminary Estimate	Final Result	From Curve	Preliminary Estimate
°K				
108	35.8	21.0		
144			20.0	17.5
491	12.7	11.4		
523			10.8	8.1
666	6.6	7.5		
690			7.2	5.1
803			~6.0	3.3

Gaseous graphite - theoretical result applicable at high temperatures = 3.5.

The preliminary estimates and final results for plane geometry yield some measure of the worth of the estimating scheme. A comparison of values from the curve for plane geometry and the preliminary estimates for cylindrical geometry shows a rather consistent difference. It is expected that this difference is a geometry effect which could not be corrected for in the plane geometry case. Final conclusions regarding this point must await the completion of the final analysis of the data.

Some additional points of interest have been found in the early analysis of these data. Inspection of traverses of epicadmium activity for all experiments has shown that the epithermal flux is, to within at least ± 4%, independent of temperature in the range 144°K to 800°K. This result was obtained with cadmium covered foils in the hot region up to 523°K only, and in the room temperature region in all cases. The significance of this lies in the fact that the relative epithermal flux is small everywhere and these small variations with temperature are negligible. Therefore, correction for epithermal activity in the hot regions may be based upon traverses made at temperatures below the melting point of cadmium.

The minimum cadmium ratio of copper observed in these experiments was approximately 25, while in the plane geometry experiments the minimum value was 20. This twenty percent reduction in the epithermal flux is due primarily to the introduction of lucite moderator into the driver fuel elements of the PCTR.

Instrumentation and Systems Studies

Past speed of control calculations associated with a loss of coolant accident in the Hanford reactors have indicated a need for accelerated vertical safety rods in the old reactors (B,D,F) in order for proposed reactor operation to comply with the current speed of control safety criterion. Further work was done on this problem this month to specify the reactivity that needed to be inserted with accelerated rods. The results indicated that if one-fourth of the total control strength of the VSR system were inserted in the form of accelerated rods, the speed of control requirement would be satisfied. These results have been forwarded to IPD - Reactor Physics and they are proceeding with their design specifications on this basis. Reactor Physics continually requires new information on this problem, and they are going to purchase an EASE problem board so that the problem can remain patched, thus eliminating some of the delays associated with programming a large problem of this nature.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Exponential Measurements of Large Diameter Fuel Elements

The material buckling for one lattice using a tube and rod fuel element was measured this month. The final buckling value is given below:

Fuel Element	Lattice Spacing (in.)	Buckling ($10^{-6}cm^{-2}$)	λ (inches)	Volume Ratios Al/U	H_2O/U	C/U
2.5 x 1.6 with 1.17	8 3/8 dry	-111	1.45	0.305	0.631	15.66

The λ quoted is the side-to-side extrapolation length. The front-to-rear extrapolation used was 1.03 inches.

1241985

DECLASSIFIED

In order to provide an absolute normalization on the recent series of small pile measurements, an exponential pile six feet wide and eight feet long has been constructed. Buckling measurements for the 8 3/8 lattice using tube-in-tube fuel elements have been started in this large pile.

Analysis of vertical traverse data has been delayed by difficulties with the IBM-709 program. The minimum work required is some hand calculations of harmonic corrections to check the machine calculations. It is anticipated that some part of the program is not functioning properly and was not caught by comparing 702 and 709 calculations because only small pile data were being analyzed at that time. For example, the harmonic corrections calculated by the program have jumped by 20% for no apparent reason in the fitting process.

PCIR Measurements of Large Diameter Fuel Elements

Work on data analysis for the 2.5 x 2.0, 1.66 x 1.12 tube-in-tube experiment is proceeding. The IBM program being used was temporarily inoperable after the first run which yielded only two traverses which were of any use.

Lutetium measurements in the dry tube-in-tube gave neutron temperatures ranging from 1[illegible]6°C in the center coolant to 82°C at the cell edge. Measurements in the dry case were not complete enough for very accurate measurements, but the temperature was about 60°C for all locations. Errors on the dry case are about ± 1[illegible]°, and 1[illegible]-10°C for the wet case.

Fabrication of uranium pieces for the measurement of p and ε for a 2.5" solid fuel element has begun. Most other equipment needed is already available.

Measurement of the k_∞ and f for the 2.5" x 2.0", 1.66" x 1.1" tube-in-tube element in an 8 3/8" lattice is underway in the PCIR. The wet case will be done first, but the dry case will be done only if no higher priority experiment is ready to use the PCIR.

PCIR Measurement for N Reactor

The design of the graphite for the NPR condensed lattice in the PCIR has been completed. The purchase requisition for the NPR mockup lattice has been sent to Purchasing with a request for bids by March 7, 1960. Two separate bids were requested, one for machined bars and one for raw bars from which the lattice might be constructed on site. The high bid and long delivery, six months, previously offered, resulted in the cancellation of the earlier requisition to allow an investigation of alternate courses of action.

Preparation of more depleted and natural uranium foil has been initiated for future p and ε measurements.

Program for Analyzing PCIR Data

AFIAF-I, the program for analyzing PCIR foil data, continued in limited production use, under the control of the programmer. Several program errors, including those briefly mentioned last month, were found and corrected. Most of the optional features of the program have been checked out. The program will be continued in semi-production status through March, in an attempt to derive an accurate formula for estimating machine running time.

1241986

[redacted]

Instrumentation and Systems Studies

A preliminary study on the desirability and technical feasibility of applying automatic control systems to Hanford reactors was completed. A reactor controller would have several functions:

1) Maintain constant power level.
2) Prevent or minimize spatial oscillation of power.
3) Provide power setbacks when warnings are reached.
4) Scram the reactor when safety levels are reached.
5) Permit the operator to override the servo and use manual control.

A sixth function would be to control a smooth startup or shutdown. However, this function is more difficult and is enough different from those of equilibrium operation that it seems likely a single servo could not do both jobs. This study concludes that an automatic control should be developed for the NPR. While a servo could be built for any one of the existing Hanford reactors, their construction and characteristics are such as to require a bigger and more complicated servo. Thus an automatic control system for the NPR would be an easier first step, and would result in greater gain. Appropriate actions for a development program have been recommended to IPD.

Preparations are being made to demonstrate the use of radiation ratio pyrometry in measuring reactor graphite temperatures. The instrument to be demonstrated performs with a ± 15 degree accuracy when once warmed up and calibrated. Difficulty has been experienced in providing an internal calibration which is adequate for long periods of time, particularly if the equipment is shut down and started again several times. A circuit revision is being tested which is expected to eliminate this difficulty.

Computer results were obtained this month on the investigation of various startup techniques for NPR. It was essentially the calculation of the reactivity transients resulting from prescribed power maneuvers. The results were forwarded to IPD - Operational Physics for use in investigating control requirements for NPR.

The NPR Heat Exchanger program was delayed since computer time was needed for speed of control information this month. The heat exchanger program is now being put on the computer.

The necessary parts have been received for the fabrication of the two-range, two-detector prototype NPR Scintillation Area Monitor. In addition, all developmental circuitry, including a cyclic indicating and alarming circuit for the low-level portion, was thoroughly tested during February. All circuits proved to be satisfactory. Fabrication is scheduled to commence shortly.

Calibration tests were completed on the prototype Scintillation Logarithmic Area Monitor for possible use at the NPR. Several slight circuit modifications were made to permit elevated temperature use to +140°F. The calibration tests covered the three-decade instrument range from 10 mr/hr to 10 r/hr. The instrument maximum negative error was eight percent of true reading, and the maximum positive error was sixteen percent of true reading. The maximum negative error (low) occurred at two r/hr, and the maximum positive error (high) occurred at 100 mr/hr. Slight adjustments of the circuit rheostats can change, as desired,

DECLA[redacted]

the type of error and/or the location of maximum error. Stability or drift tests were completed, and the drift errors were less than ± two percent of true reading in one month of continuous operation.

Fabrication is nearing completion on the lead-shielded scintillation detector head for the prototype NPR Beta-Gamma Air Monitor. All circuitry, most of which has been previously developed, will be transistorized.

Good development progress was made during the month concerning the prototype NPR Fuel Element Rupture Detection System. A transistorized voltage comparator circuit was developed and satisfactorily tested. This circuit compares the peak readings of individual samples with the average of a number of samples to compensate for reactor power level changes and drifts in the monitor system. Tests of the RCA 6199 phototube for use with both the fast and slow scan systems were satisfactorily completed. For the fast scan gross counting system, it was determined that 138 out of 150 phototubes under test would be satisfactory. Of the 12 tubes considered not satisfactory, six of these were accidentally damaged or broken during the extensive tests. For the slow-scan system, which is a pulse-height or gamma energy analysis type, 110 tubes of the original 150 were found to be satisfactory. Adequate commercial slip rings were located for the fast-scan system. No slip rings are used with the slow-scan system. The mockup mechanical design for both systems is 85 percent complete.

No further computer results have been obtained for the reactor kinetic equations due to pressure of higher priority work. Theoretically, an approximation has been evolved which will permit the nature of the solutions (i.e., stable or unstable) to be found by a comparison with Mathieu's Equation. Unfortunately, a literature search indicates that no one has ever calculated (or at least published) the numerical data that is needed to make the comparison useful. This work is being written up as an internal report, and (in abridged form) as a paper for possible publication.

Mechanism of Graphite Damage

Building alterations and equipment purchase and fabrication for the sweep system for the electron Van de Graaff are progressing satisfactorily.

A linear differential transformer was received for use in measuring length changes. It performed very well in tests with gauge blocks. An experiment with protons to measure the length change in graphite was inconclusive.

SITES RELATED TO SEPARATIONS PLANTS

Plutonium Critical Mass Laboratory

At the end of the month, Construction Engineering Operation listed the project as 73 percent complete as compared with a scheduled 74 percent. The corresponding figures for that portion of the work covered by the fixed price contractor are 88 and 80 percent. The total project is no longer ahead of schedule because of the continued delay in delivery of the control panels and instrumentation system. (This system constitutes 40 percent of the G-E engineered and procured equipment.) The vendor for the control and instrumentation system has thus far not given an expected delivery date. At present, delivery does not appear likely before another month. Progress on the rest of the facility continues ahead of

schedule. The installation of process equipment in the reactor room and mixing room was begun. The reactor hoods were emplaced in the reactor room. The mixing hood was placed in position and the mixing, waste, and wash tanks were installed. At the end of the month installation of the plutonium handling lines between the mixing hood, storage tanks, and the reactor hoods was in progress.

Critical Mass Studies on Uranium Systems Poisoned with Boron

Exponential measurements were continued for determining the quantity of neutron absorber which must be added to a water moderator in order to "safe" a heterogeneous system of enriched uranium. The buckling was measured with 1.007 percent enriched uranium rods of 0.925-inch diameter at an H_2O/U volume ratio of 2.15; a hexagonal pattern was used for the lattice. Boron was added to the water moderator in the form of boric acid and the buckling measured as a function of the boron content. The following table summarizes the measurements for the volume ratio of 2.15 (1.6-inch lattice).

BUCKLING MEASUREMENTS - 1.007 PERCENT ENRICHED URANIUM
BORON POISONED MODERATOR

H_3BO_3 (gm/L)	Boron (gm/L)	Buckling (10^{-6} cm^{-2})	Estimated Critical Mass of Poisoned System for Spherical Geometry
0	0	3416*	5625 lbs. U
1.5	0.26	1950	14,387 lbs. U
3.0	0.53	-680	--
4.5	0.79	-908	--

* Reported previously.

These data indicate the buckling would be reduced to zero (k_∞ = unity) with the addition of about 3.2 gm/L boric acid, or 0.6 gm/L boron to the moderator. Previous measurements were made in a 1.5-inch lattice with boron poisoned moderators; a 1.4-inch lattice will be measured next.

Criticality Studies in Support of Processing Power Reactor Fuels

776 8"-long, 0.6"-diameter, 2% enriched uranium fuel rods; and 426 8"-long, 0.925"-diameter, 2% enriched rods were received. This is sufficient material to conduct the planned critical approach and exponential experiments.

Critical Hazards Specifications

The preparation of Hanford Laboratories nuclear safety specifications in accordance with "Nuclear Safety Bulletin No. 1" is about 40% complete. These specifications will cover 12 HLO components. Existing specifications are being rewritten in the standard form. In many cases, specification revisions are required and in some cases new specifications must be issued.

Two talks were presented to 28 HAPO nurses on the subject of "Criticality Accidents". The locations at HAPO in which fissile materials are handled or stored were also discussed.

DECLASSIFIED

Data Correlation - Development of Nuclear Codes for Criticality Calculations

A Monte Carlo program is presently being formulated for infinite aqueous-plutonium and uranium systems. Some of the information that will be obtained from this code is the following: (1) Neutron spectrum, (2) Fermi age, (3) migration area, (4) infinite multiplication constant (k_∞), (5) fission energy distribution, (6) mean life of the neutron in the system, (7) mean slowing down time of the neutron, and (8) the effect of inelastic scattering on the Fermi age.

A Monte Carlo program for neutron thermalization studies has been formulated and is presently being debugged. The neutron spectrum below 1 ev will be determined for any desired position within the lattice cell. This code will also calculate the thermal utilization, and η for the lattice in question.

Further work was done on the revision of the IDIOT code to include plutonium in the fuel regions and to adapt the code to the Monitor system. The revision has been completed and debugging has continued throughout the past month. The code has been compiled on Monitor but little success has been obtained in the debugging effort. It is hoped that the difficulty will be overcome and the code will become operable on the Monitor system. This code (non-monitor version) has been used to carry out criticality calculations for uranium rods in water. The results compare quite favorably with previous calculations for water-moderated systems with the exception of the two parameters τ and ϵ. A very simple modification to the existing program will be required to bring τ and ϵ into agreement.

Fairly reasonable values of the multiplication constant for cylindrical Pu-assemblies can now be computed with the latest version of the 709 C-3 Program. Data from P-11 critical experiments were used to develop this program. The effective dimensions of the assembly were changed to replace the moderator (reflector) with an equivalent bare assembly (C-3 cannot properly account for a reflector). The thermal group cross-sections were made spectrum sensitive by using flux weighted values in a matrix dependent upon H/Pu ratio and temperature. The code now interpolates in the matrix for both temperature and H/Pu ratio. Values of k are still an approximately linear function of the H/Pu ratio with a difference from max. k to min. k of about 30%. Further changes in C-3 are anticipated.

Critical Mass Theory Development

The RKE program, which numerically integrates the reactor kinetic equations with time varying reactivity, has been run using input corresponding to a simple analytical solution. Such a solution is desirable for checking purposes. At the time of last month's report, it was believed that certain characteristics of the program prevented the use of these specific input values. Fortunately, a means was discovered of circumventing this difficulty without altering the program. In the resulting comparison, the program calculations differed from the analytical values by about 0.1% to 0.2%. This is about an order of magnitude larger than had been anticipated on the basis of the convergence requirements imposed on the solution. An explanation of this discrepancy is being sought.

The program has also been run using input more representative of cases expected to be encountered in normal use, with qualitatively correct results. Quantitative values are not yet available for comparison. The time increment required

for convergence, a few hundredths of a second, is shorter than had been anticipated. A practical consequence is that machine time of an hour or more would be required for cases in which the system is initially less than about 95% of critical. Methods are presently being sought to improve this performance.

The program to calculate the fast and thermal leakage from bare subcritical plutonium solutions has run successfully. This program has been used to revise the leakage calculations reported in HW-60255. The critical mass vs. concentration data used in the present calculations are the best information available; they will appear in a revision of the "Nuclear Safety Guide", TID-7016, now being prepared elsewhere. Though they show some significant differences from the data used before, the basic conclusions of the earlier work remain valid. The present calculations include a) the leakage as a function of concentration from 14 cm, 15 cm, and 16 cm diameter bare spheres and b) the leakage from bare spheres as a function of volume for two representative concentrations, one near minimum critical mass and the other at a high concentration. A report giving the results of these calculations is being prepared. A description of the various subroutines used in the program is also being written.

Mass Spectrometry

The instrumentation of this mass spectrometer was continued in use for development work on the ion pulse counting system. Some difficulty was encountered with high voltage stability and leakage. The difficulty has not been completely isolated or corrected as yet.

NEUTRON CROSS SECTION PROGRAM

Slow Neutron Scattering Cross Sections

Another aluminum crystal was grown during the month in an aluminum oxide crucible. Conditions during growth were adjusted such that the latent heat stored in the liquid was lost through the liquid-solid interface and the volume rate of growth was nearly constant. The freezing time was 24 hours for the 3-inch diameter, 6-inch long crystal. Neutron diffraction measurements demonstrated some lineage structure with the reflection being confined to about 0.25 degrees. Individual peaks were about 20 percent high with widths possibly smaller than 0.03 degrees. A second aluminum crystal was grown at the end of the month which was frozen under similar conditions, but the freezing time was less than 3 hours. This crystal has not been studied as yet.

The beryllium crystal presently in use as the monochromator on the 105-DR single crystal spectrometer was compared with one of the better aluminum crystals by integrated intensity measurements and high resolution rocking curves. The beryllium crystal reflection efficiency was measured to be 40 percent with a rocking curve width of 0.13 degrees. This crystal is ideally suited for the single crystal spectrometer measurements.

Three of the original batch of aluminum crystals grown in graphite crucibles were also investigated. The reflectivities were poor, about 5 percent high and 0.8 degrees wide.

DECLASSIFIED

Subthreshold Fission

Foils of U^{234} and Pa^{231} have been mounted in a gas ionization fission chamber and fission cross section measurements have been started. In preliminary measurements the known resonance in U^{234} at 5.2 ev was found in fission. The observed peak fission cross section was about (5 ± 1) barns with a resolution width an order of magnitude greater than the true resonance width. These measurements were stopped when the experimental area was badly contaminated by Operations' work on a hole adjacent to the spectrometer. The area was inaccessible for a week. After access was gained it was discovered that during this work equipment had been knocked from the spectrometer arm mortally damaging the carefully calibrated BF_3 detector. An estimated two further weeks' time will be lost in necessary realignment and calibration of the crystal, fission chamber and BF_3 detector and assessment of other possible damage.

Fast Neutron Cross Sections

The new chamber for the analyzing magnet for the Van de Graaff is about 75 percent completed and the precisions obtained in fabrication are better than expected. The precision drift tubes for the 0 degree and 180 degree ports have been completed. A second prototype of the locating electrode structure was assembled. Several design changes have been found desirable.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Lattice Parameters for Low Exposure Plutonium

Final analysis of the 8 3/8 and 10 1/2 inch graphite-plutonium cluster lattice experiments has been delayed. Difficulties with the foil processing code has prevented completion of this work.

Lattice Parameters for High Exposure Plutonium

Local AEC people have made arrangements to obtain any scrap 20% Pu^{240} material that becomes available from the DMA work. The amount of material to be available from this source will not be known for several months.

The FER irradiations toward 40% Pu^{240} material are continuing. A question has arisen concerning the 50% flux depression factor used by Phillips in computing total exposure. Resolution of this question will allow reasonable estimates of discharge dates to be made.

PRTR Startup Experiments

The final draft of the approach-to-critical experiment which contains the high spike enrichment of Pu-Al fuel elements has been written and distributed to the members of the Startup Council for approval. All of the approach-to-critical experiments have been written and will eventually appear in Document HW-61900 along with other physics experiments which are to be done at startup of the PRTR.

Critical Facility of the PRP

The decisions, concerning the purpose and scope of an experimental program for the Critical Facility, which were discussed in the last report have been forwarded to the designers.

Estimates of the time necessary for completion of various aspects of the program are being worked upon. These estimates include time for the writing of a Program Document, the procurement of fuel for the D_2O moderated reactor, the procurement of fuel and templates for the light water experiments, and the planning of experiments.

Subcritical Experiments with Plutonium

Critical approach and exponential experiments were continued with Pu-Al alloy fuel elements in light water. The fuel elements are Al-5 w/o Pu, 0.506-inch in diameter and 24-inches in length; the cladding is Zircaloy-2 with a wall thickness of 0.03-inch. Measurements were made this month with lattice spacings of 0.90-inch, and 1.80-inches; a hexagonal pattern was used for the lattices which were fully water reflected. These data are summarized below.

Lattice Spacing (inches)	H/Pu* (atom ratio)	Extrapolation Length (λ)	Critical No. of 24-inch Rods (cylindrical geometry)	Estimated Critical Mass (spherical geometry)	Buckling ($10^{-6}cm^{-2}$)
0.9	427	7.39 cm	192 (2.11 Kg Pu*)	1.7 Kg Pu*	11,261
1.8	2422	~ 7.00 cm	-	-	- 1,563

* Pu-240 isotope ~ 5.3 percent.

The buckling is observed to be negative for the spacing of 1.8 inches.

In the course of the experiments cadmium ratio measurements were made using U-235, and Pu fission chambers as well as a BF_3 counter. These data have not been analyzed but are summarized below for the lattices measured to date; these measurements were made in connection with possible future temperature effect measurements.

Lattice Spacing (inches)	H/Pu* (Atom Ratio)	Cadmium Ratio		
		Pu Fission Chamber	U-235 Fission Chamber	BF_3 Counter
0.90	427	15.1	9.1	12.4
1.00	583	14.3	19.7	18.6
1.10	755	22.4	21.2	23.0
1.80	2422	33.3	50.6	52.5

The results of the critical mass and exponential experiments which have been completed to date are shown graphically in Figure 1.

DECLASSIFIED [redacted]

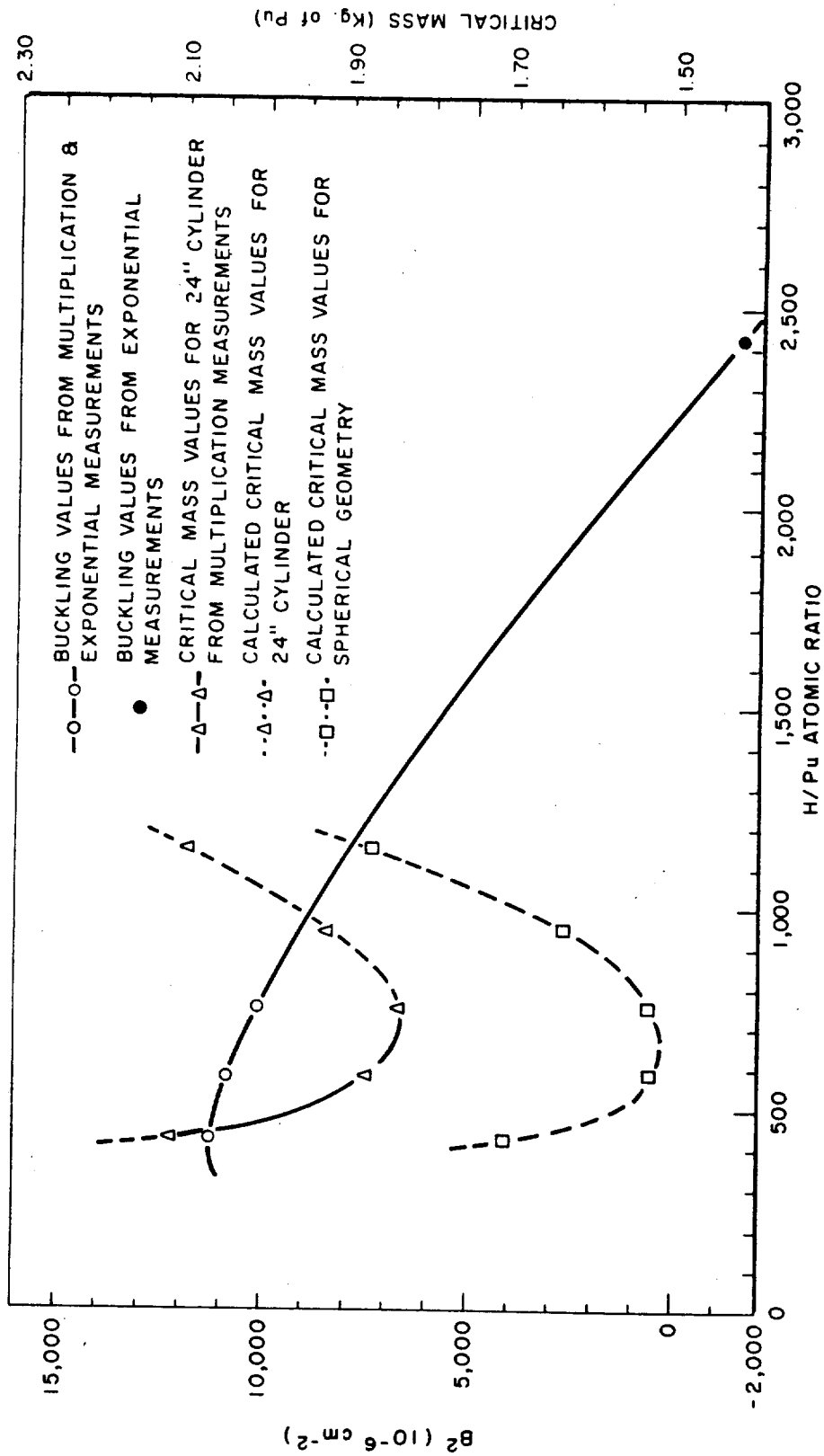

Fig. 1 - Critical Mass and Buckling Values for Pu-Al Alloy Fuel Rods in Light Water

1241994

A second plutonium contamination problem occurred this month. (The first contamination problem was reported the previous month.) Due to careful monitoring procedures no plutonium was released and only a few Pu-Al rods were contaminated, these being in a plastic bag with the faulty rod.

The cause of this incident was the rupture of one of the Pu-Al rods caused by severe etching from concentrated sulfuric acid used to removed surface contamination acquired from the first contamination incident. A number (37) of these fuel rods have been sent to the Plutonium Metallurgy Operation for re-examination and testing in an effort to prevent further contamination problems.

Instrumentation and Systems Studies

Estimates were compiled of the cost of developing and fabricating instruments to measure and record PRTR process tube inside diameter, wall thickness, and shroud tube spacing. The system includes provisions for visual inspection and the machine to raise and lower the transducers within the process tube. A second estimate was made of the cost of developing devices to measure and record inside diameter and wall thickness only, this equipment to be used before the PRTR initial loading. Copies of the two estimates were forwarded to Structural Materials Development (HLO).

Methods of obtaining the statistical data required to determine the PRTR prompt neutron lifetime are being studied. It appears that an existing magnetic tape mechanism can be used to record the primary data at the PRTR test site. The tape can then be played back through computing equipment in the laboratory to obtain the autocorrelation function and the power density spectrum. This method would require a minimum of equipment and time during the test, and would allow the use of more accurate computing equipment. It is planned to test the equipment in the laboratory on a system whose transfer function is known prior to making the actual PRTR tests.

Instrumentation phases of the PRTR Power Tests which are being planned include a) automatic and manual control tests; b) rupture monitor calibrations; c) radioactivity leak tests; d) temperature distribution and temperature transient tests on moderator, reflector, primary loop, etc.; and e) high power kinetics measurements.

A computer program to analyze the PRTR gas loop has been completed. The analysis will be started as soon as the new computer is available for problem solution.

A circuit has been devised that will detect fast neutrons with a minimum energy of 250 kv in the presence of gamma rays. The circuit represents probably the best that a simple one-tube circuit can do. Work will continue on more complex circuits. This circuit will be useful in the measurement of fast neutron leakage.

Six non-darkening relay lenses for the wide angle viewer have been received and the viewer is now being assembled. Partial assembly revealed that one lens mount had been omitted in the design drawings. The lens mount has been fabricated and the scanning heads have been assembled and tested.

DECLASSIFIED

1241995

Samples of the As_2S_3 glass were irradiated to 10^6R, 10^7R, and 10^8R. No change in transmission was noted at 10^7R but at 10^8R the transmissivity decreased 30 percent at 1 micron, 9 percent at 2 microns and 7 percent at 4 microns. Beyond 8 microns no appreciable change in transmission was noted. One sample is being irradiated to 10^9R at 10^6R per hour. Lenses and windows of As_2S_3 are being used on probes which will measure the temperature of PRTR fuel elements.

NONDESTRUCTIVE TESTING RESEARCH

The expander amplifier added to the broadband eddy current system being developed for measuring jacket thickness and jacket-to-core gap variations in an unbonded fuel element made it possible to distinguish between the two variables at the output of the instrument. Severe instrument drift and instrument electrical noise was encountered at the required sensitivity level and must be reduced. As predicted by theory the output signals vary nonlinearly with respect to the two variables, and a nonlinear readout circuit will be devised in an attempt to read the two variables independently.

In contrast to the above work which is being done by analyzing the pulse output signal of the test probe in the time domain, measurements of the output signal in the frequency domain are also being made. As in the time domain case, only small differences are observed between signals due to the variations of the two variables in the frequency domain analysis. A comparison of drift and noise in the two cases is being made.

An infrared optical head and beam chopper assembly has been fabricated and tested for use in thermal bondtesting. Preliminary tests were made using a lead sulphide and an indium antimonide infrared detector. Preamplifier noise measurements showed that a lower noise preamplifier is needed to take full advantage of the low noise indium antimonide detector. Consideration is being given to the type of readout and recording scheme to be used, and an Alden "Helix" recorder has been borrowed for evaluation.

An optical head and chopper assembly for use with various types of infrared detectors has been fabricated and tested using both a lead sulphide and a recently obtained indium antimonide photoelectromagnetic (PEM) infrared detector. This preliminary test has shown that a capacitive compensator for spurious signal introduced into the high impedance lead sulphide detector by the chopper wheel will be necessary. The PEM detector is a low impedance device, and no difficulty due to such a spurious signal has yet been experienced. Although the noise level of the PEM detector is extremely low, the signal for a given infrared power input is also low. A low noise transistor preamplifier using a 2N43 transistor and having flat response between 100 and 15,000 cycles per second has been fabricated and tested in comparison with a conventional low noise cascode amplifier using a 6BQ7A. The total noise generated in the transistor preamplifier was only about 2 microvolts referred to the input at about 1 megacycle per second bandwidth as compared to 4 microvolts for the tube preamplifier at the same bandwidth.

In using the transistor preamplifier with the PEM detector, residual detector noise was even less than the transistor noise. Improvement in amplifying techniques will be required in order to utilize the full capabilities of the PEM detector. Restriction of the amplifier bandwidth to 300 cycles per second has

[redacted]

provided great improvement in the amplifier noise level. Due to limiting the bandwidth, close control of the chopping frequency must now be maintained. A circuit for synchronizing the chopper frequency with a standard has been fabricated. Further decrease of the amplifier noise contribution should be obtained by raising the chopping frequency; amplification at higher frequencies takes advantage of the inverse frequency dependence of transistor noise. Modifications in the chopper to allow a frequency of 2000 cycles per second are now being made. According to a recent article in the September 1959 Proceedings of the IRE, further improvement in the amplifier noise should be obtained by substituting 2N185 transistor for the 2N43. A new bridge type transistor preamplifier having approximately 0.02 microvolt noise referred to the input at 10 KC bandwidth is commercially available. However, such amplifiers are expensive, and more tests will be required to establish whether such an amplifier is actually needed.

A tentative read-out scheme utilizing line length modulation with an Alden "Helix" recorder will be used to record temperature as a function of position on the surface of initial test pieces. This selection is based partly on the availability of equipment. A system using a conventional line recorder could also be used, but read-out would be much more time consuming.

An aluminum dummy test piece with 1/2, 3/8, 1/8, and 1/16 inch diameter holes drilled diametrically from one side to within .030 inch of the other side has been fabricated to simulate a fuel element having gas voids in the braze layer. Rough time transient heat transfer tests on this piece show that the temperature at the center of a 1/2 inch diameter spot will drop from about 60°C to about 35°C in less than 1/2 second when the heat source at the center of the spot is removed and when the mass of aluminum around the periphery of the spot is held at about room temperature. This means that the scanning device would have to rotate the test piece at greater than 60 rpm if the heat were applied on one side of the test piece, and the detector were placed diametrically opposite. However, since circumferentially symmetrical inductive heating is presently anticipated, requirements on the scanning device should be less stringent. A scanning device is being assembled for simultaneously rotating and translating fuel elements at 60 to 1000 rpm and 1/16 to 3/8 inch per revolution, respectively. This scanning device should be adequate to meet present needs, and also cover some of the future eventualities in the thermal bond testing program.

It is determined that conventional automatic gain control circuits will not provide the stability required by the inductive thermometry instrument to be used in the thermal bondtesting program. A precision voltage comparator circuit for use in the automatic gain controlled amplifier to compensate for probe to surface spacing variations was designed and placed in the electronic shop for fabrication. About 50 types of semiconductor diodes were tested for use in the pulse stretching section of the comparator circuit. Using minimum capacitive coupling as a criterion, Transitron types S-5700 and I-6, and Hughes type HI-2135 diodes were found best suitable.

Design of auxiliary equipment for use with a General Radio Impedance Comparator to increase its effectiveness on nondestructive testing measurements has been started. The first circuit being considered is that of a 360-phase shifter to be used to adjust the phase of the phase detector switching voltages.

DECLASSIFIED

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

The PCTR experiment on the reactivity effects of a stainless steel loop in the EGCR lattice has been completed. Data necessary to calculate k_∞ were obtained for two separate three-by-three arrays, or supercells. The first consisted of eight UO_2 seven-rod cluster fuel assemblies of 1.8 w/o enrichment with an empty stainless steel tube in the center. The second supercell was the same, except that a fuel assembly of 2.6 w/o enrichment was placed in the stainless steel tube.

The data have not yet been analyzed but it is possible to make a rough estimate of the results. From a comparison of the mass of copper necessary to poison the uniform array of 1.8 w/o fuel assemblies to a k_∞ of unity with the mass of copper required to poison each of the supercells to unity it is estimated that both the supercells have positive k_{ex}'s of about seven percent and three percent, for the case in which the 2.6 w/o fuel element is in the tube and the case in which the tube is empty, respectively.

Variation of the Doppler Coefficient with S/M Ratio

Laboratory testing of the 1.92" diameter mockup was carried out. Data were obtained on temperature distributions, rates of cooling, rates of heating, etc., as functions of fuel element temperature from room temperature to ~800°C. Failure of the nickel plating due to a uranium-nickel eutectic formation at ~740°C made further testing at higher temperatures impractical. An alternate reflective coating material was selected and tested. Al_2O_3 applied in a thin film by flame spraying was tested and appeared to remain reasonably satisfactory after temperature cycling to over 1000°C. As a result, the PCTR element, 1.92" diameter x 20" length, has been coated with Al_2O_3. All experimental equipment is being readied for PCTR work to begin about the second week in March.

An auxiliary experiment is being planned to accompany the 1.92" diameter temperature coefficient measurements. Since reactivity changes due to extraneous heating of materials other than the test fuel element are always present and difficult to evaluate, a subsidiary measurement will be made wherein the extraneous heating effects take place and the test fuel element remains at or near room temperature. This will be accomplished by heating the moderators immediately surrounding the test element electrically so as to obtain the same temperature distributions throughout the PCTR core as were present during the heated fuel element measurements. Hopefully, the reactivity changes due to heating will, in this way, be obtained in one lump sum and corrections to the fuel reactivity effect readily made.

Nuclear Graphite

A detailed outline of the first half of the chapter on nuclear properties has been partially completed for the book "Nuclear Graphite," which is being written by R. E. Nightingale.

Rod Replacement Analysis

A formal report on the methods developed for this work has been delayed pending the arrival of the results of a 4-group calculation performed at ORNL. These results, which are to be included for comparison, are expected at any time. In addition, an abstract of a paper on this work has been submitted for presentation at the June meeting of the American Nuclear Society.

A key punching error was discovered in the input for the calculations of k_∞ for the 9:1 fuel to control rod ratio in the EGCR lattice. The corrected value of $\frac{\Delta k_\infty}{k_\infty}$ for this case differs from the experimental results by only 0.3% instead of the 1.7% quoted last month.

RESEARCH - 5000 PROGRAM

Isotopic Analysis

The mass spectrometer for this program operated at 90 percent efficiency during February. About 75 percent of the time was spent on furnishing isotopic analyses of program samples. One day was spent in maintenance transferring accumulated mercury from the traps. One day was spent in making measurements of the mass discriminations produced by ion source focusing conditions.

A study is underway to calculate possible improvements in abundance sensitivity resulting from energy analysis of the final ion beam. Several practical systems are being studied.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Funds were received from the U. S. Air Force Cambridge Research Center for use in conducting more basic studies of dispersion and deposition processes in the atmosphere.

The field sampling grid, including all twenty sampling towers, was reactivated to 3200 meters' distance from the source. A "shakedown" experiment was conducted on February 16, followed by a successful field trial on February 18. All equipment operated satisfactorily. The new portable electric starters fabricated locally for starting the gasoline engines on the vacuum systems proved very satisfactory and reduced the required startup time to about one and one-half hours.

Plans were made for installing additional arcs of samplers to cover the Northeast quadrant centered on the Meteorology Tower. The present course is centered one hundred meters south of the tower and covers the southeast quadrant. The new samplers will be used for studies of dispersion from elevated sources during unstable temperature stratification, thus providing greater opportunity for daytime experiments.

DECLASSIFIED

DECLASSIFIED

Equipment believed to have sufficient range and stability for assaying ZnS loadings on membrane filters using the phosphorescent technique was received and calibration of the system by the Radiological Chemistry group was begun. Even the new instruments are very sensitive to ambient temperature changes, and must be used in a carefully controlled environment with the amplifiers in a cold box. Reassaying of the Green Glow samples on this equipment is expected to start in early March. Meanwhile, efforts will continue to stabilize the equipment for use under less stringent environmental requirements.

Work continued on preparation of individual chapters for the Geophysical Research papers according to agreement with the Air Force. A chapter titled "Wind Prediction for Operation Green Glow" was transmitted to the Air Force for review and comments. Computations of stability ratios from the portable mast data were completed for two height intervals and four averaging periods ranging from the one-half hour of generation to the entire duration of the experiment. The stability ratios were also transmitted to the Air Force for correlation with the dispersion data.

The first in a series of three scheduled reports on prospective 1960 crests of the Columbia River flow at Hanford Works was issued on February 23. Because of the low water content of snow cover in the Columbia River watershed above Hanford, the crest this year is expected to be the lowest of any year since HLO began forecasting them in 1956. The preliminary outlook for 1960 follows, together with the comparative figures for both 1959 and 1958.

	1960 Forecast	1959 Observed	1958 Observed
Peak flow at Trinidad*			
(Units of 10^3 CFS)	330-410	438.8	406.0
Peak stage (feet MSL)			
100-B	403.5-406.5	407.8	406.2
100-D	392.5-395.5	396.2	395.0
100-F	379.0-382.0	383.2	381.8
Richland	346.5-349.5	350.5	349.2

* Trinidad is a gaging station 22 miles downstream from Wenatchee.

DOSIMETRY

The Shielded Personnel Monitoring Station was closed January 11 to January 26 to permit change of the cell door to screw drive so it can be opened from inside the cell if the electric power should fail. The new apparatus was faulty, however, and three additional days were lost in making the necessary changes.

A recalibration of the whole body counter for Cs^{137} was completed. Our results for Cs^{137} will be 16% higher than those previously reported. Our plastic phantom was used for calibration with Cs^{137}, Zn^{65}, Na^{22} and K^{40}. The results were 16 to 25% off from those obtained with human subjects.

1242000

[redacted]

The new potassium and cesium calibrations were used in a recalibration of all the results for routine examinations during 1959. The old calibration for Zn^{65} was used. There is now good agreement between our results for potassium and cesium and those obtained by other laboratories. Enough new data had accumulated since the last over-all analysis to begin to draw conclusions about the spread of Zn^{65} in different work areas and communities. Subjects working in the 200 Areas have about the same average Zn^{65} burdens as 300 Area workers. As reported earlier, 100 Area workers have about twice as much as the others. Residents of Kennewick have slightly higher Zn^{65} burdens on the average than Richland residents. Pasco residents have two to three times the average burdens of Richland residents.

A check of the Zn^{65} calibration was begun. First results indicate considerable differences between people.

Other Activities in Whole Body Counting: The large scintillation counter was remounted so that it can be moved to any position in a plane. This makes possible the scanning of a subject to locate the radioactivity in his body. Tests were begun of a shadow-shield counter. We began to count women without requiring them to shampoo their hair. An additional count is made directly above their hair to see if not shampooing makes any difference. A tape punch was ordered to put the analyzer data in a form that can be processed and stored by the IBM system. A de-bug run was made on the IBM system using data prepared by hand.

The rewiring made necessary by the rearrangement of the positive ion Van de Graaff laboratory was completed. The Van de Graaff is now in operation again. A positioning device was modified for use in lining up the accelerator. A new system of warning lights was installed.

We borrowed a plutonium-beryllium neutron source from the University of Washington. With it we were able to show that the fraction of the neutrons emitted that came from fission was intermediate between those of our own sources which are both larger and smaller. These data are pertinent to neutron dosimetry in plutonium production operations.

Cooperative work on neutron dosimetry with other groups included work on moderated dosimeters, Hurst dosimeters for criticality accidents, Li^6 spectrometer, a precision long counter, and BF_3 tube standardization.

An ion source power supply and vacuum manifold were prepared for work leading to alpha particle bombardment studies with our Van de Graaff. Material was received for making tissue equivalent chambers, and molds for the chambers were designed.

An evaluation of the energy loss measurements used in the mechanism of graphite damage studies showed they were reproducible to 0.1%. It was decided that this was not good enough for making stopping power measurements for application to dosimetry work.

INSTRUMENTATION

The personnel dose alarm detector and a major portion of the necessary circuitry have been formulated and portions tested for one type of personally carried personnel dose alarm unit. The detector gamma energy dependence curve will be very similar

DECLA[redacted]D

to that of a standard HAPO pencil-type dosimeter. The unit, thus far, appears to have selectable (± 10 mr accuracy) alarm levels from < 20 mr to about 200 mr as desired by the user. In addition, the accumulated dose may be read simply and easily at any time.

Extensive transistorized circuit revisions were incorporated in the experimental scintillation portable beta-gamma dose-rate meter to improve its temperature characteristics. To this point, the instrument reading error is less than ± 10 percent from 10°F to 140°F.

Most of the alpha air monitor experimental transistorized circuitry has been completed using coincidence counting techniques to eliminate radon-thoron background effects. Running tests, which are being made continuously, of the transistorized circuitry completed thus far indicate excellent reliable operation. The only circuits remaining to be fabricated are the count-rate meters which are merely adaptations of our previously developed circuits. The conservative calculated sensitivity of the system is such that the system can alarm on Pu^{239} air concentrations of less than 10 MPC in 20 minutes with no false alarms from radon-thoron effects.

The experimental transistorized logarithmic count-rate meter was completed and is being tested. The complete circuit consists of three small printed-circuit boards containing an amplifier, binaries, a diode pump circuit, and the meter drive circuits. The transistorized count-rate meter covers the range from 10^2 to 10^6 counts per minute with a complete range accuracy of ± seven percent of the true reading. The unit drives both a meter and a 10-millivolt recorder.

An experimental transistorized approximate dose-rate integrator and alarm was developed using a miniature G-M tube detector and associated transistor circuitry. The circuitry drives a register to indicate approximate accumulated dose, and it works satisfactorily to levels of less than 0.25 mr/hr. It is recognized that the G-M tube detector will not produce a true indication of dose except over defined gamma energy limits; however, this does not preclude the use of such an instrument for specific purposes. Using a small modified mechanical register, a signal can be obtained to energize an alarm at any accumulated dose level desired.

Investigations with the multichannel analyzer were conducted concerning NaI crystal photopeak efficiencies with and without surrounding lead collimation shielding. Data were obtained and curves plotted concerning the photopeak efficiency versus gamma energy. The addition of lead collimation markedly improved the efficiency. The data obtained will materially aid in the analysis of the previous data from a number of experiments at the 234-5 Building.

Some investigative work was done concerning the use of thermistors for wind velocity measurements for the Atmospheric Physics Operation. The thermistors were heated by current flow to a high enough level to preclude adverse effects caused by ambient air temperature variations. Several experiments were conducted with the thermistors heated to +85°C. Several other types of thermistors are available with temperature ratings as high as +300°C.

Two, four-by-eight-inch effective area scintillation experimental detector probes were designed, assembled, and satisfactorily tested. One was for alpha-

only detection and the other for alpha-beta-gamma combined detection. The probes will be used in the two respective scintillation transistorized hand and shoe counters. For the alpha probe, the geometry over the four-by-eight-inch area with no protective screen was 25.3 percent ± 0.8 percent geometry variation, and the geometry was 17.8 percent ± 1.3 percent with the protective screen in place. For the combined probe with screen, the alpha geometry was 16.9 percent ± 1.3 percent geometry variation after biasing out all beta-gamma effects. Using a uniform four-by-eight-inch Ra-D source, the beta-gamma geometry came to 2.2 percent. Both probes use RCA 6655-A phototubes to replace the originally used RCA 6372 phototubes. The economic advantages of the new probes are extensive since the 6655A costs $250 less than the 6372, and the remainder of the probe costs are essentially equal. This means that the alpha-only scintillation transistorized hand counter which uses four probes will cost $1,000 less to fabricate than originally. The combined alpha-beta-gamma hand and shoe counter which uses six probes will cost $1,500 less to fabricate than did the original unit.

The experimental transistorized alpha monitor for use with either air proportional or scintillation probes, as desired, was modified to produce a better and louder output loudspeaker indication and a simplified high voltage adjustment for the delicate air proportional probes. Using the newly developed non-gamma sensitive (to five r/hr) uniform geometry two-by-four-inch and two-by-seven-inch scintillation probes, the instrument consistently produced alpha geometries about 12 percent. This was measurably better than the air proportional probe geometry. The complete instrument was laboratory tested for three weeks and then taken to Redox for field tests.

A miniature scintillation alpha probe was assembled and tested. The probe consists of a four-inch-long fused quartz light pipe of 0.15-inch diameter with a hemispherical detecting end. Uniform detecting geometry over the ZnS-coated hemispherical end was six percent with a background of less than one c/m. The light pipe attached directly, with rapid interchangeability, to a phototube probe housing.

Experiments continued concerning the electron beam deflection and control system for the electron Van de Graaff. An eight-kilovolt hydrogen thyratron was obtained and a high-voltage relaxation oscillator was designed and tested. It was determined that 2.5 milliamperes of high-voltage supply current was required for correct operation. An adequate high-voltage supply is presently under order, and the necessary remaining commercial items will be ordered shortly.

Some investigations were conducted using a miniature glass switch at mechanical resonance of one kc/s as a vibrating reed for use with an electrometer tube. The switch performed well; however, the leakage resistance was such to preclude its use with five micromicrofarad miniature ionization chambers over long-time periods (eight hours).

Experimental work continued concerning the servo-controlled logarithmic wide-range scintillation area monitor wherein the high-voltage to the phototube is reduced by the servo feedback loop as the field strength at the detector increases. The high-voltage change is then metered to produce a reading of gamma dose rate. The experiment used a Brown servo system and operated successfully. Eventually, the complete circuitry will be transistorized.

DECLASSIFIED

A study is being made to determine the materials and development needed to allow data to be entered manually into the memory of the RCL multi-channel analyzer. In addition, it is desired to enable the system to perform certain arithmetical functions such as automatic channel information summation and deletion.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month without unscheduled shutdowns. The EGCR experiment with stainless steel tube, second enrichment fuel was completed during the month. A mock-up run of the Pu solution in stainless steel critical mass experiment was completed. Tests were completed to determine the type and position of the fine control rod. Installation of the fine control rod was started. This rod is designed to increase the accuracy of measurement of small reactivity changes.

The TTR facilities were shared equally by the Critical Mass Experiments and Neutron Temperature Experiments. There was one unscheduled shutdown due to an operational error during the month.

CUSTOMER WORK

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	87	83.5
24-Hour General	58	86.0
Special	144	84.7

In spite of a cold wave during the last five days of February, the mild temperatures which prevailed before then established the month as somewhat warmer than normal. Although rain fell on ten of the first fourteen days, there was no measurable amount thereafter and the monthly total was slightly less than normal. Average wind speed of eight and one-tenth mph was somewhat higher than normal for February.

Instrumentation

Fuels Preparation Department has requested assistance in improving the performance of their autoclave temperature control system during startup operations. The work consists of two parts: (a) To modify an existing control system as required to obtain satisfactory startup control and (b) to define the requirements for future installations. It is planned to simulate the autoclave process on the analog computer and apply simulated models of several different types of available control systems to the process. Recommendations for future installations will then be made, based on these tests.

Test equipment for measuring extrusion press deceleration after impact has been assembled for testing. The equipment consists of a piezoelectric accelerometer and a Memoscope, with a suitable impedance matching network.

The Scintillation Mask Monitor instrument for the Laundry Operation was modified with the addition of a second detector for specific checking of the filter container. At present, the unit will detect less than 5,000 d/m of Ru^{106} at any

point on the mask. The geometry varies from 1.0 percent to 1.5 percent over the complete mask surface with Ru^{106} used as a test source. The instrument is a direct attempt at automatic monitoring wherein the mask is placed, by hand, between the probes, and a count is made. No mask or probe movement or adjustment is necessary.

The mechanical conveyor portion of the automatic laundry monitor for the Laundry Operation was received and will be set up for experiments as soon as room is available.

Eight of our designed vacuum-tube high-level alpha air monitors, which were ordered for installation at Redox, were debugged, tested, calibrated, and delivered to Redox.

Fabrication continues in the 328 Electronics Shop using our designed circuits on ten, three-decade logarithmic response scintillation area monitors for HLO and on three similar, but higher level, units for IPD. The IPD units will be used as reactor elevator monitors with two-level alarming features incorporated.

Assistance and cooperation was rendered to the Calibrations Operation, RPO, HLO, concerning preparation of "as-built" drawings for several transistorized portable radiological instruments and on the alpha-only and alpha-beta-gamma transistorized scintillation hand and shoe counters.

Assistance was rendered to the Calibrations Operation, RPO, HLO, concerning the debugging, testing, and calibrating of the first of four Scintillation Transistorized Alpha Hand Counter fabricated offsite to our specifications. The principal troubles evolved from poor workmanship--especially concerning the detector probes. The debugged instrument now performs quite satisfactorily and will produce ten to twelve registers in 15 seconds from a 500 d/m Pu^{239} alpha source distributed over the four-inch by eight-inch effective probe area. The background count, in 15 seconds, averages less than two registers. A 50 d/m Pu^{239} point source can be detected and indicated above background in 15 seconds count time.

Acceptance tests were completed on two portable, scintillation, transistorized, battery-operated, gamma energy analyzers, and on four battery BF_3 portable instruments which were converted from vacuum-tube operation to the new transistorized circuitry locally designed.

A suggestion was evaluated concerning the spray coating with white paint of the inside of alpha air proportional probes. The white background will aid, somewhat, in the stringing of the collector wire. The principal concern is that of too thick a coating which would impair probe operation.

One new, non-gamma sensitive, alpha scintillation probe of two-inch-by-four-inch effective area was tested in the 329 Building, in the 308 Building, and at Redox under field conditions. The performance was quite satisfactory in all cases. In a Co^{60} field of 10 r/hr, the counting background increased only to four c/m while the alpha counting geometry consistently exceeded 12 percent in the field tests.

The experimental transistorized alpha monitor for use with both air proportional and scintillation probes was satisfactorily laboratory tested and delivered to Redox for field tests.

DECLASSIFIED

A new secondary emission tube manufactured by CBS Hytron Type 7548 was received and tested. It was hoped that these new tubes could be used as a substitute for the EFP 60 in fast pulse work. It was found that the engineering samples received do not approach the advertised transconductance and current output and do not appear satisfactory as a substitute for any tube type.

Analog Computer

The computer solutions this month included the speed of control (see 2000 Program - Present Reactors) and the NPR startup calculations (see 2000 Program - Future Reactors).

A tabulation of the operating and down time for the GEDA computer for February follows:

Total possible operating time	-	184 hours
Total scheduled down time	-	0 hours
Total unscheduled down time	-	23 hours
Total use time	-	161 hours

The unscheduled down time amounts to 12.5 percent of the net possible operating time (total possible operating time minus scheduled down time). The equipment failures encountered during the month were random.

The new Berkeley EASE computer was delivered on February 8, 1960. Berkeley representatives were at HAPO through February 26 to complete the installation. On the whole, the installation progressed quite well. There were no major difficulties encountered, except for failure of the Digital Voltmeter. This was corrected by a replacement of several of the printed circuit boards comprising the logic circuits. One minor difficulty remains to be corrected. This difficulty involves the appearance of two decimal points in the remote readout. Berkeley has promised to send a new circuit board to correct this. It is estimated that approximately one month more will be required to complete the acceptance tests and place the computer in active service.

Optics

A total of 448 manhours shop work was completed of which 10 percent was for IPD, 17 percent for CPD, 62 percent for HLO and 11 percent for CEO. The work included:

1. Fabrication, assembly and testing of components for the Wide Angle Viewer for PRIR.

2. Fabrication of a pyrometer head for the IPD Nondestructive Testing Program.

3. Repair of one crane periscope head for Redox.

4. Repair of one microscope for FPD.

5. Fabrication of quartz pieces for the 231-Z Building.

6. Modification of a 1-1/8 inch diameter borescope for IPD.

7. Preparation of microscope slides for the Health Records Unit.

8. Preparation of four quartz rods for use as light pipes.

9. Fabrication of three non-darkening lenses for the crane periscope.

R S Paul

Acting Manager
PHYSICS AND INSTRUMENT RESEARCH
AND DEVELOPMENT
HANFORD LABORATORIES OPERATION

RS Paul:mcs

DECLASSIFIED

Chemical Research & Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Reactor Components

Gamma analyses showed that the poor decontamination reported last month for all coupons in a loading discharged in late December, 1959 from KER Mockup Tube 3 was due to Sb^{124} and Ag^{110}. This is the first time these isotopes have been encountered in laboratory tests of decontamination procedures for the NPR. They were removed only about one-tenth as effectively as Fe^{59} by decontamination procedures proposed for the NPR. It is not anticipated that these two isotopes will be significant in NPR contamination.

Phenylthiourea was evaluated as a corrosion inhibitor in ammonium citrate-EDTA solutions. Corrosion of carbon steel was reduced by a factor of about three without significant loss of decontamination.

Studies of decontamination of process tubes and pigtails of present HAPO reactors were continued. The stainless steel pigtails are effectively decontaminated by solutions containing oxalic acid. Aluminum surfaces are not. Among decontaminating solutions so far tried, sodium dichromate-sulfuric acid is the only one found especially effective for aluminum surfaces. The solution corrodes carbon steel excessively at concentrations required for effective decontamination of aluminum.

Uranium Oxidation and Fission Product Volatilization Studies

Performance testing of the high-level fission product volatilization facility was continued in preparation for the fission product volatilization studies at high irradiation levels. Several problems were encountered and are being remedied. The problem of most concern is the retention of fission products on the surfaces of stainless steel equipment and tubing even after intense decontamination efforts. Since quantitative recovery of the fission products is essential to the success of the experiments this condition cannot be tolerated. Where possible, stainless steel apparatus is being replaced by pieces fabricated from either quartz or Pyrex.

Two experiments were performed in which uranium-aluminum-Zircaloy systems were heated to temperatures of 1400 and 1440 C in carbon dioxide-helium atmosphere and held for 26 and 5 minutes, respectively. During both experiments no flow or break-through of molten uranium through the Zircaloy boat was observed. However, subsequent observations and metallographic examinations of the residue from the 1400 C and 26-minute experiment definitely established that uranium had completely penetrated the Zircaloy and that the latter was extremely brittle and had failed at several points. Further experiments are planned to define more completely the penetration of Zircaloy by molten uranium in the region of 1400 C which is about 400 C below the melting point of the alloy.

[redacted] DECLASSIFIED

N.P.R. Effluents

Experiments continued on the scavenging of radionuclides by the precipitate formed on mixing the candidate NPR cleaning solutions. Scavenging decontamination factors ranging from 500 to 10,000 were obtained for radioisotopes of iron, strontium, barium, zirconium and niobium, cerium, calcium, cobalt, zinc, and iodine. Little decontamination was obtained in the case of radionuclides of ruthenium, antimony, silver, chromium, cesium, and phosphorus. Even so, it is believed that the reaction will be useful for assisting with the disposal of spent cleaning solution. The precipitate (a manganese oxide) resulted from the reduction of permanganate ion, a component of one of the cleaners. Somewhat less effective scavenging of calcium, cobalt, zinc, and iodine was found when a hydrogen peroxide solution is included in the mixture as it would be in the case of a three-step cleaning process. The peroxide solution reduces the scavenging decontamination factors for these isotopes by about an order of magnitude. This difference in scavenging may be related to the acceleration of permanganate reduction by the peroxide cleaner.

Reactor Effluent Treatment

Estimates were prepared for performing scale-up studies of aluminum beds for reactor effluent decontamination. Lathe, shaper, and other machine tool methods for preparing aluminum and Alsi for highly porous beds were demonstrated. A wide variety of turnings and chips was produced which will be further studied for the optimum bed configuration. It is important to establish the availability and cost of satisfactory bed material before proceeding with pilot scale testing.

SEPARATIONS PROCESSES

Neptunium Recovery in Redox

The essential first step, the retention of neptunium in the Redox plant during normal processing operations, has been demonstrated in recent plant tests. Recent laboratory work indicates that the necessary additional concentration and purification (to load-out limits) of the retained neptunium can probably be effected by a rather straightforward and readily-controlled flowsheet applied in the 3A-3B columns. This flowsheet entails addition of vanadyl ion to the scrub stream (and possibly the aqueous feed) in the 3A column. This enables neptunium to be retained in the aqueous phase as inextractable neptunium(V) while plutonium and uranium are extracted in the 3A column and stripped (in the 3B column) back to an aqueous phase appropriate for recycle. The neptunium(V)-bearing aqueous waste (3AW) from the 3A column must be recycled to the 3A column feed point during this operation or else discharged to an interim storage facility. The neptunium stream is thus unavoidably diluted with the 3AS during this operation. Following removal of uranium and plutonium the neptunium-bearing waste would be oxidized with dichromate and a typical "spin" flowsheet applied in the 3A-3B columns to accomplish the final concentration and purification preparatory to load-out. The main attraction in this flowsheet is the fact that all operations can be conducted with acidic streams, thus avoiding any delicate acidity adjustments.

Flow rates and concentrations of bulk constituents employed in a batch countercurrent test of this flowsheet were as follows:

Stream	Flow	M ANN	M HNO_3
3AF (aq)	2	1.3	0.3
3AS (aq)	1	1.3	0.3
3AX (hexone)	3	-	0.25

During the partition of neptunium from plutonium and uranium the scrub stream (3AS) was made 0.05 M in vanadyl ion. In the simulated final recovery of neptunium the feed (made up from the waste from the partition run) was made 0.02 M in dichromate.

With the three extraction and three scrub stages which were used in this run, neptunium losses in both cycles were somewhat high (1.4 percent to the organic extract in the partition cycle and 0.7 percent to the aqueous waste in the recovery cycle). However, these losses could probably be reduced with additional scrub and extraction stages, as should be available in the 3A column.

Separation of neptunium from plutonium and uranium was good, decontamination factors being 1000 for plutonium and 275 for uranium. Again, these could probably be improved with a longer extraction section in the partition cycle. Measured ruthenium decontamination factors were about two in the partition cycle and about six in the neptunium purification cycle, which comprised only a single pass. Thus a spin flowsheet would undoubtedly be required to accomplish the necessary fission product decontamination to permit the neptunium product to be loaded out.

Purex HA Scrub Column Studies

Both a sieve plate (0.08-inch diameter holes, 21 percent free area) and nozzle plate cartridges were investigated as possible alternates for the HA column "zebra" cartridge. The nozzle plate cartridges were far superior to the sieve plate cartridge, both with respect to operability and crud scrubbing effectiveness. The most favorable scrub cartridge investigated to date is composed of two-inch spaced, six percent free area nozzle plates with 1/8-inch diameter holes. The flooding frequency of this cartridge in a typical dual diameter column was about 15 to 20 cycle/min greater than that of the extraction section. The organic phase was continuous throughout the operable range of pulse frequencies, and no tendency for phase inversion was noted.

One series of runs at 1.1-inch pulse amplitude made in a uni-diameter column with two-inch spaced ten percent free area nozzle plates in the scrub section gave flooding frequencies about 20 cycle/min lower than the corresponding extraction section flooding frequencies. It was observed, however, that crud entrainment in

[redacted]CLASSIFIED

the scrub section was excessive at high frequencies. This crud entrainment was not observed at lower frequencies nor with the same cartridge operated at 0.6-inch pulse amplitude. These observations indicate that the plate spacing should be greater, perhaps by as much as 50 to 100 percent, than twice the pulse amplitude.

Attempts to produce a "zebra" effect by inserting one-foot sections of one-inch fluorothene Raschig rings at two-foot intervals in the 0.08-inch hole sieve cartridge were only partially successful. The plastic rings did tend to control flooding, but the coalescing ability of the rings was poor. In crud scrubbing studies, the material that was scrubbed tended to be carried to the top of the column by the entrained aqueous.

Purex 1C Column Studies

A graded nozzle plate cartridge with 23 percent free area and 3/16-inch diameter nozzles pointing up has been evaluated in the three-inch diameter 1C column with a 1.0-inch pulse amplitude. The bottom half of the nine-foot column has four-inch plate spacing, and the top half has two-inch plate spacing. The maximum flooding capacity was about 2000 gal/hr-sq ft at 55 cycles/min. This maximum varies less than five percent from the previously evaluated sandwich cartridge at a 1.0-inch amplitude, and the plant type cartridge at 0.5-inch amplitude. The maximum was about ten percent greater than for the same cartridge with the nozzles pointing down. The graded nozzle plate cartridge operated stably over a wider frequency range at the higher flow rates, and was easier to start up and less sensitive to upsets than the other two cartridges. The efficiencies of all cartridges were good.

WASTE TREATMENT

Semiworks Waste Calciner Prototype

Six runs, using simulated formaldehyde-killed threefold concentrated Purex waste as feed, were completed during the month.

The primary problem continues to be the buildup of lumps on the feed nozzle. When lumps occur, three deleterious conditions may result:

a. Poor atomization, resulting in excessive agglomerate formation

b. Breaking off of the nozzle lumps with attendant lump buildup in the product

c. Difficulty in proper control of feed rate due to the variations in pressure drop at the nozzle.

Variations in operating temperature from 400 to 600 C showed no significant effect on nozzle buildup. Atomizing air to feed flow ratios of about 600 are sufficient to keep nozzle buildup and lump formation to near acceptable level, but result in undesirably small average product particle size. Lower atomizing air-feed flow ratios result in more desirable average product particle size, but also result in excessive nozzle lump formation.

Air cooling of the feed nozzle in one experiment (an attempt to prevent potential precalcination in the nozzle) confirmed last month's observations (HW-63740 C, p. 4-2) that nozzle lump formation is not prevented by this technique.

1242011

One run using aged feed solution which had precipitated was performed without difficulties due to the slurry. This successful performance is encouraging with respect to the processing of potential slurry-containing feeds.

Increased operating temperature has resulted in increased nitrate and sulfate volatility.

Batch Waste Calcination Studies

Laboratory scale studies were made on firing of simulated Purex high-level, high-acid, wastes that had been neutralized with caustic to 0.8 M excess NaOH and dried to a solid. Upon firing at 650 C in a four-inch-diameter stainless steel pot, the dried solids were reduced to molten caustic containing the iron and aluminum. The cooled solids were light green, and had a bulk density of 2.2 grams/cc.

Granular calcined solids from the fluid-bed calciner prototype were fired to 1000 C both with and without the addition of sodium sulfate. The solids from the fluid-bed prototype were from simulated formaldehyde-killed threefold concentrated Purex waste with a feed sulfate to salt nitrate ratio of 0.55. Bulk density was 1.60 grams/cc. Pertinent observations were as follows:

a. Without the addition of sodium sulfate, the granular solids sintered into a solid mass, except for the top one-half inch. No volume reduction was noted.

b. With the addition of sodium sulfate equal to 61 volume percent of the calcine, no melt was formed. The granules sintered into a hard mass with a bulk density of 1.5 grams/cc.

c. With the addition of sodium sulfate equal to 130 volume percent of the calcine, a melt formed with a density of 2.15 grams/cc and the volume decreased by 31 percent. This mixture simulates the calcine composition which would be obtained from a feed with a sulfate-to-salt nitrate ratio of 1.48. Such a feed normally forms a melt on calcining.

Observation Wells

Survey data for Hanford monitoring wells were examined to evaluate the accuracy of reported well locations and well casing elevations. Several errors were found in addition to those previously reported. The errors are generally associated with some of the early wells constructed on the project which were surveyed in some cases from inaccurate temporary bench marks and in other cases without adequate corroborating rechecks. These errors can generally be corrected only by resurveying. Only those wells in which erroneous survey data would significantly affect geological or hydrological interpretations will be corrected at the present time.

The trailer-mounted scintillation probe is being calibrated in a mock test well to determine its sensitivity for detecting Ru^{106}-Rh^{106} concentrations in water. This probe may be used for determing the concentration of gross beta emitters in monitoring wells and for recognizing significant variations in concentrations with depth. Plans were made to survey several deep

[redacted]

monitoring wells with the probe after it has been calibrated.

There were no significant changes in ground water contamination patterns in the vicinity of the 200 Areas. Revised ground water contour data assisted in establishing Purex cribbed wastes as the most likely source of the contamination found four miles southeast of the Purex Plant. The current beta particle emitter concentration being detected in the ground water at that distance from Purex is 1.7 x 10^{-6} uc/cc, essentially all of it being Ru^{106}-Rh^{106}.

Disposal to Ground

Wastes discharged to the 216-A-3 crib were sampled and analyzed to evaluate the need for soil column testing. Seven samples were analyzed and found to contain less than 5 x 10^{-6} uc/ml Cs^{137} and less than 5 x 10^{-6} uc/ml Co^{60}. The analyses for Sr^{90} are not yet complete.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Fission Product Packaging Prototype

Exploratory tests were conducted on the inductively heated rotary kiln (hydrolyzer) to determine its possible use in converting an aqueous sodium chloride brine into a dry free-flowing salt powder. In the test runs to date, it has been found possible to deliver a free-flowing powder, but all runs have been characterized by low powder yields. That is, some of the salt builds up as a cake in the transition zone (wet-dry area) of the kiln tube. Consequently, on the basis of these exploratory runs, it appears that the kiln may require operation in a cyclic manner rather than as a continuous unit. Periodically, it would be necessary to leach out and recycle the accumulated cake. Several different equipment arrangements were tried to improve product yields and to minimize cake deposits. Results of these runs are summarized below:

Arrangement	Percent Yield
1. Hydrolyzer + balls and cubes	30-40
2. Hydrolyzer + balls + scraper	40
3. Mild steel tube + mild steel rods	50
4. Stainless steel tube + mild steel rods	60

In all cases the equipment performed well in the evaporation and roasting zones. However, in the transition zone the crystals stuck to the walls of the tube and could not be removed simply by the scraper or the milling action of the rods. The reason for the superiority of the stainless steel tube and the mild steel rods was the lower temperature developed in the tube which reduced the tendency for salt to stick to the wall. In no case did cake build up on the balls or rods, even in the case of the inductively heated rods.

Additional runs are planned using modified feed introduction methods and modified equipment arrangements.

Remote maintenance features of the prototype assembly were demonstrated using the recently installed General Mills manipulator. All components met design expectations. However, some methods of refining the equipment to improve remotability became evident during testing.

Volatilization of Cesium

Solid cesium zinc ferrocyanide traced with Ca^{137} was air-dried at 105 C and then heated to 600 C. With the temperature held at 600 C, air was passed through the solid for one hour. The air sparge was then followed by a steam sparge for two hours. Off-gases were collected in water scrubbers. Less than 0.03 percent of the total radioactivity initially present in the solid was found in the off-gas scrubbers after sparging with both air and steam.

Strontium Recovery from Purex

Effort has been directed toward (1) proving-up the details of the promethium plant test, and (2) developing flowsheets for the recovery of strontium in the Purex head-end equipment --- either on a strontium-only basis or as one product of various crude product mixes. Most significant finding of the month was that strontium, too, is largely dissolved by the alkaline metathesis of the sulfate cake (which was intended to remove the lead carrier). This finding has required revision of the proposed flowsheet. It now appears that the cake can be adequately dissolved from the centrifuge by a combination of nitric acid and ammonium acetate washes. An acidic oxalate precipitation separates the soluble strontium from the insoluble lead and rare earth oxalates. Caustic metathesis then solubilizes and removes the lead, and the rare earth hydroxides are readily dissolved in acid.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Plant UO_3 Reactivity

Reactivity of plant UO_3 was obtained from thermobalance measurements during its reduction and hydrofluorination. Finished Products Technology used the data for comparisons with corresponding Paducah data. Sample processing rate was doubled to two per day (8 hours) by locating the thermocouple regulator nearer the sample.

Feces Sample Preparation Prior to Radiochemical Analysis

Laboratory time for the destruction of organic material in feces was reduced from three days to two days, and analytical accuracy was improved significantly. Organic material interfered with radiochemical methods used to measure isotope concentrations. The generally accepted destruction method consists of repeated evaporations with concentrated nitric acid followed by heating at 575 C in a muffle furnace. Destruction was accelerated by evaporating in 8 N nitric acid with dropwise (at first) addition of about 5 ml of 30 percent hydrogen peroxide just prior to dryness. The more dilute acid gave a very controllable reaction. Often a single evaporation was adequate to produce an inorganic product suitable for radiochemistry. When the destruction was not controlled quite carefully enough, as many as two subsequent

1242014

DECLASSIFIED

evaporations with fuming nitric acid containing about 10 ml of 30 percent hydrogen peroxide were needed. Elimination of the muffle furnace heating step avoided the analytical error from occasional spattering.

Electrodeposition of Plutonium

Plutonium was securely electrodeposited on the end of a nickel rod of one-eighth-inch diameter. One microgram of plutonium in 0.005 M sulfuric acid - 0.076 M ammonium formate was 98 percent deposited by means of an average current density of 50 ma/cm^2 for 60 hours. The plutonium deposit will be used as a calibration source for neutron spectrometers.

EQUIPMENT AND MATERIALS

Summary Pump Report

A report which summarizes pump, agitator, and valve development activities within Chemical Development for the years 1950 through 1958 is currently being issued as HW-63806.

Purex Organic Treatment Pump-Mixer

On the basis of plant-scale tests in prototype equipment, the aqueous recirculation pump of the Purex G-1 tank has been modified to improve the contacting efficiency. With the modified arrangement, organic from the C column is discharged directly into the pump suction where it is mixed with several volumes of aqueous wash solution then discharged to the Raschig ring settling area of the tank. The 321 Building studies with "cold" solutions have demonstrated that the phases are thoroughly mixed in the pump and adequately settled in the settling chamber. Additional studies are planned with the system to determine performance characteristics of "degraded" solvent and to study modifications of the system which should permit recontacting settled organic.

Nonmetallic Materials

Samples of Viton A rubber, Urethane rubber, and Teflon felt were tested at room temperature in phosgene gas. There were no significant changes after 26 days. Equipment is being assembled for 500 F phosgene-atmosphere testing of those materials which have been resistant to phosgene at room temperature.

Koroseal, (B. F. Goodrich plasticized polyvinyl chloride) linear polyethylene and unplasticized polyvinylchloride were tested in boiling 38 percent hydrochloric acid for 10 days. The changes in the materials were negligible.

PROCESS CONTROL DEVELOPMENT

UO_3 Plant C-1 Vessel Calibration

The uranium inventory vessel (C-1) at UO_3 plant has been recalibrated according to the procedures established by C. G. Hough and C. L. Pleasance, HW-57866 REV 1, "Calibration of Process Vessels." Statistical analysis of the calibration data indicate the new statement of accuracy to be ± 0.18 percent for thirty 2000-gallon transfers, based on one calibration. The previous accuracy value

for one calibration was ± 1.0 percent and ± 0.6 percent for three calibrations.

The new and old calibration curves are not significantly different. The significant difference in the new calibration data is the accuracy limits. If the new limits are applied to past inventory data, it is apparent that the uranium inventory discrepancies are not attributable to the C-1 volume measurement.

Resin Level Detector

Report HW-63632, titled "Ultrasonic Resin Level Detector" by D. C. Hunter and C. L. Pleasance, was issued this month.

Purex HSP Photometer

An analysis of the HSP photometer and the HA column operation during the month reveals some correlation between the HSP uranium concentration, the column waste losses, and the column decontamination. The selective sensitivity of the instrument to uranium concentration in the presence of a number of other changing variables (e.g., pulsing frequency, minor flow sheet changes, etc.) has given the instrument sufficient potential to warrant further observation.

Purex E-3 pH Probe

Studies on the effects of gamma radiation on glass and calomel electrodes indicate that failure of the electrodes in the Purex E-3 tank probe was not due to radiation damage. Additional experiments with gland-type sealing mechanisms indicate that failure was probably due to fracture of the glass envelope in the gland seal.

A new probe unit has been assembled using "Swagelok" fittings with polyethylene ferrules. This unit will be installed in E-3 for further evaluation.

Alpha Detection with Polyvinyltoluene

Dry tests of polyvinyltoluene (PVT) plastic phosphor have been completed. The maximum beta energy response to a 0.76 mev thulium source (beta) is reduced by a factor of two when the PVT phosphor thickness is reduced from five mils to two mils. Even with this reduction in beta response, it appears that PVT will be applicable only to installations where the alpha to beta ratio is constant or when beta background is negligible.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Processing

Shear System. The 321-A Building shear system is currently being modified to permit testing of a scale-model of the modified NPF shear system recently developed. The modified concept was formulated as a result of preliminary shear basin cleanup studies by Chemical Development, and scope design studies by Chemical Processing Department Facilities Engineering. The current concept includes: (1) a shear attached to a critically safe feed trough, (2) a critically safe catch bucket for the sheared material, (3) a critically safe sump below the catch bucket equipped with a recirculation pump, (4) a hydroclone in the circulation line for gross particulate

1242091b

DECLASSIFIED

cleanup, and (5) a high efficiency filter for cleanup of the bath at the end of a shear campaign. In the above concept, the catch bucket must be firmly connected (not water tight) to the shear to hold liquid in the feed trough and minimize leakage of water from the system. Leakage is collected and routed through the hydroclone for separation of particulate. The particulate-rich underflow is routed to the shear throat while the "clean" overflow is routed to the shear trough. Although this concept introduces a shear-catch bucket seal problem, it eliminates the critical mass problem encountered when particulates are suspended in the larger nonsafe shear basin previously considered. Since considerably less liquid is held up in the proposed system, the bath cleanup system is implified considerably.

Yankee Atomic Fuel Element Band Cutting. Disassembly studies of Yankee fuels continued with test cutting of assembly bands (approximately 3/64-inch thick by 1/2-inch wide stainless steel bands) by knife slitting. In the tests, the knives are pulled upward to cut the bands which are held in a jig. Cuts with Vee-knives of various shapes have been successful. Pull forces vary from 150 to 900 lbs. for 1/2-inch-wide bands 20 to 50 mils thick. Knife-slitting of bands currently offers the most promise for (1) minimum equipment costs, and (2) minimum probabilities of fuel rod damage during disassembly.

Yankee Atomic Fuel Element Rod Cutting. Hardware cutoff studies continued with hacksaw cutting on bundles of unsupported rods. Simulated Yankee assemblies, with solid 3/8-inch-diameter rods, were cut successfully (i.e., without gross rod bending or blade damage) on both the hydraulic and spring feed hacksaw. The latter, however, required a sacrificial backup plate to limit the blade feed rate. Results were sufficiently promising to warrant fabrication of a more exact Yankee prototype from special tubing. Successful rod cutting with the hacksaw eliminates the need for using shims and other specialty devices.

Feed Preparation

Processing of Uranium-Molybdenum Alloy Cores. Effects of the presence of boric acid, as a soluble neutron poison, on the dissolution of uranium-molybdenum alloy in iron(III) nitrate-nitric acid solutions and during subsequent processing steps was studies. No significant effects attributable to the presence of boric acid at about 0.3 M were noted on alloy dissolution rates, stability of dissolver and feed solutions, oxidation of plutonium, or extraction of molybdenum.

During dissolution of uranium-molybdenum alloys in concentrated nitric acid (12-14 M), most of the molybdenum is precipitated as molybdic oxide. In experiments wherein U-3 w/o Mo alloy was dissolved in nitric acid containing plutonium-(IV), about 2.5 percent of the plutonium was retained on the molybdic oxide after exhaustive washing with water, dilute nitric acid, and dilute sodium dichromate. The fraction of plutonium retained remained constant as the plutonium to uranium ratio was varied by a factor of five at a terminal uranium concentration of 1.5 M. Molybdenum not precipitated during high-acid core dissolution was not extracted into hexone during batch contacts simulating Redox process extraction.

Zirflex Process Modifications. A modification of the Zirflex decladding process involving continuous addition of hydrofluoric acid during Zircaloy dissolution instead of continuous removal of ammonia was studied. Initial decladding solution was 1.0 M NH_4F - 0.5 M NH_4NO_3. As Zircaloy-2 was dissolved at the boiling point,

hydrofluoric acid was added to maintain a constant pH. Instantaneous dissolution rates were obtained at pH values ranging from six to nine and in solution compositions representing steps in the dissolution to 0.8 M $(NH_4)_2ZrF_6$. Dissolution rates were generally lower than those obtained in the standard Zirflex decladding procedure (initial 6 M NH_4F). An integrated penetration rate of about ten mils/hr for dissolution to a terminal ammonium fluozirconate concentration of 0.8 M was indicated for oxide-free Zircaloy-2 when the pH was maintained constant at seven. Penetration rates were less at higher pH. Oxide coated fuel pieces have been prepared for test in this procedure.

Sulfex Decladding Modifications. The use of boron (boric acid) as a soluble neutron poison during Sulfex decladding is being explored. At room temperature, the solubility of boric acid in 4-6 M sulfuric acid is about 0.3 M. Dissolution rates for 304-L stainless steel were not appreciably affected by the presence of boric acid (0.3 M). Preliminary data indicate no effect of boric acid on uranium dioxide core losses in Sulfex decladding solutions.

Recirculating Dissolver Studies. The dissolution of 55 mil, Zircaloy-2 tubing in 5.5 M NH_4F - 0.5 M NH_4NO_3 with an F/Zr mole charge ratio of seven was carried out in the pilot plant recirculating tube dissolver using a steam sparge for motivation. This run indicated that superheated steam is attractive as a motivating gas for recirculating Zirflex dissolutions. While the dissolvent was heated to boiling by using steam jackets, motivation was provided by air sparge. When boiling was reached, the sparge was switched to superheated steam (350 F) and the heat supplied by the steam jackets was reduced to compensate only for atmospheric losses. A steam sparge of 2.77 lb/min provided a recirculation rate of eight gal/min. and a boil-off rate approximately equal to the sparge rate (0.25 lb mol/hr-sq ft). A maximum dissolution rate of 41 mils/hr and an integrated rate of 18 mils/hr were attained. The discrepancy between the pilot plant rate and the maximum demonstrated laboratory rate of 80 mils/hr is attributed to the buildup of free ammonia in the dissolvent.

Flooded Tray Dissolver. Ten runs were made to scout the dissolution of UO_2 in uranyl nitrate-nitric acid solutions. The UO_2 pellets were sintered, 92 ± 1.5 percent of theoretical density. Over the range of 0.5 M HNO_3, 2.2 M $UO_2(NO_3)_2$ to 6.0 M HNO_3, 0.05 M $UO_2(NO_3)_2$ the UO_2 dissolved according to the formula:

$$\text{Penetration rate (mils/hr)} = (12.5 \pm 3)\ (HNO_3\ M)$$

Five additional runs were made to determine the effect of recirculation rate on dissolution rate of aluminum in mercury(II) nitrate catalyzed nitric acid. Laboratory analyses are incomplete; however, off-gas analyses show less than 0.01 percent hydrogen evolved during dissolutions in 0.005 M $Hg(NO_3)_2$ with acid concentrations from 2.0 to 6.5 M.

One U-3 w/o Mo dissolution was made in the flooded tray dissolver. This run, simulating initial Piqua dissolving conditions of 1.25 M HNO_3, 1 M Fe^{+++}, gave an attack rate of about 60 mils/hr, as compared to 40 mils/hr that would be predicted from laboratory data.

NPF Dissolver Solution Transfer. Although operating difficulties have been encountered with auxiliaries, the basic feasibility of two pumps for recirculating boiling dissolver solution has been demonstrated in recent tests. A "jumbo-pogo-stick"

[redacted] DECLASSIFIED

(an air pressure transfer pump) has transferred 35 gallon/minute of boiling water against a head of 90 ft, and a pump-jet system (a short shaft pump actuates a liquid jet) has generated a flow of 28 gallon/min against a 23-ft head. With the jumbo-pogo-stick pump, difficulties have been encountered with the solenoid valves which supply transfer air. Motor-driven rotary valves are currently being built to replace the troublesome solenoids. Additional studies are contemplated on the pump-jet system to determine operating characteristics of different jet designs. Following completion of these tests a prototype pump will be fabricated using a short-shaft conventionally lubricated pump rather than a pump employing process lubricated bearings.

Redox Solvent Extraction of Uranium-Molybdenum-Alloy Feeds. Additional mini mixer settler runs were made testing recovery of plutonium from high acid (0.4 M) feeds containing 0.1 M dichromate, but not heated for plutonium oxidation. The feeds were prepared by dissolving unirradiated U-3 w/o Mo alloy; fission products and plutonium(IV) were added after the dissolution. Total salting strength (aluminum plus iron), time between adding plutonium(IV) and processing, and digesting at low temperature (55 C) were variables studied. Percentage losses to the HAW were $\leq$ 0.05 for uranium, $<$ 0.2 for plutonium and 0.2 to 1.2 for neptunium. Decontamination factors varied from 10 to 20 for gross beta and from 8 to 20 for gross gamma.

Materials of Construction

Corrosion testing of the twelve experimental vacuum-melted nickel base alloys prepared at Battelle Memorial Institute was continued. Highlights of these studies are as follows:

a. Self-welded weldments (unannealed) of alloys containing both molybdenum and niobium are subject to sensitization and preferential weld metal attack by acidic fluoride solutions. Elimination of niobium or substitution of titanium for niobium essentially eliminates both sensitization and weld metal attack.

b. Corrosion resistance to neutral and acidic fluoride solutions increases with increasing molybdenum content. The effect of molybdenum, in the three to nine percent range, on the corrosion resistance to Sulfex decladding solutions is slight.

c. Copper improves the corrosion resistance of the alloys to sulfuric acid, but has little effect on the resistance to sulfuric acid-stainless steel solutions. In the range of one to two percent, copper is slightly detrimental to the resistance of the alloys to acidic fluoride solutions.

Personnel from Battelle Memorial Institute visited HAPO during February to discuss progress to date on the experimental alloy study (DDR-82) and to decide on the composition of the second series of twelve alloys to be produced. Four of these will define more closely the optimum molybdenum content of the basic 45 Ni - 22 Cr alloy. The other eight are to provide information on the effects of molybdenum and copper in alloys of greater nickel and chromium content and of substituting cobalt for part of the nickel. All twelve will be stabilized with titanium.

[redacted]

Support of Criticality Studies

Preparation of Materials. All 321 Building holdings of three percent U_{235} enriche uranium trioxide have been converted to the nitrate. The forthcoming PCTR experiments to determine K_∞ vs H/U ratio for three percent enriched homogeneous uranyl nitrate-water systems will consist of five experiments; three in the H/U ratio range of eight to 12, and two in the range of 30 to 40.

UO_2 Cake Densities. To provide information for critical mass studies for NPF processing, the density of uranium solids (expressed as g U/cc) and the atomic ratio of hydrogen to uranium (N_H/N_U) have been determined for UO_2 - H_2O mixtures ranging from compact cakes to dilute slurries. The points all fall very close to a theoretical curve of the equation:

$$\text{Grams U/cc} = \frac{26.4}{3.0 + N_H/N_U}$$

which assumes the density of UO_2 particles is 10.0 g/cc.

DECLASSIFIED
[redacted]

DECLASSIFIED

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Salt Cycle Process

Development work on this process during the past month has been concentrated on problem areas requiring elucidation prior to initiating experiments in the High Level Radiochemistry Facility. These include:

a. Elucidation of plutonium behavior.
b. Development of cathodic deposition techniques for UO_2 yielding deposits from which the UO_2 can be recovered by remote manipulative techniques.
c. Development of needed chemical analytical methods for salt cycle UO_2 products.

Behavior of Plutonium in Salt Cycle Systems

It has been previously reported that under certain conditions plutonium tends to co-deposit with uranium dioxide in the cathodic deposition step by which the UO_2 is to be recovered. Additional work has confirmed this and suggests that the co-deposition is most efficient when solid oxide is present in the cell and dissolution (via chlorine generated at the anode) is occurring concurrently with desposition of oxide on the cathods.

This work has also shown that complete dissolution of mixed crystal uranium-plutonium dioxide can be effected at a reasonable rate with anhydrous hydrogen chloride gas in the NaCl-KCl eutectic at 750 C. The soluble uranium and plutonium species under these conditions have been shown (via dissolution of the salt systems in aqueous solutions) to be uranium(IV) and plutonium(III) but the exact nature of the ions present in the salt phase has not yet been ascertained. Chlorination of the melts does not produce higher oxidation states of plutonium.

Exploratory attempts to effect a clean separation of plutonium from uranium have been only partially successful, five to ten percent of the plutonium tending to follow uranium in all cases. Approaches which have been tested include:

a. Air sparging NaCl-KCl melts containing uranium(IV) and plutonium(III) in the hope of precipitating PuO_2 while leaving uranium in solution as UO_2^{++}. In all cases four to ten percent of the plutonium remained in the melt (either in solution or as finely dispersed solid).

b. Precipitation of UO_2 from a solution of UO_2Cl_2 and $PuCl_3$ in NaCl-KCl eutectic by sparging with "anhydrous" ammonia gas, thereby precipitating UO_2 and hopefully retaining plutonium(III) in solution in the salt phase. Again a fraction of the plutonium appeared in the UO_2 precipitate.

c. Cathodic deposition of UO_2 in the presence of an anhydrous hydrogen chloride gas sparge in the hope that partial redissolution of the UO_2 deposit as it formed might reduce its plutonium content. Once again, a fraction of the plutonium was incorporated in the UO_2 deposit.

1242021

[redacted]

In the course of this work it was shown that use of a graphite electrode on which UO_2 has been previously deposited as an anode in electrolysis of a UO_2Cl_2-NaCl-KCl melt results in smooth anodic dissolution or uranium, and corresponding reduction in the amount of chlorine evolved. Thus, there is a possibility of reducing the plutonium content of uranium to be discarded via a second electrorefining step or perhaps by employing anodic dissolution to effect the initial dissolution of the feed, hoping to find conditions leading to preferential dissolution of U_3O_8 over PuO_2. Should this latter approach likewise fail, it will be necessary to employ a two-stage operation to effect clean separation of plutonium and uranium however.

Preparation of Electrolytic UO_2

One of a number of practical difficulties which confronts the conduct of experiments in the High Level Radiochemistry Facility is removal of UO_2 from the cathode. In the course of piloting procedures for this operation, considerable information has been obtained on the effect of variables on the character of the UO_2 deposit formed by cathodic deposition. Within the realm of practically attainable conditions, UO_2 can be deposited on graphite in deposits ranging from a very dense, hard coat which must be chiseled off the electrode, to a porous, dendritic deposit which can be removed from the cathode with gentle mechanical abrasion. The latter type of deposit is preferred for the remote operations in the High Level Radiochemistry Facility. However, measurements are currently in progress to evaluate other properties (surface area, particle size distribution, particle density, oxygen/uranium ratio, etc.) to ascertain if these properties which relate to ease of refabrication and ultimate performance vary appreciably with the manner of forming the deposit.

Determination of Oxygen/Uranium Ratio in UO_2

Detailed procedures have been evolved and will be published on all steps involved in preparing samples for analysis and determining the U(VI)/U(IV) ratio in UO_2 by controlled potential coulometric titration. The method is quite sensitive and precise and should be considerably more accurate than the ignition method which will yield erroneous results if the sample contains volatile or combustible materials. For example, coulometric titration of a "stoichiometric" UO_2 prepared by hydrogen reduction yielded a value of 2.0003 for the O/U ratio. Titration of duplicate samples of non-stoichiometric "UO_2" yielded values of 2.0958 and 2.0959, respectively, which is considered gratifying but probably atypical precision.

Analysis of Chloride in Salt Cycle UO_2 Products

Preliminary experiments have been done to evaluate light scattering (from AgCl) and turbidimetric techniques for determination of chloride in dissolved samples of Salt Cycle UO_2 product. Coarse aggregates (about 1/8-inch diameter) of electrolytic UO_2 were used in these tests. A sample of the coarse powder after exhaustive leaching with hot water was dissolved and analysis showed 106 ppm chloride. Another sample of the same powder was ground fine enough to pass a 300 mesh screen and after exhaustive hot water leaching, was found to contain only 37 ppm chloride. Thus it appears that a substantial fraction of the chloride may be confined in voids from which it can be leached only if the powder is ground to a smaller particle size.

DECLASSIFIED

Salt Cycle Chemistry

In the Salt Cycle investigations to date, experimental observations have suggested that perhaps the reaction $UO_2 + UCl_4 + O_2 \xrightarrow{NaCl-KCl} 2UO_2Cl_2$ may occur. Preliminary experiments in which NaCl-KCl eutectic saturated with UO_2Cl_2 was heated in vacuo for two hours at 700 C disclosed the presence of uranium(IV) and UO_2 at conclusion of the experiment. Although not conclusive, this finding is further evidence that the postulated reaction may occur.

The visible absorption spectra of two fused salts were examined to help elucidate the nature of the uranium species present. Salt(I) was prepared by reaction of UO_2 with HCl in NaCl-KCl eutectic. Salt(II) was prepared by reaction of U_3O_8 under the same conditions. The spectra revealed an unknown species in both salts which might be due to uranium(V) since dissolution in 0.5 M HCl resulted in the presence of both uranium(IV) and uranium(VI). Salt(I) also exhibited the spectrum of UCl_4, but neither salt contained more than small amounts, at the most, of UO_2Cl_2.

Aluminum Chloride - Alkali Chloride System

Further work aimed at cycling uranium metal from aluminum alloy through a salt phase back to aluminum alloy has continued. The addition of 130 and 200 per cent of the stoichiometrically required amount of $AlCl_3$ to a NaCl-KCl eutectic resulted in the oxidation of about 60 per cent of the uranium and its transfer from an aluminum - 8.1 w/o uranium alloy into the salt phase. The contacting was a static equilibration of one hour. Sparging for a similar period of time with moist air resulted in about 98 per cent of the uranium being transferred to a fresh aluminum phase. It is believed that extraction into the salt phase can be considerably improved.

This chemistry may have application to the processing of aluminum-enriched uranium alloy fuels.

Processing of Al-Pu-Si-Ni Alloy

Study of the dissolution of the proposed PRTR spike fuel (94.5 w/o Al-1.8 w/o Pu-1.35 w/o Ni-0.35 w/o Fe) in nitric acid-mercuric nitrate solutions was continued. Twenty samples of known history have been tested. All dissolve rapidly in 2.0 M HNO_3 - 0.002 M $Hg(NO_3)_2$. The range of nitric acid concentration over which rapid dissolution (> 5 mg/min-sq cm) occurs is narrow --- from one to three molar. At nitric acid concentrations above three molar, dissolution rates were ≤ 1 mg/min-sq cm. The dissolution rate appears to depend on nitrate concentration rather than acidity. Low dissolution rates are obtained in solutions having total nitrate (from uranyl or aluminum nitrate) above three molar, even though the acidity is proper for rapid dissolution.

Solutions produced by rapid dissolution of the alloy were adjusted to proposed Redox process feed solution composition. These solutions formed stable emulsions when contacted with Redox solvent. The property responsible for forming emulsions with hexone (presumably colloidal silicic acid) can be removed by increasing acidity of the terminal dissolver solution and refluxing for several hours. The additional acid presents some problems in preparing a low acid feed for the Redox process. In the laboratory studies, the excess acid was destroyed with formaldehyde. Removal of the colloidal silicic acid with gelatin is under study.

1242023

[redacted]

Equipment is now complete for studying, under constant pH, the loss of plutonium from the alloy to Zirflex decladding solutions. The fact that a coating of colloidal graphite is applied to the alloy rods before they are inserted into cladding tubes presents some problems in this study.

Continuous Ion Exchange Contactor Development

Jiggler Contactor. Significant modifications to the jiggler apparatus include use of an air lift to ensure that resin slurry does not clog the resin return line. With a pulsing condition of 2-1/4-inch amplitude and 8 c/m, a recycling of more than 2 gal/min-sq ft of wet settled resin can be maintained.

A technique for direct slipwater recycle was also successfully demonstrated. Although the return line (from the decanter on top of the elution column to the pulse chamber on the bottom of the adsorption column) requires a check valve to prevent pulse energy loss; the returning slip water appears to smooth the operation and, of course, improves process efficiency.

Weiss Contactor. The results of efficiency studies in the 3.0-inch-diameter by 48-inch-long Weiss contactor indicate good extraction efficiency and smooth, stable operation when operating as an adsorption column at feed flow rates up to 230 gal/hr-sq ft. Waste losses of from two to seven per cent were obtained when absorbing thorium from a feed solution containing 7 M HNO_3 and two grams thorium/liter on to Permutit SK, 20 to 50 mesh, anion resin. The column temperature was 40 C.

Multistage Agitated-Bed Contactor. A resin pump of improved horizontal design was installed on the four-inch-diameter by 36-inch-long two-stage contactor. The resin flow characteristics were much better than were obtained with the original vertical-screw design. Baffles and impellers of a different design have also been installed in the column to improve the agitation.

RADIOACTIVE RESIDUE PROCESSING DEVELOPMENT

Radiant Heat Spray Calcination

The program of studies (in the eight-inch by ten-foot demonstration unit) aimed at determining the limiting throughput of the spray calciner, its applicability to a wide variety of feeds, and ways of overcoming certain operational difficulties continued. Ten runs were made during the month. Significant findings were as follows:

1. Feed rates were increased to 6.3 gal/hr/sq ft with simulated formaldehyde-killed Purex waste and to 11.4 gal/hr sq ft with neutralized waste. Although operation remained smooth, the completeness of calcination declined somewhat at flow rates greater than about 4 gal/hr/sq ft. Thus, residual nitrate increased from a value of <0.004 per cent at 4 gal/hr/sq ft to 0.04 per cent at the highest rate, and weight loss on subsequent heating (for one-half hour at 900 C) increased from a value of 31.5 per cent to 35.1 per cent.

DECLASSIFIED

DECLASSIFIED

2. Ammonia neutralization (vice NaOH) was tried successfully in one run. This substitution has the important advantage of eliminating sodium ion (which increases solubility and leachability of the calcined residue) and sodium nitrate (whose wide liquid range complicates calciner operation). Formaldehyde-treated waste was neutralized with aqueous ammonia and the slurry calcined without sugar or other additives. Operation was uneventful, and the product was more compact than that obtained either with acidic waste or caustic neutralized waste. The total weight of residue was also decreased (from 200 grams per liter of acidic waste to 150 grams per liter of ammonia neutralized waste), apparently due to greater destruction of sulfate.

3. The ceramic filters have continued to give trouble, due to leaks around the gaskets or to cracking caused by differential thermal expansion. A cyclone was tried but failed to work well, probably due to a too low vapor velocity. A different, and novel, approach shows much promise for insoluble residues. This consists of eliminating the filters and condensing the condensibles with the powder product followed by evaporation to dryness in the final storage container. This treatment has the added advantages of a two to threefold increase in product density (as compared to as-produced powder) plus an increase in thermal conductivity. Advantages over pot-type calcination include elimination of foaming and of danger of off-gas line plugging.

Waste Thermal Conductivity Studies

An interim report on the thermal conductivity studies of various powders was completed and is currently being issued as HW-62614 (Secret).

Various amounts of stainless steel chips were added to some granular solids, and tests were made to determine how this affected the effective thermal conductivity of the materials. The chips, obtained as scraps from saw testing, were nominally 1/9-inch by 3/8-inch by 0.01-inch. The effective thermal conductivities were increased by a factor of only about two with up to 50 volume per cent chips.

RADIOACTIVE RESIDUE FIXATION

Mineral Reactions

Experiments to study the capacity of clinoptilolite for cesium in actual boiling tank condensates indicated a decontamination factor of about 5 across the 5-gram, 22 cm bed after receiving about 30,000 column volumes at pH 5 and 7. At pH 9, the d.f. was about 100 after 28,000 column volumes throughput. By comparison, a d.f. of about 100 was maintained for more than 45,000 column volumes in a similar experiment using tap water traced with cesium, even though this latter experiment was conducted at a somewhat higher flow rate (6.3 gal/ft^2/min vs 4.0 gal/ft^2/min). The tap water used contains about ten times as much dissolved solids as does the boiling tank condensate. Thus it is unlikely that the low d.f.s developing from condensate experiments reflect actual depletion of ion exchange capacity. Since the Purex tank farm condensate

[redacted]

contains from about 0.001% to 0.01% TBP, it is suspected that organic material may be coating the mineral surfaces and reducing its effectiveness for adsorption. The coating effect would be expected to be most pronounced at low pH levels, which is consistent with experience. The removal of organic material from the condensate waste by adsorption on activated carbon was under investigation.

To demonstrate the actual adsorption capacity of clinoptilolite for cesium, column experiments were performed using distilled water containing 10^{-5} M cesium traced with Cs^{137}. It was possible to put 54,000 column volumes of this solution through a 5g, 22 cm bed of the mineral at 4 gal/ft^2/min before any cesium could be detected in the effluent (d.f. >5,000). The radiocesium content of low-level wastes is much less than the 10^{-5} M solution studied.

Work was begun to study the effects of radiation on minerals. The first mineral being examined is clinoptilolite. Carefully pretreated samples of the material were prepared to permit reproducible equilibrium distribution measurements after various levels of irradiation. As a tool for studying crystal changes following irradiation, the differential thermal analysis instrument is being adapted, tested and calibrated.

Plutonium Recycle Test Reactor

Nuclear track film measurement of external surface uranium contamination of PRP fuel rods indicated possible low level contamination of two rods of seven examined.

A large-area scintillation counter capable of counting alpha particle emissions from about one-eighth the area of a fuel rod was assembled and tested. A triangular light pipe transmits scintillation to a phototube from a 21-inch-long phosphor supported in a semi-circular groove milled in the light pipe facing the fuel rod. A counting efficiency of about 30% is realized. The sensitivity is limited by the scintillator background, some 2 c/m, and the economically permissible time for counting. The entire surface of a fuel rod can be checked for contamination in about fifty minutes. With this time of counting, a detection limit of 0.1 ug per sq cm is achieved with a 99% confidence error of 0.05 ug per sq cm. Much lower detection limits are achieved with long counting times.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Separation of Zn^{65} from Reactor Effluent Water

Over 90 per cent of the Zn^{65} can be extracted from reactor effluent water made 0.1 M in tartaric acid by contacting it with 1.5 per cent zinc amalgam. Of the other radioisotopes only Cu^{64} is removed with the Zn^{65} and this does not interfere with gamma spectrometric measurement of the Zn^{65}. Preliminary results indicate that Zn^{65} may be extracted free from Cu^{64} from an ammoniacal solution. These methods show promise for rapid analysis and monitoring applications.

Radioisotopes in Effluent from Zircaloy Reactor Tubes

Reactor effluent water from a Zircaloy reactor tube in operation for over four years was analyzed for Na^{24}, P^{32}, Sc^{46}, Cr^{51}, Mn^{56}, Fe^{59}, Co^{60}, Co^{58}, Zn^{65}, Ga^{72}, As^{76}, Zr^{95}, Zr^{97}, Ba^{140}, La^{140}, Ce^{141}, Ce^{143}, Eu^{152}, Sm^{153}, and Np^{239} and the values compared with the reactor effluent water from all

1242026

of the reactor tubes. The values from the Zircaloy tube for all of these 20 radioisotopes except for Mn^{56} were equal to or less than those from the reactor as a whole (or from aluminum tubes). The Mn^{56} was about 25 per cent higher from the Zircaloy tube. Further data are needed to establish what the effect would be if the entire reactor were tubed with Zircaloy, but these data indicate that the reactor effluent water would not be greatly affected.

Compton-Cancelling Spectrometer

The Compton-Cancelling Spectrometer was assembled and tested. A reduction in the background of factors of two to five and a reduction of the Compton portion of the Zn^{65} spectra of about a factor of five were obtained. The detector consists of a five-inch diameter, five-inch high NaI(Tl) well crystal in the center of a plastic scintillation detector 26-inch diameter and 30-inch high which is operated in anticoincidence. Further improvements in performance may result from increasing the efficiency of light gathering from the large detector.

Geology and Hydrology

The last well on Project CAH-848 (CET FY 1959 well drilling program) was begun. Fifteen wells are complete for a total depth of 3062 feet. This is 38 feet less than predicted or an underrun of 1.2%. A single well (699-48-51) encountered basalt 63 feet higher than predicted; this indicates that sites exist, even close to operating areas, where numerous wells provide presumably good control but where geologic data are inadequate for proper predictions.

Plans were made to determine the differences in head between the aquifers penetrated during the drilling of the individual wells on FY 1960 program. This will help determine the potential of interchange of water between aquifers in a sedimentary series through the intervening aquicludes or by means of the wells themselves. The continuity of the aquifers and aquicludes also will be better established. The data will help determine where the well casings should be perforated to minimize vertical flow. This will permit more representative sampling of ground waters at depth and provide better data toward understanding the possible movement of wastes at depth.

A technique was developed for tracing the flow lines at any point in a two-dimensional flow model. A dye solution is injected into the flow pattern by means of fine hypodermic needles; the dye is swept along the transparent plastic side of the model thus defining the streamline. The technique will be used to evaluate the influence of density on the "sinking" of denser solutions in the ground water. Observing the dye-traced stream lines, the movement of water beneath water mounds imposed on the water table in the model was clearly demonstrated.

A study of the flow lines beneath a mound was started to establish the conditions, if any, under which a mound could be considered to block the natural movement of ground water. For this purpose the Forchheimer equation for two-dimensional flow was assumed to represent the top flow line in a two-dimensional model. The bottom flow line would have to be horizontal in the case of a horizontal model and the equation for this flow line can thus be integrated. From these two equations, the boundary values of the potential can be obtained for flow

through a two-dimensional model having only one source. A hypothetical case was set up to test the assumptions made in obtaining the equations for the upper and lower flow lines. No contradiction to these assumptions has appeared from this analysis.

Soil Chemistry and Geochemistry

A radiotracer method for determining effective diffusion coefficients was investigated for application to the study of particle diffusion in clinoptilolite and perhaps with other radioisotope removal reactions. The method involves measuring the fraction of zeolite loading with time in a flowing system using a scintillation crystal monitoring a small bed of the mineral. The effective diffusion coefficient of the two exchanging cations in the zeolite may be calculated from this loading curve. By determining the effective diffusion coefficient at two different temperatures it will be possible to obtain the heat of activation of the exchange reaction. Assembly of apparatus for performing these measurements was started.

It was previously noted that zirconium was removed with apparent completeness from soil equilibrium systems when the zirconium concentration was ten times the measured cation exchange capacity of the soil in the system. Similar experiments performed without soil indicated that zirconium could be centrifuged from 3.2×10^{-2} M distilled water systems above pH 5. In 3.9×10^{-4} M Zr solutions, removal was nearly complete near pH 7. It is believed that zirconium exists as a colloid over a wide pH range in the systems studied. The Zr colloids are apparently isoelectric near pH 7 and thus can be centrifuged from distilled water systems. In alkaline systems, however, the colloids became strongly peptized and negatively charged and are adsorbed by anion exchange resins.

Ground Waste Investigations

In the mathematical analysis and graphing of laboratory data evaluating the influence of column length, the results were too scattered to establish the function relating column length and column capacity. Therefore a program was started for performing six replicate experiments for each column length studied and for each of three competing ions (Na, Mg, and Ca).

It is possible to define the effect of system pH on soil adsorption nearly as well with equilibrium determinations as with column experiments. Thus batch equilibrium studies are being used to define the interaction between pH and the effect of competing ion concentration on adsorption of strontium in soil systems both with and without their naturally occurring carbonate minerals. Initial experiments are with systems containing strontium and barium over the pH range 1.0 to 11.0.

Unsaturated-flow adsorption experiments with soil columns were continued; five new experimental columns were started. The breakthrough curves drawn from the results of experiments successful enough to permit this examination reveal the typical, "s"-shaped curve. To date, no trend is evident in either the slope of the curve or the position of the 50% breakthrough point with respect to degree of saturation or tension gradient across the bed.

1242028

DECLASSIFIED

The breakthrough of Sr^{85} apparently reached its maximum in two wells near the experimental crib near Gable Mountain. Both of these wells show a continuing C/C_0 of about 0.075 while no radiostrontium has been detected in other monitoring wells at the site. The strontium solution entering the crib is significantly diluted by natural ground waters before sampling, resulting in the low C/C_0 equilibrium value. The water level in a surface pond near the model crib site rose six inches during the past 24 days. This change is not yet reflected in the water levels in wells monitoring the experiment but may have some influence on the results obtained. The small experimental crib now accepts the spiked solution at a flow rate of four gallons/ft^2/day.

Field Apparatus Development

One unit of a deep-well water sampler was fabricated and tested. The sampler operated satisfactorily under a depth of 460 feet of water. The desirability of a check valve is indicated for more positive release of air pressure from the sample bottle as it is raised from depths.

Micromeritics

The deposition was measured of two and four micron particles from a fluid in laminar flow through a 3/4-inch-diameter stainless steel pipe and a one-inch-diameter aluminum pipe. In the transition from turbulent to laminar flow, the deposition of four-micron particles decreased sharply, indicating that deposition was dependent primarily on turbulence of the fluid. The deposition of two-micron particles decreased at a much slower rate in the same transition, from high to low Reynolds numbers, indicating that deposition of the smaller particles was more dependent on laminar diffusion. This observation was supported by the preferential deposition of the very small particles in the laminar flow experiments. In general, the particle deposition rate in laminar flow is several orders of magnitude lower than for deposition at Reynolds numbers greater than about 5000.

Deposition of some larger particles was observed under flow rates which should have precluded deposition by either turbulent or laminar diffusion. It was postulated that unbalanced aerodynamic forces on unsymmetrical particles could impart a radial velocity component resulting in deposition of larger particles near the wall. In experiments using 30 micron spherical glass beads the deposition constant decreased from 4 cm/min at N_{RE} of 3000 to immeasurably small values (less than 0.01 cm/min) at N_{RE} of 2000. This supported the hypothesis of unbalanced forces causing deposition of the larger unsymmetrical ZnS particles.

W. H. Reas
for Manager
Chemical Research and Development

1242029

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

No significant changes in organization took place during the month.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

Concentrations of I^{131} in the thyroid glands of jack rabbits were about one half those observed one year ago. Values follow:

Location	μc/g Wet wt. Average	μc/g Wet wt. Maximum	Trend Factor
Prosser Barricade	1×10^{-3}	2×10^{-3}	- 2
4 Miles SW Redox	1×10^{-3}	2×10^{-3}	-
Wahluke Slope	1×10^{-3}	1×10^{-3}	-

Columbia River Contamination

Concentrations of gross beta emitters in game species of waterfowl collected from the Columbia River were approximately two times those observed one year ago. Values follow:

Sample Type	Location	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor*
Coot flesh	Hanford Res.	3×10^{-3}	3×10^{-3}	-
Diving duck flesh	" "	2×10^{-3}	3×10^{-3}	-
Grebe flesh	" "	4×10^{-4}	6×10^{-4}	- 2
River duck flesh	" "	2×10^{-4}	2×10^{-3}	+ 2
Gull flesh	" "	1×10^{-4}	2×10^{-4}	- 10
Merganser flesh	" "	8×10^{-5}	2×10^{-4}	- 9
Heron flesh	" "	7×10^{-5}	7×10^{-5}	- 9
Goose flesh	" "	3×10^{-5}	3×10^{-5}	-

* Values are compared with those obtained in November 1959.

Fallout Contamination

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

1242030

Sample Type	μc/g Wet Material Average	Trend Factor
Bone	2×10^{-5}	+ 2
Feces	1×10^{-5}	- 2
Muscle	5×10^{-6}	-
Liver	4×10^{-6}	-

Swamp Contamination

Concentrations of mixed fission products in tissues of waterfowl collected at 221-U and Redox swamp were about one-fifth those observed one year ago. Values follow:

Sample Type	μc/g Wet Material Average	Trend Factor*
Diving Duck		
Bone	9×10^{-5}	-
Soft Tissue	7×10^{-5}	-
River Duck		
Bone	1×10^{-3}	-
Soft Tissue	2×10^{-4}	-
Coot		
Bone	1×10^{-4}	- 3
Soft Tissue	5×10^{-4}	-

* Values are compared with those obtained in November 1959.

Effect of Reactor Effluent on Aquatic Organisms

Routine monitoring of the effluent from the 100-KE reactor was continued with fingerling chinook salmon. Mortality of the fish held in effluent concentrations typical of those present in the Columbia River and predicted for the future amounted to about 2 per cent. While this is slightly greater than the controls (mortality approximately 0.5 per cent), it is well within the expected range and probably reflects only a more rapid developmental rate which results from the slightly warmer temperatures.

Survival of columnaris cells in river water was tested at temperatures ranging from 50 to 74 F. At the lowest temperature, survival was approximately 4 times greater at 6 days than was survival at the highest temperature. Microscopic examination showed no formation of microcysts, indicating that cyst formation probably occurs only under conditions of growth.

With concentrations of columnaris several fold greater than used with salmon last year, fish were killed sporadically and only after a prolonged post-exposure period. It is still uncertain whether this represents a resistance of the younger salmon to the organism or whether the Western Washington strain of salmon presently used is more resistant than the local strain used in last year's tests.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Phosphorus

Cichlids (an egg laying tropical fish) have been exposed to three levels of P^{32} in water for approximately five months. Survival has been excellent in all lots. Some of these fish have now reached maturity and a few egg lots have been obtained. Attempts are being made to improve the technique for handling the newly spawned eggs so that more reliable estimates of the viability of the sex products can be obtained. A discouraging feature is the wide range in concentration of P^{32} of fish in the same aquaria. Addition of the isotope to the water has not resulted in the hoped for consistency in body burdens between individual fish.

Zinc

The rate of turnover of Zn^{65} in rams varied from 10 to 30 per cent per day for most tissues to less than two per cent in bone and voluntary muscle.

Strontium

Retention curves were obtained for Sr^{90} and Ca^{45} administered intraperitoneally to weanling rats. These data compare to similar retention curves previously obtained with mature rats. As in the case of the mature animals, a single power function of time did not adequately describe the results. The data could be resolved quite nicely into two exponential functions. The retention of both Sr^{90} and Ca^{45} were dietary calcium dependent--Ca^{45} to a much greater extent than Sr^{90}. A more detailed analysis of this data will be forthcoming.

After a 28-day "conditioning" period on the experimental diets, the 25 mature rats in the experiment to study simultaneous variation of phosphorus and calcium levels in the diet were each administered a tracer dose of Ca^{45} and Sr^{90} by stomach tube. Excretion will be collected daily until the animals are sacrificed 15 days post administration.

No evidence of bone damage was seen in the 120 x-ray plates of representative original or F_1 animals in the chronic Sr^{90} toxicity study (9 months after starting radioisotope feeding). Histological changes were observed in the liver of 90-day fetuses and a suggestion of change in a 70-day fetal liver in the 25 μc/day group. This damage was predicted on the basis of observing some changes in the blood of the pigs seen after birth. (Two more sows were placed on 25 or 50 μc/day Sr^{90} feeding schedules and then bred in order to verify the damage seen in the 70- and 90-day fetuses.)

In addition to the changes in blood constituents, some of the 25 μc/day F_1 animals show a depressed growth, dry skin, hair loss, lethargy and loss of appetite.

The test to determine the toxicity of Sr^{90} to trout was started late in the month after difficulties involving high dose rates during spiking of the pellets were overcome. Sr^{90}-Y^{90} is now being administered via force-feeding techniques to rainbow trout at levels of 5×10^{-3} µc, 5×10^{-2} µc, and 5×10^{-1} µc/gram of fish/day.

Iodine

The Palouse swine that have been fed I^{131} daily during most of their adult life are being sacrificed at various stages of gestation. One sow sacrificed on the 84th day of a 112-day gestation period exhibited a thyroid concentration only about one-half that of the fetus. The fetal thyroidal I^{131} concentrations, however, varied by more than a factor of two.

Three young (3/4 bred) Pitman-Moore pigs were given tracer doses of I^{131} prior to sacrifice. Following intraperitoneal administration, peak uptake in the thyroid was 55 per cent of the administered dose at 10 hours, while the peak concentration at 24 hours after oral administration was 40 per cent.

Cesium

Previous data has indicated that substantial amounts of Cs^{137} may be adsorbed on to root surfaces under nutrient culture conditions. In an attempt to remove the adsorbed cesium, roots were treated for varying periods of time with carrier cesium so that the Cs^{137} could be exchanged off of the roots. It appeared that some 50 per cent of the Cs^{137} was removed under all conditions. Future attempts will be made to determine whether the concentration of adsorbed cesium is a function of potassium concentration in the substrate.

Plutonium

Three pigs treated with 9 grams of DTPA one hour after Pu injection excreted, in the urine, from 78 to 88% of the Pu dose, during a period of 6 days following injection. This compares with excretion of from 1 to 2 per cent of the Pu dose in control animals. The DTPA treatment lowered deposition of Pu in the liver by a factor of 26 and deposition of Pu in bone by about a factor of 10. Final results and material balances await the completion of additional analyses. It would appear from these preliminary results that the action of DTPA in the pig is essentially similar to that previously observed in great detail in the rat.

Skin sites injected 6 months ago with Pu^{239} (IV) nitrate at levels up to 1 µc/site show varying degrees of eschar formation, the degree being generally a function of dose.

Two more swine were subcutaneously injected with plutonium in order to test the effectiveness of tourniquets in preventing plutonium translocation. (Analyses are not yet complete; however, it appears that the liver of the animal on which no tourniquets were applied showed concentrations about eight times that of the animal on which tourniquets were used.)

1242033

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

X-ray plates of two animals injected at 6 weeks and 6 months of age with 1.3 μc of Pu^{239}/Kg body weight evidenced bone changes. The changes in the bones of the animals injected with Pu^{239} three and one-half months ago looked like an early stage of an osteogenic sarcoma (precancerous lesions). (Five more animals were injected - 3 with Sr^{90} and 2 with Pu^{239} - to bring the total animals on this study to 33.)

Radioactive Particles

A study of the effects of single and daily (for six months) exposures to $Sr^{90}SO_4$ aerosol was terminated by sacrifice of the surviving mice. About two and one-half years has elapsed since the mice were exposed. Small changes in the circulating leukocytes were observed. Histologic studies and assay of the tissues for Sr^{90}-Y^{90} content are not complete.

Equipment has been assembled for study of the effect of various parameters (viz. rate and depth of breathing, relative length of expiration and inspiration) on deposition of particles. A thermistor is being used to study respiratory pattern in rats and dogs.

A total of 13 beagle dogs died between 55 and 105 days after deposition of $Pu^{239}O_2$. The acute lethal dose may be less than was expected from earlier studies. In all dogs, death was preceded by loss of weight, increase of respiratory rate from 30 to 170 or more per minute, and decreased numbers of circulating leukocytes. At autopsy the lungs were consolidated.

A more detailed study of the acute toxic syndrome of inhaled $Pu^{239}O_2$ in beagle dogs is in progress.

Gastrointestinal Radiation Injury

Additional data were obtained on the effect of intestinal radiation on the fecal excretion of intravenously administered I^{131}-labelled polyvinylpyrrolidone (PVP). Experiments in rats indicate no increased excretion in the X-ray dose ranging from 1000 to 1500 r, and a decreased excretion with a nitrogen mustard dose of 2 mg/kg as compared with 1 mg/kg. Limited studies with dogs indicate an X-ray dose dependent increase in the fecal excretion of PVP during the two-day period following administration (3 to 5 days following irradiation). The normal excretion of PVP in the dog is quite different from the rat and present data is insufficient to completely evaluate the diagnostic potentialities of this procedure in the dog.

Microbiological Studies

Additional data were obtained indicating that leakage of potassium and phosphate from irradiated yeast cells was greater under anaerobic than aerobic conditions. This difference was similar whether the experiments were conducted with or without glucose as a substrate.

Associated with experiments to evaluate the lag phase of growth in yeast cells, some experiments were conducted using X-irradiation of the cultures prior to the growth phase. In cultures receiving a pre-growth dose of 25 kr, there was no difference in the growth rate nor total growth obtained by the cultures with or without 40 mc tritium/ml of solution. Such a dose of tritium with cells not pre-irradiated gives a markedly depressed growth rate as compared to cells grown in the absence of tritium. There is at present no explanation for this seeming protection of the pre-growth dose of X-rays.

Effects of Radioactivity on Populations

Cultures of grain-infesting moths, Ephestia, which were established last month in media containing different concentrations of Sr^{89} reached the 3rd larval stage of development by the end of February. Effects will be evaluated when the control cultures reach maturity next month.

Stock cultures of Habrobracon, a wasp which is parasitic upon Ephestia, were obtained and are being developed for studies of the effect of radiation upon populations.

HA Kornberg

Manager
BIOLOGY OPERATION

HA Kornberg:es

1242035

C. Lectures

a. Papers Presented at Meetings

None

b. Off-Site Seminars

H. A. Kornberg, February 5, 1960, "Radiation Biology at Hanford," Argonne National Laboratory, Lemont, Illinois.

R. L. Uhler, February 12, 1960, University of Washington, Seattle, Wash.

c. Seminars (Biology)

P. L. Hackett, "Hematology of Experimental Animals," February 10, 1960.

Capt. J. E. West, "Metabolism of P^{32} in Mice," February 10, 1960.

Prof. R. J. Foster, Dept. of Agricultural Chemistry, WSU, Pullman, Wash. "Specificity of Enzyme Action".

Dr. R. A. Hennacy, "Factors Affecting the Filling of the Frog's Heart", February 24, 1960.

D. E. Warner, "Technical Administration," February 24, 1960.

d. Seminars (Local)

W. C. Hanson, "Narrated color slides of Alaska," for the Father and Son Banquet at the Westside Protestant Church, February 1, 1960.

W. C. Hanson, "Radioecology," Information meeting - 202-Bldg., 200-West, February 12, 1960.

W. C. Hanson, "Narrated color slides of Alaska", for Carmichael Jr. High Science classes (5 talks), February 19.

W. J. Bair, "Radioisotope toxicity from pulmonary absorption," Radiation Monitoring Information Meeting, February 23 (300 Area).

D. Publications

a. HW Publications

R. F. Foster and R. L. Junkins, "Off-Project Exposure from Hanford Reactor Effluent," February 1, 1960.

1242036

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT - FEBRUARY, 1960

ORGANIZATION AND PERSONNEL

R. L. Basmann transferred to TEMPO effective February 15, 1960.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Programming of the GCL method of estimation was completed. An interim guide for the use of the method was issued.

Several cases of the highly aggregate HAPO model were logically listed and prepared for computation.

Redox Dissolver Study

The logical analysis of one model of the Redox Dissolution Process was completed. The logical analysis emphasized that models of this type cannot be calculated by repeated application of multivariate regression and GCL methods to what may appear to be logical subsystems of the over-all model. Furthermore, it was evident that the model was not logically identifiable for two reasons:

(1) The model contained two basic identities which would cause singularities in the multivariate treatment.

(2) The model failed to meet criteria for necessary and sufficient conditions of identifiability in two of the seven structural equations.

Upon removal of the two identities and adjustment of the causal pattern so as to satisfy the necessary and sufficient conditions in the two equations which were not identifiable, a model having logical identity was obtained.

OPERATIONS ANALYSIS STUDIES

Quality Certification Program

Assistance was given in defining data requirements of the quality certification program such that the program to utilize IBM equipment in processing the data can be completed.

Post irradiation data from the first seven tubes discharged under this production test were analyzed, with the results discussed in a secret document HW-64031, "Analysis of Data from Initial Seven Tubes Discharged Under IP-216A," 2/24/60.

Control charts were set up for pre-irradiation dimensional measurements based on quality certification data from October, 1959 -- January, 1960. These charts will be maintained in the future by FPD personnel.

1242037

DECLASSIFIED

DECLASSIFIED

Fuel Element Failures

1959 I and E rupture data are being used to obtain estimates of the parameters used in the basic rupture rate equation. These estimates were originally based on solid fuel elements. Since the amount of I and E rupture data is still relatively limited, the parameters cannot be estimated with much precision. The present rupture model will continue to be used unless these I and E data suggest that it is not valid for this geometry. Calculation assistance is being provided by Process Analysis personnel.

Probabilities of attaining a goal incurring less than R ruptures during 1960 were calculated as a function of a true metal quality improvement.

Optimization of Reactor Operations

A formula giving the distribution of time between unscheduled outages was used in the rough draft discussing expected downtime as a function of reactor operating conditions and manpower. Industrial Engineering personnel suggested that this formula in itself could be useful to area analysts as an aid in scheduling reactor outages. It was therefore documented and discussed in HW-64013, "Distribution of Time Between Unscheduled Reactor Outages," 2-23-60.

It is felt that a real savings in total reactor production can be effected by using an optimum system of allocating supplemental crew personnel during simultaneous shutdowns of more than one reactor. Such a system was proposed in December. In an effort to illustrate this or similar systems, attempts were made to collect pertinent data associated with recent shutdowns to show what savings would have resulted from different crew assignments. The necessary data could not be found. The present plan is to issue a report using a general approach and point out what data would be required before a realistic estimate of savings would result. Such data are also required before one can realistically evaluate the effect on total production of having additional personnel.

Z-Plant Information Study

The AEC bid request for computing equipment to be used in the Z-Plant study was issued late last month. Vendor bids on the equipment are now being evaluated. Operations Research & Synthesis Operation has accepted the project management for this study.

Reliability Studies

Work on the K reactors system reliability study continued. A rough draft of a letter summarizing the results has been written. Further work has been done on the NPR reliability study. Initial steps have been taken toward programming the model for digital computation.

A new and general technique for computing the reliability of a system of arbitrary complexity has been discovered, and is undergoing further development.

Inventory Studies

The economic order quantity formula used to guide the procurement of general supplies does not at present include a formal procedure to determine whether or

124038

[redacted]

not it is advantageous to take advantage of quantity discounts offered by vendors. A procedure to handle this situation was developed during the month. The procedure is presently being communicated to General Stores and Excess Property Operation management and buyers through a series of meetings.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Several tubes of data describing variation in clad thicknesses for co-extruded tubes were analyzed. Two methods of measuring the clad thickness were used, and the results were compared.

Thermocouple readings (specifically, the $\beta \longrightarrow \alpha$ transformation temperature) were evaluated from several runs using co-extruded fuel elements in order to evaluate the effects on $\beta \longrightarrow \alpha$ readings of type of thermocouple, insertion depth, age of thermocouple, and set temperature. There was considerable confounding of effects in the data which clouded the interpretation.

Brazed Layer Integrity reject data from the canning lines covering several days experience in January were analyzed to determine what the effects on reject rates were of vibrator frequency and/or amplitude. Data from a controlled experiment conducted in the 306 pilot plant are currently being analyzed with the same objective in mind.

Reject data and total count data from an experiment previously designed and recently conducted in the 306 pilot plant were submitted for analysis. This experiment was concerned primarily with an evaluation of three methods of core-spire insertion, but it was also possible to evaluate other effects of interest. The experiment was designed as a 2 x 2 x 3 factorial with five replications, and once again, the importance of "time" as a variable was demonstrated.

Irradiation Processing Department

A study is being made to determine how frequently tube factors should be calculated. The effect on accuracy and precision of the calculated tube power and/or exposure as a function of the procedure used to assign tube factors is under consideration.

Several extrapolation equations based on quadratic orthogonal polynomials were constructed for personnel of D Processing Operation in connection with the evaluation of a two-phase flow experiment.

Chemical Processing Department

A presentation of B-PID experience within CPD, and of means of obtaining a more realistic measure of the effectiveness of control procedures, was made to CPD management. As a result of this meeting, it was requested that a recalculation of CPD B-PID's for the past several months be made using the minimum variance B-PID estimating technique previously recommended. The results of this work will be presented to management in early March.

The C-1 vessel was calibrated during January using precision equipment and a procedure for calibrating process vessels which was documented earlier. Data

DECLASSIFIED

DECLASSIFIED

from this calibration were analyzed during the month. In addition, an IBM program was written which will generate the calibration table.

A report was written showing the precision of the uranium content in a shipment of oxide powder as a function of number of samples analyzed.

Finished Products Technology requested and were supplied the dimensional specifications of two more cams designed to continuously machine a proposed Lawrence Radiation Laboratory weapons component model.

Relations Operation

A series of meetings were held for the purpose of discussing efficient methods of organizing, extracting, and tabulating the information contained in the responses to a psychological questionnaire which had been given to a cross section of plant personnel. A procedure has been agreed upon, and the data analyzation is in process.

Curve fitting and consulting services were provided personnel of Employee Compensation Operation in regard to comparing HAPO salary curves with offsite salary survey curves.

Consulting services were supplied Community Relations Operation management in connection with a Tri-City Area community opinion survey.

Contract and Accounting Operation

A summary was made of the efficiency of the data processing of routine commercial applications, where efficiency is defined to be the percentage of clock time actually used in data processing by Electronic Data Processing Operation personnel. These results will be useful in determining what is a reasonable percentage of time to schedule work.

Construction Engineering and Utilities

Further work was done on the problem of evaluating fair cost estimates in relation to bids received for Hanford projects. In this respect, two methods for predicting the low bid from the fair cost estimate were developed. To facilitate keeping a running record of 1960 projects, and evaluation of the methods in actual application, easy to use procedures and charts have been prepared for Estimating Operation personnel.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program

Reactor Studies

Further investigations of the behavior of the solutions to the three-parameter reactor kinetics differential equation continued. Because of the extreme complexity of the problem, explicit solutions appear to be unobtainable without undue effort. Nevertheless, under appropriate assumptions on the parameters,

[redacted]

comparison of the asymptotic solutions with the known behavior of Mathieu functions indicates the possibility of small regions of stable character. Further studies are in progress.

Mathematical assistance was given to members of Reactor Technology Development, Fuels Design, and Physical Measurements. In all cases, the problems involved the formulation and solution of appropriate partial differential equations with prescribed boundary conditions.

Zirconium Physical Properties

Statistical analysis was completed of data from a recent Fuels Development Operation experiment to investigate the effect of hydrogen content, ambient temperature, and notch orientation on fracture angle, fracture moment, and impact breaking strength of both annealed and cold work zirconium samples. A model was formulated for each test indicating the effect of different level combinations of the significant variables.

4000 Program

PRTR Studies

The statistical analysis of the Phase 1 pressure test of the PRTR containment vessel was completed. A rough draft document has been written which contains the mathematical and statistical techniques involved in the analysis, the outcome of the analysis, and recommendations arising out of the analysis to insure sufficient precision during the Phase 3 final test.

Swelling Studies

The search for a correction factor for the distortion or extrusion introduced in the sample preparation processing has led to the development of a new mathematical model. This model more adequately represents the distribution of pore configuration produced on the replicate.

Study of micrographs of plastic balls in a "scotch" medium continues in an attempt to determine the effect of pore size on distortion.

General

Instrumentation

In connection with the study to determine the feasibility of automation of gamma spectroscopy data the problem of confidence region estimation for a two component gamma spectrum is being considered.

In some balance installations involving radiation zones it is desirable to install the balance so that the working parts are located outside the radiation zone, while the balance hand is located inside the radiation zone. Such an installation requires the use of an airtight seal between the two zones. Data were analyzed to determine the effect of the seal upon the sensitivity of a prototype triple beam balance for Chemical Development Operation.

DECLASSIFIED

DECLASSIFIED

Statistical Development

A table of tolerance interval factors for normal error distributions was constructed and will be made available in the near future to Laboratory personnel.

L. G. Waters

for Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

L. G. Waters:kss

[redacted]

PROGRAMMING OPERATION
FEBRUARY 1960

A. REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Cycle Analysis

Computer Code Development. The RBU output code was mostly debugged during the month. An improved method was adopted for the first portion of the input code, and necessary modifications made. The completed cross-section library is now ready for testing with the input code.

The use of a relatively new statistical method (Box & Wilson, J. Roy. Stat. Soc., B, 13, 1, 1951) to determine maxima in multi-dimensional space was combined with HLO's Meleager physics code to permit the determination of plutonium compositions which give the longest exposure in a given reactor. Initial testing to date has yielded what appear to be valid and consistent estimates of incremental fuel exposure for each of the four plutonium isotopes of interest. In a sample case, the reactivity controlled attainable fuel exposure of a "standard" reactor enriched to 1.5% Pu-239 plus Pu-241 in conjunction with U-238 can be represented by the following equation:

$$\text{(a)} \quad \text{Exposure} = \text{const.} \times [100\, N_{239} - 5\, N_{240} + 120\, N_{241} - 26\, N_{242}]$$

where N = mols or atoms of isotope involved

for plutonium batches in the neighborhood of the following composition: Pu-239 = 31%, Pu-240 = 34%, Pu-241 = 25%, Pu-242 = 10%.

In other words, if some number, N, of Pu-239 atoms incrementally increases the attainable exposure by 100 MWD/T, that same number of atoms, N, of Pu-240 will decrease the exposure by 5 MWD/T, etc.

If one adds the restriction that the total enrichment is constant at 1.5 atom per cent, equation (a) becomes:

$$\text{(b)} \quad -4\,(\Delta N^{239}) - 1\,(\Delta N^{240}) + 4\,(\Delta N^{241}) - 9\,(\Delta N^{242}) = +\Delta \text{ exposure}$$

where ΔN refers to the incremental atoms of the four plutonium isotopes. The results of calculations using equation (b) as compared with those calculated with the Meleager code where ΔN was changed in increments of 1×10^{18} atoms/cc are shown below.

1242043

	Maximum Exposure, 1.5 at. % Enrichment, MWD/T	
	Meleager	Equation B
ΔN	12,635	12,650
2 (ΔN)	12,867	12,875
3 (ΔN)	13,084	13,100
4 (ΔN)	13,315	13,325
5 (ΔN)	13,551	13,550

The actual plutonium composition for the last case shown (5ΔN) is Pu-239 = 30.51%, Pu-240 = 36.03, Pu-241 = 31.60, Pu-242 = 1.86. The starting composition was Pu-239 = 31.35, Pu-240 = 33.59, Pu-241 = 24.96, Pu-242 = 10.10. The close approximation in exposure obtained by the use of equation (b) is confirmation of the premise that the effect of individual plutonium isotopes on exposure is a linear one with only small interaction between isotopes.

Fuel Cycle Studies. Further progress has been made on the general correlation of the reactivity worth of plutonium fuel enrichment as compared with U-235 in several reactor types. About 150 different cases have been calculated to date using the Meleager code. A preliminary study of the data suggests that plutonium as enrichment with U-238 may be effectively utilized in reactors having rather low moderator to fuel ratios. Although the attainable exposure for a given enrichment level is in general lower under these conditions, the change in reactivity over the reactor lifetime is also less which is an important item from an operating viewpoint.

To explore potentially promising modes of plutonium bearing fuel utilization, scouting calculations were made to assist in evaluating the potential of fuel cycles combining U-238-Pu and Th-232-U-233 systems. Several logical combinations suggested themselves as a result of detailed plutonium fueling studies in the past. In effect, it appears that some deficiencies of Pu-U-238 systems can be lessened by integration with U-233-Th systems, and vice versa. Also, it appears that integration of fast and thermal reactor fuel cycles may benefit U-238-Pu systems per se, and to a lesser extent benefit the Th-U-233 cycles. It may even turn out that integration of fast-thermal reactor fuel cycles with appropriate combinations of U-238-Pu and Th-U-233 fuels can increase the productivity of such reactor systems.

These considerations arise from the fact that in the thermal spectrum, U-233 is especially beneficial as an enrichment material if employed with U-238 because of the fast effect possible with U-238 but not with thorium. U-233 has a higher η than plutonium in the thermal spectrum. From fast effect considerations neutron production is benefited more with U-233 than with plutonium because the thermal reactor neutron production is determined by the product ηε (η is the neutron production from thermal fission in U-233 or plutonium and ε is the neutron multiplication from fast fissions in U-238). On the other hand, plutonium benefits as an enrichment material if employed with thorium as a fertile material because the higher thermal cross section of thorium improves the thermal utilization, f. A further benefit results because U-233

resulting from thorium fertility is chemically different from plutonium resulting from U-238 fertility. In the case of plutonium this permits building up the Pu-241 specie relatively to Pu-239 to higher levels than possible if the plutonium is intimately mixed with U-238 and thus mixed with freshly generated Pu-239.

Pu-241 is especially valuable because it yields more neutrons on fission than does either Pu-239, U-233, or U-235. However, in any thermal reactor fuel, as Pu-241 builds up so does Pu-242, which is a parasite in the thermal spectrum. In the fast spectrum, however, it appears that Pu-242 will fission, perhaps with a high cross section. This characteristic of Pu-242 and the high neutron yield of Pu-241 on fission indicates that fast reactors may advantageously use plutonium generated in thermal reactors. Very preliminary studies performed in the past year, and now being investigated in more detail, showed the possibility of a 40 per cent reduction in over-all doubling time for a plutonium fast breeder coupled to a high conversion ratio thermal reactor.

PRTR Startup. Work in support of PRTR startup included review of critical tests and process specifications, plus preparation of preliminary schedules and content of the Power Test phase of the startup.

PRTR Plans and Schedules. Study of possible reductions of PRP plutonium needs under alternate PRTR schedules was continued. It may be possible to reduce plutonium requirements if special procedures are used for scrap recovery together with utilization of more frequent chemical processing of spent fuel. Calculations for fairly accurate determination of these potential savings are being refined.

Attempts were continued to obtain about one kilogram of high exposure plutonium for PCTR testing. The possibility of obtaining some suitable scrap material from other sites was explored with some indication that it might be made available. The final outcome will not be known for a month or two.

SPECIFIC FUEL CYCLE ANALYSIS

Progress to date and future plans were reviewed with AEC-DRD personnel in a meeting in Washington.

The new fuel cycle economics code has been defined to the point of being reviewed by programmers who will write the algebra in a form to simplify programming. Ultimately the code will use information as to the relative value of each plutonium isotope as developed by the Box Wilson method. This will simplify evaluating the worth of the "ashes" from an irradiation which can be nearly as great as the initial fissile charge in high conversion ratio machines. In addition, it may be possible to determine the fuel value of all reactor occurring plutonium batches for a specific reactor by a few simple equations.

Initial conditions of the Combustion Engineering PWR reactor have been established for the Meleager code, and work was begun on the determination of high exposure conditions.

B. BIOLOGY AND MEDICINE - 6000 PROGRAM

Radiological Consultation

Consultation was rendered concerning radiological problems involved with disposal of reactor effluent water to the Columbia River, integrated radiological instrumentation systems, and on proposed regulations for radiation protection.

The first draft of the proposed chapter for "Meteorology and Atomic Energy" was prepared; this chapter describes the methods of calculating radiation doses from the dispersal of radioactive materials.

C. OTHER ACTIVITIES

Dr. Sioma Kagan, prominent economist and demographer, presented a lecture on world-wide population growth problems at the Hanford Science Colloquium on February 5.

Additional facilities in HLO were cleared for unclassified tours. Clearance for access to four previously uncleared buildings, 3707-C, 3730, 314, and 747 has increased the number of available tour sites from 18 to 30.

Assistance was rendered and arrangements made for six tours (involving 57 people) through HLO and HAPO facilities.

In addition, special arrangements were made for broad participation by HLO personnel in Edison Day activities, involving facility tours and semi-individual counseling of 126 outstanding senior science students and faculty members from 17 high schools.

LH McEwen

Manager, Programming

LH McEwen:dl

RADIATION PROTECTION OPERATION
MONTHLY REPORT - FEBRUARY 1960

A. ORGANIZATION AND PERSONNEL

Four exempt internal transfers were effected on February 1, 1960, to provide broadened experience. The transfers included: F. Swanberg, Specialist - Radiological Development to Supervisor - Bioassay; G. D. Brown, Supervisor - Bioassay to Supervisor - Environmental Monitoring; R. C. Dozer, Supervisor - Environmental Monitoring to Supervisor - Exposure Records; and L. L. Crawford, Supervisor - Exposure Records to Specialist - Radiation Monitoring. Three nonexempt radiation monitors were transferred within the group to broaden their work experience. One technical graduate, D. N. Brady, was placed on permanent assignment as a Specialist - Radiation Monitoring on February 1, 1960. The force of the Radiation Protection Operation totals 133.

B. ACTIVITIES

Three minor plutonium deposition cases were confirmed during February. The total number of deposition cases that have occurred at HAPO is 249 of which 180 are currently employed. A review of cases of internal deposition of plutonium for 1959 indicated there were 18 employees, including one collateral contractor employee, who received measurable internal deposition of plutonium for the first time. The maximum case appeared to be about 10% of the maximum permissible body burden (mpbb). Additionally, eight employees received minor, but measurable, deposition of mixed fission products. Contaminated minor injuries continued to be one of the more common modes of internal deposition of plutonium. Use of the Whole Body Counter and minor surgical excision continued to be successful in removal of plutonium associated with minor injuries. There were nine cases during 1959 involving plutonium contaminated injuries where a small amount of tissue was excised by Industrial physicians to reduce the possibility of internal deposition. The maximum amount excised was slightly in excess of the maximum permissible body burden in bone (0.04 μc). The status of radiation and plutonium work restrictions for Hanford employees did not change during 1959. Four employees, including one collateral contractor employee, are restricted from all radiation work and 10 employees are restricted from plutonium work.

Three JA Jones Company employees and three GE employees received general external contamination to 40,000 d/m Pu when a fire resulted from welding work in N-cell at the Purex Building. External skin contamination was readily removed. Preliminary bioassay samples indicated minor, if any, deposition of plutonium.

Radiation controls were established throughout Plutonium Fabrication Pilot Plant process areas coincident with startup operations involving fabrication of plutonium-aluminum fuel elements. No unusual radiological problems were encountered during startup activities.

Radiation dose rates up to 300 mr/hr at a distance of 100 feet from the building required extension of radiation zones during radiographic testing operations at White Bluffs.

Oysters collected at Willapa Bay during the latter part of January were analyzed and contained the following quantities of radionuclides: 1×10^{-6} μc P^{32}/gm, 0.7×10^{-6} μc Cr^{51}/gm, and 40×10^{-6} μc Zn^{65}/gm. The Zn^{65} content was about the same as was observed in previous samples and previously reported.

Preliminary testing of the analytical procedures to determine individual isotopes of the rare earth group found in Columbia River water was started by the Radiological Chemical Analysis laboratory. Completion of the work was scheduled for March. Duplicate 107 Basin water samples were submitted to Purex laboratory, the Radiological Chemical Analysis laboratory and the Chemical Research laboratory for interlaboratory comparisons of radioisotopic analyses of reactor effluent water.

A survey of future radium needs at HAPO was made and a report submitted to AEC-HOO.

Additional data on Zn^{65} in examined subjects were accumulated since the last overall analysis by Radiological Physics. These data permitted initial conclusions about the distribution of Zn^{65} in different plantwork locations and nearby communities. Employees working in the 200 Areas have about the same average Zn^{65} burdens as those in the 300 Area. As reported earlier, 100 Area employees have about twice as much as the others. The average body burden of Zn^{65} for the 100 Area group is about 0.01% of the maximum permissible body burden (60 μc). Residents of Kennewick have slightly higher Zn^{65} burdens on the average than Richland residents. Pasco residents have two to three times the average burdens of Richland residents. The Pasco population appears to have about 0.1% of the maximum permissible average body burden for persons in the neighborhood of controlled areas (one-tenth of occupational maximum permissible body burdens in HE-69).

Completion of maintenance and safety modifications on the Whole Body Counter (WBC) permitted resumption of routine examinations of employees in the WBC. A total of 111 employees was counted during the month. Pre-examination procedures were modified to determine the necessity for female subjects to shampoo their hair. Elimination of this requirement will make examination in the WBC more attractive to female employees. Plans for open house tours through the Bioassay laboratory and the WBC facility were discussed with AEC-HOO and Relations Operation personnel.

The annual distribution of individual exposure report cards was completed. Questions were received from a few individual employees who required additional explanation or minor corrections to their individual report card. The annual report for 1959 occupational exposure at HAPO was completed and submitted to AEC-HOO as specified in AEC Manual Chapter 0523.

The ORNL threshold criticality dosimeters were packaged in the aluminum containers which were designed and built locally. The ninety packaged dosimeters were distributed throughout the Plant at strategic locations.

Designs for two new finger ring dosimeters were completed. Prototype models were constructed and studied. The most recent design specified the use of polyethylene as the fabrication material instead of tenite II to provide reduced electrode leakage.

Peliminary studies of Eastman Type B neutron film indicate that it may be more efficient for fast neutron measurement than the Type A packet currently in use.

This is indicated by an increase of about 30% in the number of proton tracks observed when compared to the Type A film.

Preparation was started with the Counsel's Office on a standard contract insert to accommodate the radiological aspects of HAPO collateral contractors.

C. EMPLOYEE RELATIONS

There was one medical treatment injury during the month for a frequency of 0.46. No security violations occurred during February.

Five suggestions were received for evaluation. Five suggestion evaluations were made during the month. There are two outstanding suggestions at month end. Two suggestions were approved for awards of $20.00 and $10.00, respectively.

E. C. Watson attended the President's Conference on Occupational Safety held in Washington, D. C.

Radiation protection training included: Eight 2-hour orientation talks to Plutonium Metallurgy, Biology Research, and Chemical Effluents Technology personnel; seven 2-hour lectures to Fire Protection employees in the 100 and 200 Areas; four lectures on anticipated radiation problems at the PRTR to 75 exempt and nonexempt IPD employees. One lecture and demonstration on radiation protection was presented to management and employees of Carnation Company, Sunnyside, Washington. Lectures on radiation protection regulations were presented to the senior deck officers of the N. S. Savannah.

D. SIGNIFICANT REPORTS

HW-63646 "Radioactive Contamination in Liquid Waste Discharged to Ground at Separations Facilities Through June, 1959" by M. W. McConiga.

HW-63654 "Off-project Exposure from Hanford Effluent" by R. F. Foster and R. L. Junkins.

HW-63920 "Analysis of Radiological Data for the Month of January, 1960" by R. L. Junkins.

HW-64086 "Monthly Report - February 1960, Radiation Monitoring Operation" by A. J. Stevens.

ENVIRONMENTAL MONITORING - RESULTS (Mid-January 1960 - Mid-February 1960)

Sample Type and Location	Activity Type	Monthly Average	Units
Drinking Water			
100-F Area	Isotopic	0.6	% MPC_{GI}*
Separations Areas	Gross Beta	1.5×10^{-7}	μc/cc
Pasco	Isotopic	4.6	% MPC_{GI}**
Kennewick	Isotopic	1.4	% MPC_{GI}**
Richland	Gross Beta	$<3.0 \times 10^{-8}$	μc/cc
Columbia River Water			
Above 100-B Area	Gross Beta	1.2×10^{-8}***	μc/cc
100-F Area	Isotopic	1.8	% MPC_{GI}*
Hanford	Isotopic	2.5	% MPC_{GI}*
Pasco	Isotopic	14	% MPC_{GI}**
McNary Dam	Gross Beta	1.5×10^{-6}	μc/cc
Vancouver, Washington	Isotopic	0.4	% MPC_{GI}**
Atmosphere			
I^{131} Separations Areas	I^{131}	2.1×10^{-13}	μc/cc
I^{131} Separations Stacks	I^{131}	0.6	Combined curies/day
Active Particles - Project	--	1.0	ptle/100 m^3
Active Particles - Environs	--	0.2	ptle/100 m^3
Vegetation			
Separations Areas	I^{131}	1.1×10^{-5}	μc/gm
Residential	I^{131}	2.7×10^{-6}	μc/gm
Eastern Washington and Oregon	I^{131}	1.5×10^{-6}	μc/gm
Fission Products less I^{131} - Wash. and Ore.	Gamma Emitters	3.0×10^{-5}	μc/gm

*The % MPC_{GI} is the percent of the maximum permissible limit for occupational exposure to the gastrointestinal tract calculated from drinking water limits contained in NBS Handbook 69.

**The % MPC_{GI} is the percent of the maximum permissible concentrations for persons in the neighborhood of controlled areas for continous exposure to the gastrointestinal tract calculated from drinking water limits contained in NBS Handbook 69.

***This location is now sampled quarterly. The most recent result is tabled.

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
February	0	1
1960 to Date	0	2

Gamma Pencils

	Pencils Processed	Paired Reading 100-280 mr	Paired Readings Over 280 mr	Lost Readings
February	21,864	142	6	1
1960 to Date	39,462	288	7	3

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(gm)	Average Dose Per Film Packet mr(s)
February	12,174	899	122	38	35	10.21	19.29
1960 to Date	22,146	1,836	283	77	62	10.26	20.04

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
February	573	0	0	0	1
1960 to Date	2,319	0	0	0	6
Fast Neutron					
February	117	10	5	0	1
1960 to Date	434	39	8	0	4

Bioassay

		February	1960 to Date
Plutonium:	Samples Assayed	747	1,481
	Results above 2.2×10^{-8} μc/sample	17	67
Fission Products:	Samples Assayed	741	1,482
	Results above 3.1×10^{-5} μc FP/sample	0	0
Uranium:	Samples Assayed	290	599
Confirmed Plutonium Deposition Cases		3	5*

*This brings the total number of plutonium deposition cases which have occurred at Hanford to 249.

1242051

Uranium Analyses

Sample Description	Following Exposure Units of 10^{-9} μc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10^{-9} μc U/cc Maximum	Average	Number Samples
Fuels Preparation	61	4.8	56	12	2.7	58
Hanford Laboratories	37	5.2	27	84	2.9	29
Chemical Processing	35	4.2	35	50	5.9	46
Chemical Processing*	52	33	2	41	41	1
Special Incidents	2.1	1.1	14	-	-	-
Random	1.4	1.2	22	-	-	-

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

Thyroid Checks	February	1960 to Date
Checks Taken	0	0
Checks above Detection Limit	0	0
Hand Checks		
Checks Taken - Alpha	32,181	61,271
- Beta-gamma	43,776	89,283
Skin Contamination		
Plutonium	21	46
Fission Products	45	69
Uranium	6	14

CALIBRATIONS

Portable Instruments	Number of Units Calibrated February	1960 to Date
CP Meter	958	1,831
Juno	315	589
GM	807	1,566
Other	188	355
Total	2,268	4,341
Personnel Meters		
Badge Film	1,524	2,724
Pencils	1,912	1,912
Other	380	780
Total	3,816	5,416
Miscellaneous Special Services	466	620
Total Number of Calibrations	6,550	10,377

Manager
Radiation Protection

AR Keene:kc

1242052

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - FEBRUARY, 1960

GENERAL

Security performance for the Operation was satisfactory with no violations during the month.

Safety performance of the Operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 1.97, which is considerably below average experience.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 15,164. This includes 14,325 hours performed in the Technical Shops, 500 hours assigned to Minor Construction, 235 hours assigned to other project shops, and 104 hours assigned to off-site vendors. Total shop backlog is 22,778 hours of which 50% is required in the current month with the remainder distributed over a 3-month period. Overtime hours worked during the month was 5.7% (1,079.4 hours) of the total available hours.

Distribution of time was as follows:

	Man-Hours	% of Total
Fuels Preparation Department	1,434	9.5
Irradiation Processing Department	798	5.2
Chemical Processing Department	904	6.0
Hanford Laboratories Operation	11,531	76.0
Construction Engineering & Utilities	360	2.4
Miscellaneous	137	.9

A higher than normal overtime rate was experienced due to emergency requirements of our customers. Several of these involved high priority research and development programs in HLO. Assistance was also provided to the Chemical Processing Department in the fabrication of graphite molds and temperature measuring equipment for high priority weapons work. Assistance to Irradiation Processing Department on the development and fabrication of tools to be used in over-boring graphite assemblies was completed on an emergency basis.

Security performance was satisfactory with no violations. There were eight medical treatment injuries for the month which is within the forecasted parameter.

1242053

RADIOGRAPHIC TESTING OPERATION

A total of 5,509 tests were made, of which 1,395 were radiographic (including x-ray and gamma-ray) and 4,114 were supplementary tests. Out of a total of 3,955 man-hours, 1,046 (26.4%) were in connection with radiographic tests, and 2,909 (73.6%) were used on supplementary tests. The supplementary test work included; autoclave, borescope, mensional measurements (micrometric), eddy current, penetrant (fluorescent O.D. and I.D.), surface treatment (alkaline cleaning, pickling, and vapor blasting), and ultrasonic (flaw detection and thickness measurement).

The number of pieces handled this month totaled 5,121 items. The feet of material represented by these items amounted to 53,945 feet. A high ratio of feet to pieces is the result of work with tubular components.

Work was done for 23 different organizational components representing most of the operating departments and service organizations. A total of 55 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 46 different occasions for advice and information on general testing theory and applications for other than the jobs tabulated in Part II - Testing Statistics.

Testing and treatment of the PRTR process tubes has been completed. Eighty-five tubes which meet all requirements are ready for delivery to the PRTR contractor. An additional four tubes are also ready for the PRTR contractor but these tubes do not meet all of the established requirements. Six tubes are being reprocessed and two others are rejects.

Fluorescent penetrant testing and ultrasonic testing of NPR process tubing sections were successfully demonstrated to representatives of the Allegheny Ludlum Steel Corporation, Chase Brass and Copper Company, Harvey Aluminum Company, Tube Reducing Corporation, and the AEC-HOO. These companies are potential suppliers of the NPR production process tubes. Prior to the field demonstration, the Hanford procedures were presented in detail using displays and slides, and discussions were held relative to equipment costs and other details.

As of February 8, full time support of the C-25 tube shop was taken over by Kaiser Engineers. This support work includes janitorial and maintenance service and assigned craftsmen for equipment and service modifications to the building.

Contractor work has also been started in the C-25 Building with first work being directed to installation of heaters, sprinkling system, building structural changes, and siding. A new 60' long hot alkaline cleaning tank and an associated water rinse tank has been received and installed. Invitations to bid have been sent out on the major equipment installation and construction phase of the work for the tube shop. Two engineering assistants have been received on loan from IPD to commence training for the NPR testing work. Training has also been started of KE craftsmen for the pickling, autocalving and penetrant operation.

The first major work in the 308 Building facility was started this month. Testing of TPU fuel rods will involve radiography, ultrasonic core integrity, and bond testing. In addition, claddings will be eddy current, penetrant, and ultrasonically tested. To permit optimum utilization of the 308 radiographic facilities, the darkroom was activated. The darkroom was planned in anticipation of such fuel elements as these and it contains extra deep tanks and provision for close temperature control.

The last of the 1100 sheath tubes for Ceramic Fuel element fabrication have been received on-site and testing is proceeding. Along with completion of this tubing order the first Ceramic Fuel element PRTR loading is nearing completion and final tests are being performed on the finished fuel elements.

Field testing work is proceeding routinely with major effort being devoted to the site work at PRTR, process vessel fabrication work, and assistance to biology in animal studies.

Testing Statistics

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
CE&U	28	11	4	Radiograph weld test coupons; ultrasonic thickness measurements on PRTR bottom shield.
CPD	143	65	59	X-ray weld on multi-purpose dissolver assembly (Project CG-772); Radiograph welds on modification of H-10 vessel for use in E-13 position; Dwg. H-2-39864.
FPD	133	235	97	Swaged thermocouple, NPR fuel elements.
HLO	4143	49176	4782	9/16" O.D. Ceramic PRTR fuel rod; Zr-2 wire for fuel rods; radiograph 2 NAK fuel elements; S/S thermocouples; radiograph two surge locks; .505" I.D. Zr-2 tubes; 5/8" O.D. solid Zr-2 rods; radiograph 108 C.R.B. core integrity; radiograph 2 fuel elements for can wall thickness; radiograph welds on S/S nozzles section (PRTR); radiograph swine for Sr 90 programs; 5 and 15 mil wall S/S tubing 10 mil wall inconel x-tubes; B, D and F type zirc. tubes; .680" I.D., Zr-2 tubes; 3/8" O.D. Inconel - X, Inconel 702 and Hastalloy - X-tubing; Ultrasonic thickness measurements 300 area pressure vessel survey.

1242055

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
IPD	1062	4469	179	Zr-2 KER process tube film review; radiograph welds on S/S nozzles; radiograph soot blow back lines on boilers in 184-F Building; furnace welded; NPR test tubes; fluorescent penetrant reactor pigtails; PRTR tubes.
Totals	5509	53945	5121	

CONSTRUCTION OPERATION

There were 36 existing J. A. Jones Company orders at the beginning of the month with a total unexpended balance of $348,902. Ten new orders, three supplements and adjustments for underruns amounted to $119,623; expenditures during the month on HLO work were $124,116 (Includes C.O. Cost). Total J. A. Jones backlog at month's end was $344,409.

Summary

	HL		CE&U	
	No.	Unexpended Balance	No.	Unexpended Balance
Orders outstanding beginning of month	29	$ 246,460	7	$ 102,442
Issued during the month (Inc.Supp. & Adj.)	10	$ 119,713	0	90
J. A. Jones Expenditures during month (Inc. C.O. Costs)		$ 92,235		$ 31,881
Balance at month's end	24	$ 273,938	6	$ 70,471
Orders closed during month	15	$ 61,962*	1	$ 10,500*

* Face Value of Orders Closed

On February 4 a work authorization was issued to J. A. Jones for installation of equipment in the 306 Building Addition. Preparatory work started February 11, 1960. By the end of the month, ten equipment pieces had been moved into the building and two of these have been set in their intended locations. Approval to set three others has been obtained. The 700 ton press, which weighs some 55 tons, was brought into the building horizontally, raised to a vertical position, and set into it's anchor bolts without any trouble. This is one of the heaviest units of equipment handled as a single piece in quite a while.

1242056

Project CA-747 - The removal of the equipment from 231-Z Building and transporting to 308 Building was assigned to Plant Forces. Removal work started February 22, 1960. So far, two pieces have been removed and brought to the 308 Building where Jones' forces are reinstalling them. Two more pieces are scheduled to move March 1. Work in both buildings is progressing very well and on schedule.

FACILITIES ENGINEERING OPERATION

Projects

There were 22 authorized projects at month's end with total authorized funds of $6,877,000. The total estimated cost of these projects is $8,715,000. One project was completed and one new project was authorized during the month. One project proposal was submitted to the Commission and three projects are in preparation.

The following summarizes the status of HLO project activity:

Number of authorized projects at month's end:	22
Number of new projects authorized during month: CAH-885, Geological & Hydrological Wells - FY-1960.	1
Projects completed during the month: CAH-837, Animal Pens, Isolation & Examination Facilities.	1
New project proposals submitted to AEC during month:	0
New projects awaiting AEC approval: CGH-832, Full Scale Physical Constants Testing Reactor CGH-874, Consolidation of Plutonium Metallurgy Facilities	2
New project proposals in preparation: CGH-888, Biology Laboratory Improvements Uranium Scrap Burning Facility Stress Rupture Test Facility Chemical Process Research & Control System Field Servicing Center - Atmospheric Physics.	5

The attached project report details the status of individual projects.

Engineering Services

Title	Status
Glycol Heat Exchangers - 325-A	Field work essentially complete.
329 Building Cooling Problem	Installation work depends on availability of funds.
Ventilation - 314 Building	Engineering complete. Field work depends on availability of funds.

Title	Status
Fire Detection System - 146-FR	Installation is 80% complete.
Electrical Modifications - Room 24-A - 326 Building	Field work started on 2-29-60.
Modifications, 3707-C Building	Work complete.
108-F Building Solvent, Acid & Cylinder Storage, & Loading Dock	Field work is essentially complete.
Electric Hoist - Graphite Shop - 3730-C Building	Field work depends on availability of funds.
Refrigerated Air Conditioning Room 130 - 146-FR Building	Specifications for air conditioners prepared. Field work depends on availability of funds.
Reactor Room Exhaust Ventilation Control 326 Building Basement	Design is complete.
HLO Area Improvements Study	A study is being performed to improve HLO buildings and grounds. A summary report will be issued in March.
Pressure Vessel Study	This is a continuing work program in volving vessels and safety devices.
Design Eddy Current Table	Design complete.
Investigate Coaxial Cable Between 325 and 329 Buildings	Engineering work has started.
Install Sound Enclosure for 300 Ton Hydraulic Pump - 325 Building	Fabrication and installation work has started.
Additional Improvements to Air Supply - Rooms 204 and 206 - 3706 Building.	Design complete.

Twelve budget studies for major plant additions which will be considered a part of the FY-1962 and revisions to FY-1961 Plant Acquisition and Construction and Equipment Budgets; also, several plant engineering type jobs covering structure repairs, utility extensions, air conditioning, noise abatement, and improvements to equipment are being performed.

1242058

Drafting and Design Services

Work load is constant with reasonable backlog. Branch offices in 306 and 308 Buildings are busy with steady work loads. The central drafting room has been performing an increasing amount of work for the recycle program.

Design and drafting work in progress includes the following:

1. PRTR Gas Loop - In-Reactor (14 drawings - 80% complete).
2. Break away Corrosion Loop (5 drawings - 27% complete).
3. Special Tools - Scope - High Level Utility Cell - 327 Building.
4. PRTR Fuel Element Rupture Facility - Scope (approximately 11 drawings required - 4 drawings complete) - Project CAH-867.
5. PRP Critical Facility - Service piping, weir, shielding block, and safety rods (approximately 7 drawings required - 80% complete).
6. Loading Dock Enclosure - 321 Building (approximately 5 drawings required).
7. A, B, and G Hand and Shoe Counter - (approximately 15 drawings required - 30% complete).

In addition to the above work, miscellaneous small design-drafting jobs are in progress including project "As-Built" work.

Approximately 174.8 drawings including sketches, work sheets, and formal drawings were completed during the month of February.

Maintenance and Building Engineering - Landlord Functions

Costs: December - $ 178,352
January - $ 161,558
Total through January - $ 929,368

Analysis of Costs

The $929,368 expended to date represents 63.8% of the annual budget, and 98.5% of the expenditure predicted for the first seven months of FY 60. Of the $150,000 budgeted for improvement maintenance, $110,000 has been spent, and $40,000 committed.

To date, the significant variances from the forecast are: total maintenance overrun, $47,900; janitor and power operator overrun, $12,100; total utilities underrun $33,500; engineering underrun, $3,900. In effect, there appears to be a net overrun of $22,600. Billings for improvement maintenance have not been made as promptly as anticipated; consequently, they have masked the overrun of other costs.

1242059

Already, drastic measures have been initiated to sharply reduce the maintenance trend. The controls which have been exercised since the budget cut last October were made more rigorous. More routine orders have been cancelled - and all pending maintenance work except the most critical has been stopped. Maintenance money is being rationed on a priority basis. Investigations are being made of the effects on reduced building operator and janitor service levels. At month's end, we are operating in the most austere manner of HLO's history.

Improvement Maintenance

Item	January	FY To Date
Heating & Ventilation Correction	$ 14,460	$ 57,595
Relocation & Alteration	1,374	12,560
Paint	-	11,736
Electrical Improvements	73	1,447
Lighting	-	413
Crane Installation	-	24,910
Miscellaneous	-	1,777
Total	$ 15,907	$110,438

Miscellaneous

Approximately 17,000 square feet of prints were reproduced during the month.

The total estimated value of the 14 requisitions issued during the month was $22,000.

TECHNICAL INFORMATION OPERATION

An eventual cost reduction of over $1600 was effected by a rigorous review of the Library's periodical subscriptions and the elimination of items which (1) no longer appear to be needed because of changing HAPO requirements and (2) which do not appear to be worth the cost as far as HAPO is concerned.

The verifying of key punching was discontinued during the month. The IBM Verifier 056 was returned to Electronic Data Processing Operation for reassignment to another HAPO component. Rental charges of $58,30 per month will discontinue effective March 1. Rental savings for the remainder of FY '60 will be $233.20.

Approved mailing addresses for sending documents to members of the GE Reactor Safeguard Council were received during the month. In the future, documents sent to Council members will be on a loan basis and subject to HAPO's Quarterly Inventory requirements. Since receiving the approved addresses and handling instructions, time has been spent in bringing back into accountability those documents previously sent to GE RSC members, and making necessary route cards.

Two proposed classification guides were forwarded to HOO for approval. They are:

HW-63448 "Proposed Topics on Separations Plant Data for Hanford Classification Guide"

HW-63726 "Proposed Guide to Atomic Weapon Data at Hanford"

The two guides, when approved, will replace Section 400 of the Hanford Classification Guide and HW-36713 REV2 "Guide to Atomic Weapon Data at Hanford" dated April 1, 1957.

A proposed NPR Fuel Element Classification Guide was prepared by HOO and submitted to HAPO for comment. In general it appears to be more restrictive than existing AEC approved NPR guidance. Work on developing and coordinating the comments from the three interested HAPO departments was underway at month's end.

The Specialist, Classification-Declassification made a brief presentation on the classification status of chemical processing and weapon program work at a security meeting in CPD's Facilities Engineering Process Design and Development group.

A reply was received from the Division of Classification to our request (HW-62773) that the security sensitivity of amounts of iodine 131 released to the atmosphere be reconsidered. Based on data submitted by HAPO, the DOC agreed that iodine 131 release data need not be classified.

All Departments have been informed that, after April 1, 1960, Classified Files will no longer send document inventory clerks to individual offices to clear and re-route the document holdings of employees who are terminating or transferring to a new assignment. Employees will have the option of returning their document holdings to Classified Files with instructions for re-routing, having a secretary or clerk re-route the documents using the now well-established field routing procedure, or using some combination of these procedures. So far, there have been no complaints about this minor reduction in TIO services.

At the time of their next Quarterly Personal Inventory, all document holders will receive and additional IBM listing of all CONFIDENTIAL-UNDOCUMENTED AND NON-CLASSIFIED documents charged to them from Technical Information Files. The IBM listing, when combined with the record of current charge-outs supplied by the new routing form, will enable all customers to clearly identify all material charged from Files. Intent of the program is to assist the customer to identify and ultimately return non-classified documents to Files since many are of technical reference value.

The Manager, Technical Information, attended a 5-day meeting at IBM headquarters in Endicott, New York, on the subject of information storage and retrieval. He and Dr. R. K. Wakerling, UCRL, represented the Information Storage and Retrieval Committee of the AEC's Technical Information Panel. Basic IBM equipment was shown, basic concepts discussed and evaluated, and speakers presented a number of retrieval systems actually in use. As a result of the meeting, the Information Storage and Retrieval Committee plans to submit some recommendations to the AEC concerning the mechanization of the AEC's Technical Information program. On the return trip the Manager spent a day in Washington attending the meeting of the Steering Committee of the Panel.

Two members from GE's Computer Department in Phoenix gave a formal presentation of the new GE 250 Information Search and Retrieval System to interested HAPO personnel on February 15th in the 3760 Building. Arrangements for the meeting were handled by Technical Information and all TIO exempt personnel attended. The machine appears to have possibilities for use at HAPO. Preliminary plans have been discussed for a pilot study in a limited area of HAPO technology.

Work Volume Statistics

	January	February
Document Distribution and Files		
Documents routed and discharged (copies)	14,940	19,105
Documents issued (copies)	14,041	14,571
Documents sent off-site (copies)	7,303	3,722
Document reserves filled (copies)	572	842
Documents picked up and delivered	17,256	21,045
Document Accountability		
Holders of classified documents whose files were inventoried	596	303
Documents inventories in Files (copies)	6,906	9,746
Documents destroyed or retired (copies)	5,052	5,651
Documents revised (copies)	862	1,054
Documents pulled and documents filed (copies)	11,550	12,422
Documents reclassified	385	406
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents on-site	207,230	207,778
Reference and Publication		
Books cataloged (new titles)	147	135
Books added to the collection (volumes)	373	251
Ready reference questions answered by professional staff	105	180
Literature searches by professional staff	101	105
Reports abstracted (titles)	240	269
Formal reports prepared (titles)	11	11
Off-site requests for HAPO reports (copies)	330	330
Reports released to CAP (titles)	38	21

Library Acquisitions and Circulation

	January	February
Books ordered (volumes)	361	230
Periodicals ordered	164	182
Books circulated (volumes)	1,864	1,895
Periodicals circulated (issues)	3,609	3,113
Inter-Library loans	91	72
Films borrowed or rented	15	11
Industrial film showings	63	40
Bound periodicals added to the collection	228	--

Library Collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No. of books	28,759	8,355	1,554	2,004	40,672
No. of bound periodicals	13,209	1	1,431	96	14,737
	41,968	8,356	2,985	2,100	55,409

Classification and Declassification

	January	February
Documents, including drawings and photographs reviewed for downgrading or declassification	190	98
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	21	46
Documents submitted to Declassification Branch, Oak Ridge	7	3

J L Boyd

Manager
Laboratory Auxiliaries

JL Boyd:jw

BUDGET CLASSIFICATION
General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64108
MONTH February, 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CAH-827	Automatic Columbia River Monitoring Station	$39,000	$39,000	100	100	4-3-59	---	6-18-59*
			6-30-59	100	97	11-6-59	3-31-60	3-25-60
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS: Plant Forces completed fabrication of the monitoring tank and installed it at the monitoring station. Acceptance testing of the primary pumping system is underway. Difficulty is being encountered in delivering the required flow rate. The monitoring instrumentation is undergoing calibration and testing in a laboratory in the 3706 Building until the pump tests are completed.

*A-E only.

CAH-837	Animal Pens, Isolation and Examination Facilities	$80,000	$80,000	100	100	3-30-59	- - -	6-5-59
			3-17-59	100	99	7-10-59	4-1-60	2-29-60
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS: Final inspection was made on February 19, 1960. There were a number of exceptions, including a badly cracked concrete floor in the dog quarters. The AEC has notified the contractor of the items and that corrective measures must be taken. General Electric has requested additional work be performed using unspent project funds. Servicing contractor forces would probably do this work.

CGH-840	Sheet Metal Shop Addition - 328 Building	$38,000	$40,000	N.S.	100	6-22-59	- - -	9-1-59
			6-18-59	100	99	6-25-59	5-1-60	3-1-60
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: J. J. Peterson		

REMARKS:
All work has been completed with a few minor exceptions.

1242064

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 641
MONTH February 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED COMP. DATE: DESIGN / CONST.
CG-731	Critical Mass Laboratory	$1,000,000	$1,000,000	100	74	5-22-58	--	2-24-59
			3-23-59	100	73	6-4-59	6-30-60	6-30-60
		USING COMPONENT: Physics & Instruments R & D				FED ENGINEER: D. S. Jackson		

REMARKS: The fixed price contractor is 88% complete compared to a scheduled 80%. After a 10 day extension bids were opened on the Phase II reactor control system. The bids ranged from a low of $33,418 by Allied Engineering and Products Corp. to a high of $93,298. The Commission's Labor Standards Board disapproved installation of the in-hood reactor assemblies by Plant Forces. The work will be assigned to the Hanford Construction Services Contractor. All major engineered equipment items procured by the General Electric Company have been delivered to the contractor except the Phase II items and the main instrument control panels. Delay in delivery of the control panels beyond March 15 could necessitate an extension of the construction contract. It has also caused the project to fall behind schedule since it represents 40% of the procured materials and equipment. Although the pipefitters are back on the job the dispute over installation of the cylindrical exhaust duct has not been resolved. Further labor difficulties may result upon resumption of duct installation.

CA-744	Metallurgical Development Facility 306 Building	$2,650,000	$2,685,000	100	*	6-30-58	---	9-30-59
			11-5-58	60	**	3-20-59	9-1-60	9-1-60
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: J. T. Lloyd		

REMARKS: Jensen-Rasmussen Company has permitted benificial use of rooms 170 and 171 for installation of R&D equipment. The CPFF Construction Service Contractor started equipment installation on 2-15-60. The Frank Lohse contract is being delayed because of Hauserman partition procurement difficulties. The difficulties have been encountered in the lining of the chemical processing tanks and this has not been resolved. The Pacific Scientific Company, vendor for the vacuum tub annealing furnace, is balking at conforming to the joint industry conference standards for fabrication. It now appears necessary to pay the vendor an additional amount of $3,000 to insure that fabrication of components meet the above standard.
*Total Project 56%; Jensen-Rasmussen 85%; J. A. Jones 30%; Frank Lohse 20%.
**Total Project 56%; Jensen-Rasmussen 75%; J. A. Jones 32%; Frank Lohse 12%.

CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$349,000	$345,000	100	100	6-23-58	---	12-31-58
			4-23-59	100	93	10-9-58	6-1-60	6-1-60
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: J. J. Peterson		

REMARKS: Directive authorizing extension of time to 6-1-60 was approved 2-26-60. Appurtenances to decontamination chamber such as fresh air intake duct assembly, differential pressure alarm, spot light, window frames, manipulator ball assemblies platform and yoke, could have been and should have been completed months ago are now holding up completion of the fixed price portion of the work. Painters are painting interior, roofing and flashing has been completed with minor exceptions, ventilation supply and exhaust systems have been completed with minor exceptions.

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64108
MONTH February 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CAH-848	Geological & Hydrological Wells FY-1959	$56,600	$56,600 / 6-18-59	N.S. / 100	100 / 95	5-12-59 / 7-16-59	- - - / 5-31-60	7-6-59 / 3-30-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: H. E. Ralph		

REMARKS: Fifteen of the sixteen wells have been developed. 3,000 Feet of new hole has been completed. Contractor is concentrating work force on modification for CPD work.

General Plant Projects - FY 1960

CGH-819	Increased Laboratory Waste Facilities 300 Area	$193,765	$183,000* / 2-19-60	N.S. / 15	N.S. / 0	2-5-60** / - - -	- - - / 5-31-61	5-1-60 / 3-1-61
		USING COMPONENT: Chemical R & D				FEO ENGINEER: J. J. Petersen		

REMARKS: Directive No. HW-477, Modification 3, dated 2-19-60, authorized construction. Design is in progress.

* Does not include Capital Property valued at $10,765.
** Design started on revised scope.

CGH-860	Access for PRTR Fuel Elements - 327 Building	$81,000	$81,000 / 10-8-59	92 / 75	N.S. / 13	10-19-59 / 1-4-60	- - - / 8-15-60	4-1-60 / 7-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS: Bid opening for lump sum portion of work is scheduled for 3-9-60.
Reinforcing of rigid frames and crane rail support beams and brackets is complete except for painting.

UNCLASSIFIED

BUDGET CLASSIFICATION
General Plant Projects - FY 1960

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64108
MONTH February, 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CAH-864	Shielded Animal Monitoring Station 100-F	$46,000	$46,000	100	N.S.	10-22-59	- - -*	2-4-60
			8-6-59	100	0	4-1-60	4-1-60	5-15-60
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:
The A.E.C. has the bid package in process of assembly. This project is being combined with CAH-878, and will be published on 3-7-60. The bid opening is scheduled for 3-31-60.

CGH-874	Consolidation of Plutonium Metallurgy Facilities	$285,000	None	0	0	1*	- - -	5*
			None	0	0	2*	- - -	11*
		USING COMPONENT: Reactor and Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:
The A.E.C. deferred approval of the proposal. They are interested in what CPD will use the space for that Plutonium Metallurgy releases in 234-5 Building.

*Months after authorization.

CGH-877	Pyrochemical Test Facility - 321-A Building	$70,000	$70,000	40	N.S.	12-8-59	- - -	4-17-60
			11-17-59	40	12	2-17-60	9-30-60	9-30-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:
Fabrication of the Mg still hood was started 2-17-60 by J. A. Jones and is estimated to be 30% complete. The Commission has rejected bids on the three remaining hoods. New bids have been solicited and the opening is set for 3-15-60.

1242067

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1960

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 61165
MONTH February 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CAH-878	Additional Facilities for Isotope Study on Animals - 141-C Building Addition	$61,000	$61,000	N.S.	N.S.	12-7-59	- - -	- - -
			11-18-59	100	0	- - -	4-15-60	7-1-60
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The tracings and specifications were returned revised to the AEC on February 25, 1960. The bid package to be published on 3-7-60 and bid opening is scheduled for 3-31-60.

CAH-885	Geological & Hydrological Wells - FY 1960	$69,000	$69,000	2	0	2-15-60	- - -	4-1-60
			2-5-60	2	0	4-15-60	11-15-60	11-15-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: H. E. Ralph		

REMARKS:

Total funds were authorized by AEC Directive No. 174, dated February 5, 1960. AEC Work Authority CAH-885 (1), February 11, 1960, authorized General Electric Company $9,100 for design, Title III services, field survey, related management services, site work and road maintenance. AEC bid package is being prepared.

Improvements to Production and Supporting Facilities - 60-a-1

CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None	0	0	- - -	- - -	- - -
			None	0	0	- - -	- - -	- - -
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

A meeting was held with HOO-AEC and HLO representatives concerning the project proposal being reviewed by AEC. It was requested that the justification for the proposal be modified and more substantiation for this facility, based upon the 2000 Program, be furnished to the Commission.

AEC-2000-010 (2-58)

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 60-a-1

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64103
MONTH February 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or ACTUAL COMP. DATE DESIGN / CONST.
CAH-870	Facilities for Recovery of Radioactive Material - 325-A Building	$490,000	$40,000	100	0	9-18-59	- - -	2-15-60
			12-9-59	99	0	N.S.	- - -	9-1-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS: The Architect-Engineer has requested a two week extension to his design completion date to March 1, 1960. Messrs. R. W. Dascenzo, K. H. Hammill and R. L. Moore of G.E. and J. P. Derouin of A.E.C. visited Bohna's San Francisco office to review the detailed design on February 11. All comments on drawings and specifications have been submitted to the A-E for incorporation. The A-E has requested an additional $270 for design of the remotization of the lubrication for the tank agitator pumps.

The revised project proposal requesting total project funds has been sent to the General Manager for approval. As building costs exceeded $100,000 the funding for this project was changed.

		USING COMPONENT				FEO ENGINEER		

REMARKS:

Equipment Not Included in Construction Projects - Program Class 2900

CG-661	Additional Heat Generation Facility 189-D Building	$470,000	$664,000	100	100	12-6-56	- - -	10-15-58
			9-18-57	100	100	12-3-58	8-31-59*	- - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J J. Peterson		

REMARKS: *Project is being closed out in this amount.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64100
MONTH February 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	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	100	0	1-5-59	- - -	4-1-60
			12-8-58	99	0	N.S.	12-31-60	12-31-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS: Special expediting activity has accelerated fabrication progress by the vendor on the major instrumentation assemblies. Promised delivery date for these items is still mid-March. Final completion of design is contingent upon receipt of BPF data from the instrumentation fabricator. This data will be in the form of "As-Built" drawings which will not be available until the fabrication is practically complete.

Plant Forces personnel have been alerted to the start of construction shceduled for mid-March and a work order has been issued. Modifications required to incorporate helium conservation have been scoped and are being resolved with regard to a project proposal revision requesting authorization of the scope change and additional funds.

CGH-801	X-Ray Diffraction Cell	$170,000	$170,000	40	0	6-10-58	- - -	- - -
			10-1-59	40	0	N.S.	- - -	- - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS: The project proposal for cancellation of this project was submitted to HOO-AEC on February 12, 1960.

CGH-805	High Temperature Tensile Testing Cell 327 Building	$170,000	$150,000	100	0	8-26-58	- - -	6-15-59
			2-25-59	100	0	8-1-60	3-1-60	2-1-61
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS: A.E.C. did not approve of an expedited delivery of the cell structure as it involved a premium payment of $4,000. A revised project proposal requesting $20,000 additional funds and an extension of time was submitted to AEC on February 12. Approval of the cell structure purchase order by AEC is awaiting their review and approval of the project proposal. Three purchase orders have been placed on all of the plugs in the cell structure.

1242070

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64108
MONTH February, 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-834	High Pressure Heat Transfer Apparatus 189-D Building	$700,000	$700,000	100	69	4-20-59	- - -	4-1-60
			4-8-59	98	65	4-22-59	10-15-60	10-15-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS: Both pre-heaters have been received and are being installed. The saturable reactor has also just arrived, considerably behind schedule, and this delay has curtailed construction progress. The high speed valve order has still not been resolved. The only bidder on this requisition has re-submitted his quotation breakdown as well as other information requested by the Commission and it is hoped that the order will be placed by the end of this reporting period.

Design cannot be completed until the valve procurement is resolved, as well as receipt of dimensional data, etc., from vendors on recently placed vessels and compressors.

CGH-857	Physical & Mechanical Properties Testing Cell - 327 Building	$500,000	$75,000	2	0	10-20-59	- - -	4-1-61
			10-1-59	2	0	N.S.	- - -	1-1-62
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS: Design was started on 2-2-60 on the scoping of equipment for this project. Several vendors were contacted and a survey of the commercially available physical testing equipment made.

A revised proposal is being circulated within HLO for approval changing the scope of work from vendor to General Electric design of specialized equipment.

CGH-858	High Level Utility Cell - 327 Building	$500,000	$70,000	4	0	10-20-59	- - -	1-1-61
			10-1-59	4	0	N.S.	- - -	11-1-61
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS: Scoping work on specialized tool design is continuing. HOO-AEC has approved the project proposal changing the scope of work from vendor to General Electric design, but as yet a directive has not been issued.

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 64108
MONTH February, 1960

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH 866	Shielded Analytical Laboratory 325 Building	$750,000	$10,000	0	0	9-5-59	- - -	12-15-59
			8-12-59	0	0	N.S.	- - -	6-1-61
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

Approval has not as yet been received from Washington, D.C. - AEC for design funds for this project. No work was done on it in the past month.

CGH-879	High Temperature, High Pressure Autoclave Facility - 306 Building	$46,400	$46,400	100	86	8-3-59	- - -	1-22-60
			12-3-59	100	90	12-18-59	3-31-60	3-25-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: D. S. Jackson		

REMARKS:

Additional work was required on one preheater and the large autoclaves before they could be accepted into the system. The proportional pump was shipped by Milton Roy from Philadelphia on February 8, but has not arrived. Lack of this item is currently slowing down the installation work.

		USING COMPONENT				FEO ENGINEER		

REMARKS:

AM-7300-019 (5-58)

1242072

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION

MONTHLY REPORT

GENERAL

As of February 29, 1960, the staff of Hanford Laboratories totalled 1305 employees, including 619 exempt and 686 nonexempt. There were 530 employees possessing technical degrees, including 316 B.S., 114 M.S. and 100 Ph.D.

HEALTH, SAFETY AND SECURITY

The medical treatment frequency for February was 1.44 as compared with 1.41 last month. There were 2 security violations during the month, bringing the total for the year to date to 4 as compared with 10 during the same period in 1959.

The HAPO-wide study of Pressure Systems continued during February and was highlighted by the visit of Dr. R. Plunkett, General Engineering Laboratory, to review HAPO Pressure Systems and policies and practices pertaining to their design and use.

Consultations were provided to 25 operations on 46 problems pertaining to a wide variety of safety chemical hazards and chemical toxicity and security questions.

PROFESSIONAL PLACEMENT

During February, 60 offers were extended to new BS/MS candidates, 8 acceptances were received and 76 offers remain open. To date there have been 16 acceptances received for the Technical Graduate Program. We are encountering increased evidence that the overall competition for the new graduate is higher than in previous years. It will not be until the first half of April that we will be able to accurately evaluate the effect of this competition on HAPO's acceptance rate.

Ten offers were extended to experienced BS/MS personnel and 4 acceptances were received during the month.

Four Ph.D.'s visited Richland during February for interviews. Two offers were extended during the month with an acceptance being received from a Doctor of Veterinary Medicine. There are currently 2 open offers, both to chemists for employment within the Laboratories. For the recruiting year to date, 14 offers have been extended and 6 acceptances received for HAPO. During the coming month Hanford representatives will participate in recruiting and follow-up visits at the Universities of Washington, Minnesota, Wisconsin, and Michigan.

Nine new Technical Graduates, including 8 members of the Western Circuit Engineering Program, were added to our rolls during the month, one Technical Graduate accepted permanent assignment, and at month's end there were 51 on the program.

TRAINING

A course in Applied Creativity for 15 Engineering Assistants and 2 classes of PEM-I with 40 participants were completed during the month. A second class in Applied Creativity is scheduled to commence on March 17th.

COMMUNICATIONS

The HLO annual employee information meeting was held on February 3 and February 8 with an attendance approximating one-third of the Laboratories force.

COMPENSATION

Laboratories personnel participated in the recent reconciliation of all non-unit, nonexempt jobs.

EMPLOYMENT

Fourteen nonexempt requisitions were filled during the month. With the receipt of 17 new requisitions and 3 cancellations, there are currently 5 open positions for which 4 candidates are in process and one transfer is pending.

Manager,
Professional Placement
and Relations Practices

TG Marshall:bo

1242074

TABLE II NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	Jan.	Feb.
Requisitions		
At end of month	5	5
Cancelled	0	3
Received	4	17
Filled	7	14

Nonexempt Transfer Request	Jan.	Feb
Transfers		
Active cases at end of mo.	72	74
Cancelled	2	1
New	1	6
Transfers effected	0	3

1242075

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A. Technical Recruiting Activity - HAPO - September 1, 1959 to Date

	Cases Considered	Visits to Richland			Offers*			On the Roll**
		Invited	Visited	To Visit	Extended	Accepted	Open	
Ph.D.	537	130	25	35	14	6	2	7
Exp. BS/MS	328	76	51	4	59	32	7	36
Prog. BS/MS	271	-	-	-	99	16	76	6

*Offer totals include offers open on 9/1/59
Ph.D. 3
Exp. BS/MS 6
**On the Roll totals include 1958/59 Carryover acceptances and one 1957/58 Ph.D. Carryover.

B. Technical Recruiting Activity - HLO - September,1, 1959 to Date

	Cases Considered	Visits to Richland			Offers*			On the Roll**
		Invited	Visited	To Visit	Extended	Accepted	Open	
Ph.D.	537	130	25	35	11	5	2	6
Exp. BS/MS	233	29	19	1	12	8	2	12

*Offer totals include offers open on 9/1/59
Ph.D. 3
Exp. BS/MS 3
**On the Roll totals include 1958/59 Carryover acceptances and one 1957/58 Ph.D. Carryover.

In addition to the above activity, 9 exempt employees have transferred into HLO from other HAPO departments and 8 technical graduates have accepted off-Program placement in HLO to date.

C - Technical Graduate and Technician Training Program
Month ending February 29, 1960

	TG Program	TT Program
Number of Personnel on Assignment	51	7
(HAPO Tech Grad Program.....42		
(Western District E. P. 9		
Distribution of Assignments by Departments		
HLO	20	2
CE&UO	1	0
FPD	2	0
IPD	21	5
CPD	6	0
C&AO	1	0
Distribution of Assignments by Function		
R&D or Engineering	40	7
Other	11	0

1242077

FINANCIAL OPERATION MONTHLY REPORT
FEBRUARY 1960

Personnel

There were no personnel changes during February.

Activities

GENERAL ACCOUNTING

In February, $172,100 of equipment was made available for transfer from EWIP to Plant. Of this total, $144,400 was vouchered to Plant in February. The balance of $27,700 will be vouchered to Plant Record by Property Accounting in March.

The status of EWIP at February 29, 1960 is compared with the status at February 28, 1959:

(Amounts in Thousands)	February 29, 1960	February 28, 1959
Expenditures	$1 198	$ 971
Commitments	1 992	1 280
In Process	831	646

Included in the expenditures is an accrual of $61,000 for ninety neutron dosimeters received by Radiation Protection. The cost of these dosimeters is approximately $20,000 more than anticipated. At a meeting with Radiation Protection their equipment situation was reviewed and it was determined that an additional $32,000 would be required for expenditures this fiscal year. Appropriation Requests are currently in our possession covering the bulk of this amount.

Laboratory Auxiliaries is preparing three AR's aggregating $105,000 for machine tools. This covers approximately $40,000 for replacement machine tools and the balance for new equipment. These requirements are in addition to Laboratory Auxiliaries current allocation.

It now appears that an additional $100,000 will be expended this fiscal year on Project CG-785 In-Reactor Studies Equipment because of more favorable delivery dates than anticipated for the console equipment.

A report was issued showing the results of the physical inventory of movable cataloged equipment in the custody of Physics and Instruments Research and Development Operation. Physically counted were 1,824 items, valued at $966,674. One item valued at $112 was not located during the inventory. Fifty-seven items valued at $18,470 and recorded on Property records as RDX equipment were determined to be capital. The estimated first cost of $18,470 with an accumulated reserve of $7,312 was added to record with an off-setting entry to the Non-Fund Adjustment account. Ten units of Property of Others were physically located and added to record for control purposes of which nine were the property of KAPL and one the property of the U.S. Air Force.

The physical inventory count of movable cataloged equipment in custody of Reactor and Fuels R&D Operation continues. The inventory count is behind schedule primarily due to increased number of items and lack of knowledge of equipment location by custodial personnel.

In preparation for the Inventory Budget for FY 1962 and Revision of Budget for FY 1961 information as to inventory requirements was received from all components. Consolidation of data is underway.

Assistance was provided to Contract and Accounting Operation with the reconciliation of the physical inventory of HLO Reactor and Other Special Materials. A report of results should be issued in March.

A substantial number of Property Manual Chapters were revised and distributed within Laboratories during the month. In addition, several new Chapters were added to incorporate HAPO OPG's on Property Management in the Property Manual.

One hundred and thirteen items valued at $57,093, were received at the Laboratory Equipment Pool building during February. Two items valued at $250 were permanently transferred leaving a balance of 168 items valued at $76,839 in storage. A listing of items available for loan or transfer is being prepared for distribution within HLO.

SS Accountability advised us of the continuation of Survey 17 with a verification of HLO inventories of depleted uranium and Palm as of the end of March 1960. All material custodians were advised of the survey and requested to submit inventory information to be compiled and forwarded to SS Accountability. In addition, material custodians were requested to submit forecasts for inside diversion of SS Material covering the entire fiscal year 1961. Upon receipt of the information, a consolidated report will be prepared and forwarded to SS Accountability.

COST ACCOUNTING

Considerable effort was devoted during the month to the preparation of Budget for FY 1962 and Revision of Budget for FY 1961.

1. Personnel requirements were consolidated for HLO, reviewed and approved by the Manager, Hanford Laboratories and submitted to Contract and Accounting.

2. Detailed operating cost budgets have been prepared for the following components. Review and approval by Section management to-date are indicated.

Hanford Laboratories - General	
Financial	Approved
Professional Placement and Relations Practices	Approved
Radiation Protection	Approved
Operations Research and Synthesis	Approved
Laboratory Auxiliaries:	
Technical Information	Approved
Buildings and Utilities	Approved
Other Components	

3. Standard rates for liquidating Building and Utilities costs for Fiscal Years 1961 and 1962 have been calculated and building rental has been allocated to HLO components for budget purposes.

4. A detailed estimate of HLO requirements for Data Processing services was prepared for Fiscal Years 1961 and 1962 and submitted to Contract and Accounting Operation.

The control budget for Hanford Laboratories operating cost was adjusted during February to reflect changes in authorized funds as follows:

	Increase
4000 Program (Division of Reactor Development)	
Plutonium Recycle Program	$ 45,000
GCPR - Reactor Physics Studies	60,000
GCPR - Graphite Irradiations in GETR	130,000
Non-Destructive Testing	20,000
Waste Fixation	70,000
Graphite Contraction Studies	35,000
5000 Program (Division of Research)	
Computation and Statistical Analyses	25,000
Irradiation Effects on Metals	56,300

Additional funds, in the amount of $38,000 have been received from the University of California Livermore Radiation Laboratory to cover capital equipment expenditures associated with Project Whitney. This revision increases the authorized amount for FY 1960 to $88,000.

A special request was received by Hanford Laboratories during February for the fabrication of unirradiated UO_2-PuO_2 pellets for ORNL with an authorized amount of $1,500. Costs will be billed to Union Carbide Nuclear Company.

Action as indicated occurred on the following projects during the month:

		New Funds Authorized to HLO	Physical Completion Notice Issued	Transferred to Expense
CGH-819	Increased Laboratory Waste Facilities	$150,000		
CGH-882	5000 Ton Hydraulic Press		x	x
CAH-885	Geological and Hydrological Wells - FY 1960	9,100		

There were 10 new authorizations for $108,081 and 3 supplements for $11,250 issued to J. A. Jones Construction Company during the month. One authorization of $90,000 for work on Project CA-744, Metallurgical Development Facility accounted for the major portion of the dollars authorized. Work was physically completed on 16 authorizations during the month and 30 authorizations were still open at month end.

Letter of February 19, 1960 from Contract and Accounting Operation authorized HLO $126,000 for Miscellaneous Capital Work Orders for FY 1960. This is the first formal allocation of these funds we have received this fiscal year. This allocation will permit us to complete work already authorized and to authorize the air conditioning of instrument rooms in the 329 Building, estimated to cost $15,540. Work on the animal farm waste disposal estimated at $15,200 cannot be authorized until additional funds become available.

GENERAL

The Hanford Laboratories contribution to the HAPO Annual Report has received final approval. The Measurements Report for 1959 was distributed. A summary of technical reporting is nearly complete.

Payroll Statistics

Number of HLO Employees Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 300	615	685
Additions and Transfers in	23	10	13
Removals and Transfers Out	18	6	12
Employees on Payroll at End of Month	1 305	619	686

Overtime Payments During Month	February	January
Exempt	$ 3 231	$2 325
Nonexempt	7 842	6 139
Total	$11 073	$8 464

Gross Payroll Paid During Month		
Exempt	$511 059	$509 462
Nonexempt	317 814	306 887
Total	$828 873	$816 349

Participation in Employee Benefit Plans at Month End	February Number	February Percent	January Number	January Percent
Pension Plan	1 132	99.5	1 119	99.1
Insurance Plan				
Personal Coverage	1 296	99.8	1 292	99.8
Dependent Coverage	921		921	
U.S. Savings Bonds				
Stock Bonus Plan	78	39.0	78	39.4
Savings Plan	92	7.1	92	7.1
Savings & Security Plan	1 028	88.9	1 038	89.9

Insurance Claims Employee Benefits	February Number	February Amount	January Number	January Amount
Life Insurance	0	$ -	0	$ -
Weekly Sickness and Accident	14	1 208	21	1 142
Comprehensive Medical	179	11 258	102	6 778
Dependent Benefits				
Comprehensive Medical	89	5 641	183	11 248
Total	281	$18 107	306	$19 168

Good Neighbor Fund	February	January
Number Participating	918	919
Percent Participating	70.5	70.7

W. Sale:bk
3-10-60

1242081

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
R. J. Engelmann	Temperature Compensation of Conductors for the Purpose of Maintaining Constant Resistance
O. F. Hill	A Simple Device for the Conversion of a Fission Product Solution or Slurry to a Free Flowing Powder in a Shipping Container
R. J. Sloat J. Dunn	Leak Proof Control Valve - Thermally Actuated
R. J. Sloat J. Dunn	Leak Proof Control Valve - Bourdon Tube Actuated
A. K. Postma	A Moving Wall Elutriator for Improved Sizing of Particles
R. T. Allemann	Radioactive Waste Treatment (HW-64076)
R. T. Allemann	Remote Manipulation Technology: Quick Make-and-Break Screw-On Toggle Clamp for Swagelock and Concentric Fittings (HW-63739)
R. H. Moore	A Method for Preparation of Uranium-Aluminum Alloys (HW-63749)
A. S. Wilson	The Separation of Thorium and Uranium by the Use of a Solution of Nitrogen Dioxide in Tributyl Phosphate as a Solvent
H. Harty H. K. Nelson	Fusible Contact High-Temperature Monitor for Reactor Instrumention

H M Parker