HAN-72024

729420

HW-59717

COPY NO. [redacted]

DECLASSIFIED

REPOSITORY PNL

COLLECTION Atmospheric Releases R

BOX No. N/A

FOLDER N/A

HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT

MARCH, 1959

APRIL 15, 1959

BOX: 002816
BIN: 0176

[redacted]

HANFORD ATOMIC PRODUCTS OPERATION

RICHLAND, WASHINGTON

GENERAL ELECTRIC

1252126

DECLASSIFIED

AEC-GE RICHLAND, WASH.

LEGAL NOTICE

DECLASSIFIED

HW-59717

This document consists of 175 pages. Copy No. of 26 copies. Series A

HANFORD LABORATORIES OPERATION

MONTHLY ACTIVITIES REPORT

MARCH, 1959

72024

Classification Cancelled

Compiled by
Operation Managers

April 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

[redacted]ed.

PRELIMINARY REPORT

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

Route To:	P. R. No.	Location	Route Date	Signature and Date

[redacted]

1252128

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	P. F. Gast
9	A. R. Keene
10	H. A. Kornberg
11	T. G. Marshall
12	L. H. McEwen
13	W. Sale
14	J. W. Healy
15	H. P. Shaw - V. R. Cooper
16	H. A. Paulsen
17 - 20	Atomic Energy Commission, Hanford Operations Office Attn: J. E. Travis
21 - 23	E. J. Bloch, Director, Division of Production, Washington 25, D.C.
24	Savannah River Operations Office, Aiken, South Carolina
25	300 Files
26	Record Center

TABLE OF CONTENTS

	Page
Staff	iv
Force Report and Personnel Status Changes	v
General Summary	vi through xiii
Reactor and Fuels Research and Development Operation	A-1 through A-51
Physics and Instrument Research and Development Operation	B-1 through B-22
Chemical Research and Development Operation	C-1 through C-26
Biology Operation	D-1 through D-7
Operations Research and Synthesis Operation	E-1 through E-7
Programming	F-1 through F-7
Radiation Protection Operation	G-1 through G-8
Laboratory Auxiliaries Operation	H-1 through H-20
Employee Relations Operation	I-1 through I-6
Financial Operation	J-1 through J-7
Invention Report	K-1

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, Employee Relations . . . . . T. G. Marshall

Manager, Financial . . . . . W. Sale

TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE March 31, 1959

	At close of month			At beginning of month			Additions		Separations	
	Exempt	NonExempt	Total	Exempt	NonExempt	Total	Exempt	NonExempt	Exempt	NonExempt
Chemical Research and Development	123	93	216	123	91	214	1	3	1	1
Reactor & Fuels Research & Development	187	133	320	187	126	313	2	9	2	2
Physics & Instrument Research & Development	66	32	98	67	27	94	0	5*	1	0
Biology Operation	36	44	80	37	44	81	0	0	1	0
Operation Res. & Syn.	14	3	17	14	3	17	0	0	0	0
Radiation Protection	33	100	133	34	99	133	0	4	1	3
Laboratory Auxiliaries	46	180	226	44	181	225	2	4	0	5
Financial	16	33	49	16	33	49	0	0	0	0
Employee Relations	40	25	65	38	25	63	3	0	1*	0
Programming	14	4	18	14	4	18	0	0	0	0
General	1	2	3	1	2	3	0	0	0	0
Totals	576	649	1225	575	635	1210	8	25*	7 *	11
Totals Excluding Internal Transfers	576	649	1225	575	635	1210	7	19	5	6

*1 Exempt to NonExempt

Composite Separation Rate	1.4693
Separation Rate (based on separations leaving G. E.)	.7346
Controllable Separations Rate	.1632

BUDGETS AND COSTS

Costs for March were $1,886,000, an increase of $224,000 over the month of February. The major change was in the Plutonium Recycle Program which increased $149,000 over February to $548,000 for the month. Fiscal year-to-date costs are 69% of the operating budget of $20,510,000.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Progress on PRTR construction is as follows: Phase I, 86% completed versus 96% scheduled; Phase II, 84% completed versus 90% scheduled; and Phase II-A, 58% completed versus 58% scheduled. Construction of the Plutonium Fabrication Pilot Plant, Phase II, is 89% completed versus 97% scheduled.

Preliminary project proposals have been prepared for the PRTR Reactivity Measurement Facility and for the PRTR high pressure water loop. Another for a PRTR rupture test loop is in preparation. A revision to the PRTR gas-cooled loop proposal, to increase the maximum temperature from 1100 F to 1500 F, has also been prepared.

The redesigned PRTR shim control assemblies are based on a lead screw drive, with three half rods in each assembly. These features preclude loss of a shim from the core in the event of chain drive rupture and reduce the reactivity carried in individual rods.

The first twenty Zircaloy-2 PRTR process tubes have been inspected and accepted at the vendor's plant, and will be shipped in April.

Improved x-ray diffraction techniques now permit the accurate determination of the slip planes in extruded Zircaloy tubing and rolled Zircaloy sheet. The difference in orientation of the planes in the two materials accounts for the commonly observed 30 percent greater circumferential strength in tubing as compared to shee

A careful analysis of the recrystallization and grain growth characteristics of 50 percent cold worked zirconium heat treated in helium reveal that recrystallization takes place by a process of nucleation and growth. No evidence of recrystallization is noted at 400 C, whereas the process is complete after 1000 minutes at 500 C. Studies reveal that higher temperatures are required for recrystallization as the degree of cold work is decreased.

Using vibratory compaction, UO_2 fuel has been compacted to a density of 82 percent of theoretical. Rod cluster elements with cores compacted in this manner have been readied for MTR and ETR irradiation.

A one-inch diameter loose powder element was operated at a heat transfer rate in excess of 1,000,000 BTU/sq ft/hr. A partial collapse of the can wall resulted in excessive jacket temperatures and ultimate rupture of the test piece by solid state reaction between the UO_2 and the Zircaloy cladding. Conditions of operation exceeding the limits of the UO_2-Zircaloy system were defined.

Seven-rod UO_2 elements exposed for four months in KER revealed no evidence of

fretting corrosion caused by the wire wrap.

The first 19-rod fuel element for the first PRTR loading was assembled during the month.

The development of a swage feeding mechanism employing canted rubber rolls has resulted in improved straightness and a reduction of 50 percent in swaging time of Zircaloy-clad UO_2 rods. The necessity of a drive mechanism capable of slipping was convincingly demonstrated by means of motion pictures of the die action in both the stationary and rotary die machines.

The sinterability of mechanically mixed PuO_2-UO_2 has been determined over the range from 0 to 10% PuO_2 and temperatures from 1000 to 1600 C for one hour sintering time Densities of PuO_2-UO_2 systems were less than for UO_2 only at the same sintering temperatures.

Loading of extruded Pu-Al cores into Zircaloy sheathing while maintaining an extremely small gap in the finally assembled fuel rod has been difficult. A honing machine has now been developed and is available to correct the i.d. variation of Zircaloy tubing to within one-half-mil over a length of eight feet.

Heat transfer experiments confirmed the validity of present K Reactor outlet temperature limits in the event of low front header pressure or a failed-front hydraulic connector.

Two seven-rod metallic uranium fuel elements with inter-rod spacings varying from 0.025" to 0.060" were exposed to 1250 MWD/T in KER Loop 1. Only the rod with the minimum clearance to both adjacent rods showed measurable increase in diameter. The increase was presumably caused by the higher internal temperature and was consistent with an increasing amount of evidence that swelling becomes a severe problem at temperatures above about 450 C.

Two tube-and-rod elements are now operating at 80 kw/ft in 240 C water in KER Loop 4. Exposure is currently 1200 MWD/T with goal exposure 2500 MWD/T.

A closure with considerable promise for NPR rod elements consists of projection welding a plug on the end of a fuel rod with the jacket thickened by a previous die upsetting operation. Preliminary tests show that a secondary, circumferential fusion weld can be successfully applied leading to a closure with high strength and good corrosion resistance.

Studies show that several aluminum alloys, including X-8001, dissolve more rapidly in molten AlSi than does 2S aluminum. This implies that temperature control of the canning bath may be more critical when using alloy cans, if excessive penetration is to be avoided.

Useful new techniques for following the rate of rupturing of pre-defected, unirradiated, jacketed fuel in an autoclave at 300 C have been developed, involving two different methods for continuously measuring the rate of release of hydrogen gas.

The first successful out-of-reactor rupture test has been conducted in a flowing system with electrical heating of the fuel rod to simulate in-reactor heat gen-

eration. Two of the three 25-mil pre-defected pin holes in the jacket exhibited raised areas essentially similar to previous tests without heat generation in the fuel rod.

Decontamination of reactor systems with strongly alkaline decontaminating agent, such as might be used in the presence of carbon steel, appears to be undesirable if both aluminum and Zircaloy are present in the system. Evidence has been obtained of hydriding of the Zircaloy by hydrogen released by reaction between the aluminum and the alkaline decontaminating agent.

It appears quite probable that the initial expansion which has been observed in graphite irradiated at high temperatures may be due to the annealing out of a mechanical "compression set" imposed on the graphite during manufacture and machining.

2. Chemical Research and Development

Continued laboratory investigations on neptunium recovery have emphasized a flowsheet utilizing lower nitric acid concentration and the addition of ferrous sulfamate and hydrazine reducing agents. Mini laboratory pilot runs were encouraging. The process will be utilized in the next Purex Plant campaign. A precise determination of the half-life of neptunium-237 has resolved differences in analytical results between coulometric titration and specific alpha activity measurements. The new established half-life is $2.14 \pm 0.01 \times 10^6$ years.

Laboratory study of rare earth recovery from Purex 1WW wastes showed that a previous method of removal by sulfate precipitation is complicated by current 1WW composition which is more concentrated and contains a higher iron content. A tentative promethium recovery and purification method is presented but much experimental work remains to be done.

Work on the potential recovery of plutonium from recuplex waste streams by means of anion exchange resins has progressed to a point where the technical data have been transmitted to CPD for consideration of detailed design for plant application.

Several significant items are reported on Non-Production Fuels processing studies. Mechanical tests on fuel chopping or sawing have progressed to studies on shear blade life, zirconium sawing, with its pyrophoric problems, some work on particulate filtration, tests on the consequences of cutting into sodium or NaK bonded fuel elements in the presence of water, and also experimental exposure of fuel segments containing sodium or NaK to dissolver media. The practical discovery was made that the presence of ferric nitrate greatly stabilizes dissolver solutions of uranium-molybdenum alloys. Ferric nitrate additive also increases the dissolution rate in nitric acid of uranium-molybdenum alloys, uranium metal, or uranium dioxide. No explanation is apparent yet for the anomalous dissolution behavior of stainless steel in the Hastelloy-F Niflex dissolver. Other than this somewhat minor problem the Niflex pilot plant is behaving satisfactorily.

Work is progressing to assure that no explosive residues remain on dissolution of zirconium-uranium metallic systems which will be encountered from either zirconium co-extruded clad uranium metal or from power fuels utilizing uranium-zirconium alloy cores.

Cooperation with off-site laboratories continues and two new runs were completed at ORNL on power reactor fuel feeds to simulated Redox solvent extraction systems; ANL has begun a study of synthetic Purex 1WW waste calcination in their fluid bed waste calciner prototype.

Uranium dioxide was found to dissolve rapidly in molten sodium chloride, potassium chloride mixture when phosgene is bubbled through the solution. The solute, believed to be uranyl chloride, precipitates uranium dioxide when zinc or zinc magnesium alloy is added to the melt. This simple uranium dioxide cycle could have application in reprocessing power reactor fuel. The method does not work well for plutonium dioxide.

It was determined that a full size PRTR fuel element can be charged in existing Redox dissolvers provided a special folding bail is used.

The use of metallic aluminum turnings to remove radioisotopes from reactor effluent water has moved to the pilot plant stage where pressure - flow characteristics are being determined on beds of aluminum turnings. Paper electrophoresis studies of reactor effluent water radioisotopes indicate that chromium-51 activity may exist as three distinct chemical species.

Six out of ten rats injected with erioglaucine 10 minutes prior to receiving a radiation dose of 900 r of x-radiation were alive 30 days afterwards. Only one of ten uninjected control animals survived. This corroborates similar ratios on the first test of this kind using mice, and further indicates that the erioglaucine blue dye inhibits damaging radiation effects to living systems.

Over 400 correlations indicate that residual moisture in vadose zone soil can be closely estimated by means of centrifuge tests which can be easily carried out in a laboratory.

3. Physics and Instrument Research and Development

Exponential pile measurements continued on massive uranium slugs as part of a program to build up physics information to assist in the selection of good fuel element designs for the NPR.

Reactor lattice physics experiments began in support of the Gas Cooled Reactor Program. PCTR data suitable for calculating physics parameters were obtained on a seven-rod cluster of uranium oxide rods in a graphite moderated core.

A safe batch size of two tons was recommended for dissolving 0.95% enriched I and E fuel elements in the present dissolver after a review of recent experimental results and of the various contingencies which might reasonably be expected in loading the dissolver.

Experimental work to accumulate critical mass information continued with 3% and 1.25% enriched uranium in homogeneous and heterogeneous configurations.

Installation of towers and poles for this summer's experimental program in atmospheric physics was begun after completion of the survey of the course. Procurement of the additional temporary employees was completed.

In the basic data field, agreement of cross-section measurements on graphite by American, British, and French laboratories was improved even further, as compared to the situation reported last month, by the direct measurement in the PCTR of the absolute value of the cross section of one bar.

Studies of the neutron scattering properties of light water continued on the KE neutron spectrometer.

Testing of a prototype criticality alarm was completed and the instrument was demonstrated for product department personnel. Tests in a gamma field of 30,000 r/hr indicated no tendency to block or overload.

A directive to proceed with construction of Phase I of the Critical Mass Laboratory was received.

4. Biology

Further important information is being obtained relative to "observed ratios". It seems that not only do similar cations affect the uptake of one another but dissimilar ones also do.

The effectiveness of DTPA orally administered is continuing to be investigated. At this time, there is good reason to have hopes for the development of an effective pill.

Good progress is being made in radioactive particle work with dogs. Sufficient numbers of these animals have recently arrived to promise interesting results shortly. Turnover times from the lung to other organs and excreta are being obtained.

5. Programming

A detailed study of a schedule for charging, discharging, and chemical processing of PRTR fuel was completed. The study was presented in chart form and should be useful in the procurement of plutonium and for the planning of chemical processin operations.

The Meleager A and B fuel cycle analysis codes were compiled and run. Preparatio of cross-section and related input information was essentially completed.

Consultations were held on the possible use of iodine-131 as a tracer in meteorological experiments designed to study the deposition properties of vapors as compared with particles.

At an ASEE - Nuclear Committee meeting in Washington, a proposal to expand the 1959 HLO SINE program by utilization of several off-site speakers was accepted. This proposal was preferred over others involving off-site trips because of the lesser interference with the problem assignment portion of the program. Ten candidates were selected for this summer's institute.

Technical and Other Services

An experiment designed to locate the optimum combination of preheat and submerge times

in the canning cycle has been successfully completed and analyzed, and the results used to define a smaller experimental region for subsequent pilot plant work.

Work on two operations research studies and six operations analysis programs continued during the month, and work on one new operations analysis program was initiated. In addition, statistical and mathematical assistance on 20 problems was given within HLO and to other departments and operations.

An explosion occurred on March 31 in a lathe hood located in the plutonium metallurgy facilities in the 234-5 Building. Several Hanford Laboratories' employees were contaminated with plutonium materials. Two employees were machining a piece of plutonium metal in the hood at the time of the explosion. One employee received a laceration above the left eye. Minor skin excision was performed on the contaminated wound as a precautionary measure. The injured employee also received treatment with DTPA to minimize any likelihood of internal deposition of plutonium. Surveys of the wound area in the Shielded Personnel Monitoring Station and very preliminary bioassay measurements indicated that the deposition of plutonium will probably be less than the permissible limit. Complete skin decontamination of the four involved employees was successful.

Excluding the above incident, no additional cases of plutonium deposition were confirmed during the month. This maintains the total number of deposition cases which have occurred at Hanford at 228. There are 162 employees currently employed who have a measurable deposition of plutonium.

There were 18 authorized projects at month's end with total authorized funds of $7,726,400. The total estimated cost of these projects is $7,870,400 (PRTR and PFPP are recorded separately). One project was completed during the month. Two new projects are awaiting AEC approval. Project Proposals for ten new projects are in preparation.

Radiographic Testing service work for the month continued above normal due to examination of tubular products. A total of 9,555 tests were made of which 1,217 were radiographic and the remainder supplementary tests. In man hours, 55% of the total available time was on radiographic testing.

The Technical Shops overtime rate continued high due to heavy work load and emergency requests. The proposed unit price contract agreement was not approved by AEC. Steps are being taken to set up procedures for rapid award of small fixed price jobs to off-site shops.

Contracts for construction of the 327 Building Addition (CGH-790) and the 306 Building Addition (CA-744) were awarded during the month. A project proposal was prepared and submitted to AEC requesting additional funds on CGH-790 due to unanticipated SWP work required.

The results of the 1958 inventory of Research and Development reports and Atomic Weapon Data reports were reported to GE Security. HAPO's holdings are 10,130 copies of which 105 copies are Weapon Data reports and the remaining 10,025 copies are Research and Development reports. Twenty-nine copies were reported as unaccounted for, of which twenty-seven were carry-overs from previous annual inventories. None of the unaccounted for reports are Weapon Data.

Supporting Functions

The HLO Operating Budget for FY 1961 and Revision of FY 1960 has been completed. Proposed levels are $22.2 million for FY 1960 and $23.5 million for FY 1961 compared to $20.5 million in FY 1959.

Hanford Laboratories inventories are forecasted to increase from $806,000 in FY 1959 to $1.4 million in FY 1960. Major increases are in Heavy Water and Spare Parts for PRTR.

Whitney Program equipment has been physically inventoried and the records established on IBM 709. Total holdings at this time are 324 pieces valued at $574,000.

Procedures have now been established to provide each HLO unit with an IBM tabulation of their commitments for off-site material and service. This tabulation which shows open requisitions, purchase orders and contracts for each research program will permit exact planning for these elements of cost.

At month's end, the staff of the Hanford Laboratories Operation totalled 1225 employees, including 576 exempt and 649 nonexempt employees. There were 489 exempt employees possessing technical degrees, including 278 B.S., 108 M.S. and 103 Ph.D.

Seven sessions of the first program of the Information and Orientation Series were presented with approximately 85% of Laboratories nonexempt employees attending. Plans were completed for presentation of Program II.

One new grievance was received during the month. It pertained to the transfer procedure for bargaining unit employees. The Step I answer was not satisfactory but the grievance is now considered settled at Step I due to expiration of the time limit.

The grievances processed by Hanford Laboratories since January 1, 1959 total six.

Two sessions of the annual HLO Department Information Meeting were held in the Village Theater on March 9 and 17. Approximately 300 HLO employees attended.

Tours were held in March for 10 National Bank of Commerce officials, 30 Clarkston High School students, 40 Kennewick High School students, and 60 Richland school teache

Laboratories personnel worked a total of 206,000 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 5,878,868 man-hours have been completed with no disabling injuries.

The medical treatment frequency for March was 1.60 as compared with 1.67 during February.

Ph.D. recruiting continues to encounter difficulty in the acquisition of Ph.D. physicists with two rejecting our offers during the month to accept post doctoral or academic positions.

Other Ph.D. recruiting activity is progressing favorably. Recruiting of Technial Graduates and experienced BS/MS candidates continues to meet with success although here again it is difficult to acquire the necessary numbers of candidates in physics.

Recruiting for the Summer Program is now complete with acceptances received from 11 professors, 12 graduate students, 10 juniors, and 5 high school teachers.

Twenty-five nonexempt requisitions were filled during the month. With the receipt of 14 new requisitions, there are currently 40 openings in the Laboratories. Seventeen candiates are in process and two transfers pending, leaving 21 candidates to be procured.

H M Parker

Manager,
HANFORD LABORATORIES

HM Parker:bms

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Dynamic Corrosion of Aluminum in Deionized Water. Since several of the newer experimental aluminum alloys (viz., those containing small percentages of Ni, Fe, and Ti) exhibit corrosion resistance superior to X-8001 in 360 C static water, testing of representative alloys has been extended to flowing systems employing deionized water at 300 C. On the basis of average penetration of the samples there was no significant difference between X-8001 and the newer alloys attributable to alloy composition alone, although one alloy designated KAB (0.6 w/o Ni, 2.1 Fe, 0.1 Ti) was visibly less attacked by erosion-corrosion on the leading edge of the upstream coupon. However, the average penetration of all samples was approximately the same, within experimental reproducibility, increasing from approximately 1.8 mils in two months at 4 ft/sec water velocity to 4.1 mils in two months at 38 ft/sec.

Another test was conducted to measure the effects of water refreshment rate, flow rate, and time on the corrosion of X-8001 aluminum alloy at 250 C in deionized water. The average penetrations observed ranged from approximately 0.36 mil in one month in an un-refreshed low-flow system to 2.5 mils in two months in a refreshed system at a water velocity of 25 ft/sec. Increasing the velocity from effectively zero to 25 ft/sec increased the corrosion rate by a factor of approximately 3.5, increasing the time from one to two months increased the corrosion by a factor of approximately 1.4, and refreshment increased the corrosion rate by a factor of approximately 1.4.

These experiments illustrate the importance of the dynamic effects (e.g., flow velocity and refreshment rate) on the corrosion of aluminum alloys in hot water.

Effect of Autoclave Pre-treatment. The effect of autoclave pre-treatment of coupons in 250 C water has been discussed (January 1959 Monthly Report). After two months in 200 C water, 7 fps flow rate, 1 gph refreshment, the following rates were observed for samples with various pre-treatments:

Pre-treatment	Mils Corrosion
None	1.70
Autoclaved 1 day at 200 C	1.64
Autoclaved 1 week at 200 C	0.67
Autoclaved 1 day at 300 C	0.75

Jet Impingement Studies. Tests are continuing to determine the relative susceptibility of aluminum alloys X-8001 and 1245 to attack by impingement of a jet of hot water. Recent data employing high purity water at 100 C with a 0.009 inch orificed jet show no measurable penetration of either alloy in 200 minutes at a jet velocity of 44 ft/sec. At higher jet velocities (60 to 202 ft/sec) the rate of penetration of the 1245 alloy was greater than or equal to the penetration of X-8001 (viz., at 202 ft/sec penetrations were 17.0 and 21.7 mils, respectively, for X-8001 and 1245 alloy). The differences are relatively insignificant, however, and similar previous tests employing 300 Area tap water rather than high purity water showed a small difference in favor of the 1245 alloy (HW-57225 Al, pp. 2-5).

Fuel Element Rupture Kinetics. Studies are continuing to determine rupture kinetics and characteristics of coextruded Zircaloy-2 clad fuel elements in cooperation with Fuel Element Design Operation. Samples are defected with a 25-mil hole drilled through the cladding into the core. These are exposed to water in an induction heated autoclave at temperatures up to 300 C. The failure of these samples occurs in two phases. During the first phase, a blister is slowly formed at the defect, and there is little or no liberation of corrosion product or hydrogen. The second phase begins when the blister pops open as a result of fracturing of the cladding. During this phase there is generous liberation of corrosion product and hydrogen as a result of extensive ripping of the cladding and rapid corrosion of the core material.

Two techniques have been developed to study rupture kinetics. The first method uses a palladium tube as a hydrogen valve to detect the end of the first phase of failure. The second method uses a recirculating system to collect and measure the hydrogen gas liberated. This method provides kinetic data on both phases of the rupture process. Preliminary tests have shown no hydrogen liberation during the first phase. At the start of the second phase there is a sudden burst of hydrogen leading into an approximately constant rate of hydrogen liberation. The data for three runs are tabulated below:

RUPTURE DATA

Temperature	Duration of Phase 1	H_2 Evolution Rates During Phase 2
250 C	60 min.	28.5 ml/min
300	33 "	33.3
300	30 "	133.3

It was observed during the latter run that the constant hydrogen evolution was actually a series of hydrogen bursts which may correspond to the successive rupturing of blisters on the failing samples.

Zircaloy Etching Studies. The occurrence of white spots on autoclaved Zircaloy fuel elements is cause for rejection. These spots are usually associated with defective metal and thus properly rejected. Occasionally, however, these white spots can be caused by the etching and rinsing procedures. In order to prevent etch spotting, spot-causing substances and rinsing techniques are being investigated. The investigation to date has shown that even deionized water will cause light spotting when dried in laboratory air but no spots when dried in argon. Rinsing in deionized water will remove dried spots caused by dilute etch solution (1:2000) and tap water. The final rinse can be effectively accomplished by starting the autoclave full of deionized water. Dried spots of standard etch solution were partially removed by rinsing in hot 1% NH_4OH. Presumably, spotting can be caused by non-volatile impurities left on the surface of the Zircaloy as it approaches autoclaving temperature. This investigation is continuing.

Etching and autoclaving of experimental Zircaloy-jacketed fuel rods for the PRTR has also contributed to an understanding of conditions which cause water spotting. The best procedure found to date involves the use of deionized water (rather than tap water), at room temperature for the final rinse step after etching, and then wiping the Zircaloy surface dry with paper towels rather than permitting the water to evaporate on the Zircaloy surface.

Radiometallurgy Laboratory Studies

Examination was begun on three 7-rod cluster type elements which had been given a high irradiation exposure, five tensile tests were conducted on cyclically annealed uranium, and seven low temperature irradiated tensile bars were examined on the metallograph and Faxfilm replicas obtained. Studies were also begun on the effect of annealing temperature on the swelling characteristics of uranium. The results and conclusions from this work will be reported in connection with the respective development programs.

Basic Metallurgy Studies

Radiation Effects in Fissionable Materials. The design of advanced fuel elements depends upon some knowledge of the effects of irradiation on significant mechanical and physical properties. A program to obtain these data for uranium irradiated to 0.018, 0.031, 0.075, and 0.10% burnup is under way. Tensile tests were performed on two specimens which were cyclically annealed after irradiation. One specimen represented a burnup of 0.031% and was cycled three times between 400 and 700 C. The holding time at each terminal temperature was two hours. The other specimen was irradiated to 0.075% burnup and was similarly annealed between 400 and 800 C. The 0.031% burnup specimen exhibited yield strength of 32,500 psi, an ultimate strength of 45,900 psi, and an elongation of 1.2%. The 0.075% burnup specimen displayed a yield strength of 31,500 psi, an ultimate strength of 43,700 psi, and an elongation of 1.0%. Practically no change in ductility compared to

as-irradiated uranium resulted from cyclic annealing; whereas single pulse annealing caused a slight improvement of ductility at 700 C and considerable improvement at 800 C. These results suggest that thermal cycling through phase transformations either enhances rare gas diffusion to grain boundaries or enlarges microcrack networks both of which weaken the material. The appearance of microcracks on the surface of the specimens after annealing supports the latter mechanism. The yield strength of both specimens is lower than the unirradiated yield strength which was 37,800 psi. Such a decrease in yield strength can be explained by the microcracks in the specimen cross section.

Radiation Effects in Structural Materials. A series of metals representing the common metal crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposure conditions. These metals include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Post-irradiation measurements of mechanical and physical properties of these metals were initiated at KAPL and will be completed at HAPO to advance the theory of neutron damage to metals.

Metallographic procedures were established for the unirradiated control specimens, and photomicrographs at 250 and 1000X were taken. Examination of zirconium microsections revealed a large hydride concentration. An analytic program to quantitatively determine the impurity content of both the unirradiated and irradiated materials was initiated. The determination of lattice parameters by x-ray diffraction was started for molybdenum, zirconium, and titanium. Measurements of reflection line widths for control molybdenum reveal a residual cold work after annealing of from 5 to 12 percent. All electrical resistivity measurements for specimens to be used in the isochronal annealing investigation were completed.

Mechanical and Physical Properties of Materials. The creep properties of Zircaloy-2 are considerably improved by small amounts of residual work. The extent to which increasing amounts of cold work improve creep properties and the effect of recovery occurring in the test temperature range is not known. These effects are being determined in order that Zircaloy-2 fabrications procedures can be specified for process tubing. A portion of the Zircaloy-2 stock supplied to Battelle Memorial Institute for the HAPO Assistance Program Creep Testing was further cold worked to 15, 25, and 45%, and flat specimens of the 25 and 45% material are now being tested in the vacuum creep units at stress levels of 21,000 and 18,000 psi and 400 C (752 F). In addition to the creep tests in the vacuum units, advantage is being taken of the availability of four atmosphere creep units to determine the effect of CO_2 contamination in the helium atmosphere on the creep properties of Zircaloy-2. Similar conditions will be used on the atmosphere machines to those in the vacuum units except for the carbon dioxide content of the atmosphere.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel materials is a direct way of detecting radiation damage in these materials. Thin films of UO_2 prepared by vacuum

evaporation of uranium metal have been irradiated and examined in the electron microscope. Comparison of the electron transmission microstructure and diffraction patterns of three films irradiated to 2.6×10^{18}, 1.3×10^{19}, and 2.6×10^{19} nvt with that of an unirradiated control as well as controls annealed for 72 hours at 100 C and 200 C shows: (1) annealing of the evaporated films causes lattice contraction with increasing annealing temperatures; (2) lattice parameters after a 200 C anneal for 72 hours are identical to those obtained from the 45 C irradiation to 2.6×10^{18} nvt; (3) the irradiation to 1.3×10^{19} nvt causes additional shrinkage; with further irradiation to 2.6×10^{19} nvt, the lattice expands to the value characteristic of the control specimen annealed for 72 hours at 100 C; (4) no change in transmission structure of the thin films after annealing is apparent; (5) during irradiation of the uniform thin films regions of high electron scattering or absorption form; the largest of these regions which are opaque to electrons in the respective films have sizes of 0.15 micron, 0.5 micron, and 0.75 micron diameters corresponding with the increasing exposures. Qualitative calculations on the expected number of fissions occurring in a UO_2 film with a thickness of 10 Å indicate that 400 fissions per square micron per 2.6×10^{18} nvt should occur. If each fission in the foil causes rearrangement of UO_2, then the opaque regions in the film may arise from such fission events, and their size will vary with the angular distribution of the fission spike through the foil (range of fission fragment approximately 10 microns). In order that the damage in thin foils can be studied more precisely, foils of evaporated U and also of aluminum are currently being irradiated to exposures in the range 1.4×10^{16} to 2.5×10^{19} nvt.

The microscopic study of the fracture surfaces on irradiated uranium broken at various temperatures is continuing. Uranium with a burnup of 0.018 a/o fractured by impact at -196 C has large fracture facets and extensive "river patterns" similar to non-irradiated control specimens. Small holes with diameters of 500 Å are revealed on the fracture surface. The impact fracture of uranium with a burnup of 0.018 a/o at -78 C also resembles the non-irradiated fracture with one notable exception: the degree and extent of twinning is markedly reduced.

X-Ray Diffraction Studies. To increase the accuracy in the outer portion of pole figures, a more detailed method of obtaining and plotting data for this region has been employed. This method involves the correlation of data from spiral scans of tangential, longitudinal, and transverse specimens of tubing and effectively eliminates the need of correcting for varying amounts of absorption and defocusing of the x-rays. As a result of this procedure, previously reported textures in Zircaloy-2 tubing must be somewhat modified. The basal planes (slip planes) in the extruded tubing are found to be oriented parallel to the tube axis and perpendicular to tube surface. In contrast, the basal planes in rolled sheet are oriented parallel to the rolling direction, but approximately 40 degrees to the rolling plane. The resulting difference in the resolved shear stress on the slip planes accounts for the observed 30 percent greater circumferential strength in Zircaloy-2 tubing than in rolled Zircaloy-2 sheet.

Solid State Reactions. Mechanisms of radiation damage are being investigated since an understanding of the role of imperfections produced by irradiation upon a set of material properties is essential to full utilization of any material in reactor. An analysis of x-ray diffraction data obtained from irradiated molybdenum indicates beyond a reasonable doubt that the interstitials produced by irradiation are mobile at the irradiation temperature. More important, there is evidence that these interstitial atoms are interacting with the defects which are present in the metal before irradiation as well as with the vacancies produced by irradiation. The interstitials combine with dislocations, impurity atoms and with each other, resulting in highly immobile regions of microstain. The result is an increase in yield strength and a loss of ductility in the metal as well as an increase in transition temperature. These changes in properties are often deleterious to a material from a practical standpoint. This result indicates that introduction of appropriate "sinks" in the material before irradiation could improve in-reactor performance of structural materials. This would be accomplished by the addition of selected alloying constituents or by introducing controlled amounts of residual work in the material.

Optimum conditions of heat treatment for zirconium, Zircaloy-2 and Zircaloy-3 are being studied as a function of cold work, temperature, time and heat treatment atmosphere. A zirconium hydride phase has been identified in zirconium heat treated in helium. A series of photomicrographs indicate that the concentration of the second phase, zirconium hydride, increases with increasing temperature where the time of heat treatment is held constant. At 300 C the hydrides stand out at small and sparsely distributed gold globules; as temperature is increased, a needle-like structure is formed; after treatment at 800 C the needles are very large, covering the diameter of one or two grains. Several conclusions regarding rate of recrystallization and grain growth in 50% cold worked zirconium heat treated in helium can be drawn from recent metallographic evidence. Recrystallization takes place by a process of nucleation and growth in contrast to the recrystallization in situ reported by other investigators for highly cold worked material. No evidence of recrystallization is noted at 400 C in the 50% cold worked material. At 500 C small grains begin to appear after 10 minutes. After 100 minutes they are numerous and after 1000 minutes recrystallization is complete. The resultant average grain diameter after completion of recrystallization is 0.016 mm. No grain growth is observed at 600 C, while above this temperature growth is observed to be sensitive to time and temperature. The relationships have been worked out so that a desired grain size may be obtained in practice by selecting a given heat treatment. These results apply only to 50% cold worked zirconium heat treated in helium. It is conceivable that another atmosphere could either retard or accelerate the recrystallization and growth processes. Results of heat treatment of 10 and 25% cold worked zirconium in helium for 100 minutes has been investigated and comparison with the micrographs of initially 50% cold worked materials indicates that higher temperatures are required for recrystallization as cold work level is decreased. Resultant grain

diameters are 0.040 and 0.022 mm after recrystallization of 10 and 25% cold worked zirconium. No grain growth was observed in the 10% cold worked material and only a small amount was found in the 25% cold worked material.

A knowledge of diffusion in various uranium/barrier metal/clad metal combinations is important in the design of fuel elements. Diffusion is presently being studied in the U/Ni/X-8001 system, and in AlSi bonded X-8001 clad uranium slugs. Two slugs have been autoclaved 56 days at 304 C and two are now being autoclaved 112 days at 304 C. These slugs are the last to be studied in the present series. Four U/Ni/Al couples, having a 0.0009" thick Ni barrier, were annealed 80 days at 450 C. The maximum penetration of uranium toward the outer X-8001 surface was 0.0045" in all of these couples. The time penetration relationship at 450 C in such couples, for times greater than 40 days, is $x^2+0.335\ (t-20)$, where x is the penetration of uranium toward the outer X-8001 surface in thousands of an inch, and t is the time in days. This expression is not valid for times less than 40 days, because of the transition from a binary to a ternary system. Several U/Ni/X-8001 diffusion couples having 0.0001, 0.0003, and 0.0006 inch thick diffusion barriers were also annealed 80 days at 450 C. The uranium completely penetrated the 0.012" thick X-8001 in all of these couples.

In-Reactor Measurements. A knowledge of the errors in temperature measurement using thermocouples in a neutron flux is essential for the quantitative evaluation of the effects of neutron irradiation of materials. Because such knowledge is lacking, a program of measuring thermocouple stability in-reactor is currently in progress. The 300 C thermocouple stability capsule charged in KW Reactor has received 1936 hours of exposure. The three thermocouples under test, iron-constantan, copper-constantan and chromal alumel, have shown no marked deviation from the ex-reactor calibration. Thermocouples of the same type in an ex-reactor "dummy" capsule have also been stable at 300 C. An order has been placed for a creep capsule complete with extension leads and necessary monitoring equipment with Technical Industries of Pasadena, California. The creep capsule will contain a Zircaloy-2 specimen. It will be capable of operating at an applied stress of 30,000 psi at a maximum temperature of 400 C, while in a water cooled test hole in the KW Reactor.

Metallic Fuel Development

Cluster Fuel Elements. Three 7-rod cluster fuel elements recharged into the ETR 3x3 loop facility are operating at 85 kw/ft. These elements were fabricated from natural uranium rods coextruded in Zircaloy-2 cladding and have reached an exposure of 650 MWD/T in 280 C water coolant.

An irradiation test of seven-rod cluster fuel elements charged into the KER Loop 1 facility to compare the behavior of differing clad thicknesses during irradiation is operating satisfactorily in 230 C water. Operation at temperature over the past month has been intermittent due to an unexplained rise in pressure differential across the loop. After a shutdown,

and subsequent startup of the reactor, pressure drop across the loop dropped sharply. This fluctuation rules out fuel distortion as the source of trouble. Goal exposure for this irradiation is 4500 MWD/T, of which 1500 MWD/T has been attained.

KER Loop 2 facility monitoring system detected what might be a fuel failure. The loop charge consisted of four 7-rod cluster fuel elements enriched to 1.6 percent U-235 and one three-foot, three-rod cluster with integral end closed rods enriched to 1.6 percent U-235. These elements were discharged March 25, 1959. Cursory examination of each element showed no visible sign of failure. Activity in the loop water increased with each rise in water temperature, but decreased during steady state operation at that temperature. This behavior is not consistent with metallic fuel corrosion. Detailed examination will be continued by Radiometallurgy Laboratory Operation.

Examination of four 7-rod cluster fuel elements made from 1.3 percent enriched uranium rods and clad in stainless steel has shown evidence of cracking. Metallographic examination of one rod shows that no grain structure exists at the estimated burnup of 0.4 a/o and that micro-cracking existed in the form of five parallel cracks across the uranium core. The cracking observed in coextruded Zircaloy-2 clad uranium rods was randomly oriented and quite different in appearance than that observed in the unbonded steel clad rods. Post-irradiation measurements show no increase in diameter of cladding but about a 0.002 inch increase in uranium diameter. An initial 0.050 inch gap between the end cap and uranium rod was also filled. Although there existed an intimate mechanical contact between the uranium and its cladding, no diffusion layer was seen at 1000X.

Three 7-rod cluster fuel elements have been prepared for charging into a KE Through-hole facility to gain exposure prior to purposely defecting a rod in the element at temperature in the ETR 3x3 loop facility. These fuel elements, fabricated with a defect in the clad which was subsequently covered with a welded cover, will be exposed to 1000 and 2000 MWD/T. Three additional fuel elements are being made to defect at zero exposure to obtain contamination data prior to failing the above pre-irradiated elements.

Closely packed cluster elements can increase the reactivity of the fuel loading in an NPR. Two 7-rod elements with interrod spacings varying from 0.025-0.060 inch were exposed to 1250 MWD/T in KER Loop 1. All rods were NMI coextruded Zircaloy-2 clad uranium with 0.630 inch o.d. Maximum coolant temperature was 270 C. One element has been examined. All rods increased in length from 0.004 to 0.027 inch. Only the rod with minimum clearance to both adjacent rods suffered measurable diametral increase. This closely spaced rod increased 0.008 inch or 1.2 percent in diameter. Presumably, the unique behavior of this rod was related to the higher metal temperature occurring in that rod.

Tubular Fuel Elements. A twenty-inch coextruded tube and tube fuel element was made for ETR 6x9 test. The weld closure of the outer rod showed uranium contamination in an autoclave test. The element is now recapped. The dimensions of this element are o.d. 1.820, i.d. 1.450 for the outer tube and 1.050 o.d., 0.500 i.d. for the inner tube. The core is two percent Zr-U alloy clad with 0.020" Zircaloy-2.

Flow measurements confirmed the coolant flow distribution calculated for fuel temperature determination. This measurement was required by the ETR Reactor Safeguard Committee. Eight tube-tube elements are now being fabricated for KER testing. Four will be alloy core, four natural unalloyed uranium.

Two tube and rod elements are now being irradiated in KER Loop 4. These elements are operating at 80 kw/ft in 240 C bulk outlet water. Calculated clad temperatures are 270 C. Current exposure level is 1200 MWD/T, and goal exposure for the test has been extended to 2500 MWD/T.

Fuel for Present Reactors. A series of "C" size AlSi bonded I & E fuel elements were canned under various conditions and submitted for bond strength evaluation. From these samples a complete series of specimens were selected whose bond strengths ranged in value from 0 to 10,000 psi in 250 psi increments. These samples are being polished and photographed so that a continuous record of photomicrographs will indicate the change of bond structures.

The quality of material for a special depleted uranium hot pressed fuel element study was found to be below standard so that difficulty was experienced in obtaining a clean nickel plate. X-ray analysis also indicated a highly oriented structure in the (200) direction. Examination of the microstructure revealed a conglomeration of beta grains near the center and alpha grains near the edge which confirmed the x-ray results. Additional samples were then given various heat treatments. After a single beta treatment the (200) plane became normalized and the growth index stabilized.

Component Fabrication. A series of coextrusion billets were prepared for extrusion at Nuclear Metals, Inc., during the first week in March. Seven billets were prepared including three machined uranium assemblies and four assemblies made by casting uranium directly into the Zircaloy-2 container. The machined cores were made from four-inch diameter dingot uranium that had been alpha extruded from a seven-inch diameter gamma extrusion. Two of the cast billets were single beta heat treated after casting, and two were extruded as cast. The billets were all 3.000 inch outer diameter with 0.063 inch copper jackets. Extrusions were made at 21:1 extrusion ratio with billet preheat of 1155 F. The resulting rods have been examined insofar as Zircaloy-2 surface and Zr-2-uranium interface are concerned, and limited examination has been made of the bond zone. All the machined dingot uranium cores produced an extremely irregular interface due to large domains not broken up by the 3:1 alpha extrusion. The as cast billets also produced a rough, irregular Zr-2-

uranium interface, probably due to the large as-cast uranium grain size. In addition, the outer Zircaloy-2 surface was rough with sharp longitudinal ridges. This effect is attributed to the Zircaloy-2 structure produced during casting the uranium into the billet cup. The Zircaloy-2 was heated into the beta phase to about 1200 C maximum and upon cooling had a large irregular grain size. The cast and beta heat treated billets produced a much smoother Zircaloy-2-uranium interface, but also had the rough outer Zircaloy-2 surface. The as-extruded bond zone of the cast and cast plus beta heat treated material is approximately the same as a normal coextrusion followed by beta heat treatment. The thicker diffusion zone is not entirely uniform at the sections examined to date.

Additional 7-rod cluster spiders were fabricated by the "Japex" process of spark gap machining. Spiders were cut from 0.100" and 0.200" thick plates of Zircaloy-2. A die design is now in progress to determine the feasibility of punching spiders from Zircaloy plate.

Closure and Joining. Satisfactory nosing of 0.630 inch diameter NPR rods with 0.030 inch thick Zircaloy-2 clad has been accomplished at temperatures of 600 C by extruding the uranium core out of the end of the rod while thickening the Zircaloy-2 cladding material and forcing it over the end of the rod. The thickened Zircaloy-2 surface is required for one form of welded end closure. A 0.593 inch diameter rod with a 0.020 inch thick Zircaloy-2 clad has been formed similarly, and the results are promising; however, full evaluation of the nosing on the thinner wall clad uranium has not been completed due to tooling difficulties. Additional work is necessary on the forming dies to insure uniform thickening of the Zircaloy-2 cladding around the end of the rod.

A simple high quality closure method is being developed for coextruded Zircaloy-2 clad fuel rods based on a press nosing operation followed by a projection weld and a final outside fusion weld. Results of tests of this process are as follows: (1) the rods can be heated and held in air at 620 C for twenty minutes without adversely affecting the corrosion behavior of the elements; (2) high quality projection welds can be made on the basis of satisfactory corrosion results consisting of exposing the elements for twenty-four hours at 400 C in a steam autoclave; (3) tensile testing of the projection weld was made, and the welds did not fail at a load of 9,100 pounds. Failure took place in the gripping jaws at this load. (4) Consistent high quality fusion welds can be made on these elements to effect a second closure. The results of mechanical, metallurgical, and environment testing indicate that this method will result in a high quality closure process for coextruded rod type fuel elements.

Two types of end closures on Zircaloy-2 clad uranium rod were tested by pressurizing the space between the uranium and the end cap. MIPB was used as the hydraulic fluid so that the tests could be made at 300 C without excessive corrosion of the uranium. Both the swaged and welded closure and the welded-only closure type broke when the longitudinal stress in the jacket was 30,000 psi.

Allied Fuel Studies. Knowledge of the swelling behavior of unalloyed clad uranium operating with a cladding surface temperature of 250-350 C and a maximum fuel temperature of 450-700 C is of importance to Hanford. To provide initial swelling data, five experimental assemblies with co-extruded natural uranium fuel rods clad with 0.030" Zr-2 are being or have been irradiated in the MTR and ETR. The chemical burnup analysis of GEH-3-31, the first of the above rods to be examined, is reported as 0.22 a/o which checks closely with the 0.24 a/o burnup calculated from the power. Discharge of GEH-3-32 from the MTR is planned for April 6 at an exposure of 3500 MWD/T. Exposure of the remaining three fuel rods has slowed considerably because of the erratic operation of the ETR. Eight additional experimental assemblies are being prepared for irradiation in the MTR or ETR to (1) compare the swelling behavior of 0.020 and 0.030 Zr-2 clad fuel rods under identical reactor conditions, (2) compare the swelling of clad ingot and dingot uranium, (3) investigate swelling behavior of 0.020 and 0.030" Zr-2 clad rods at a series of temperatures and exposures.

A mock-up of the capsule assembly for the in-reactor fuel element jacket burst test has been tested in a cooled test hole mock-up to verify heat transfer calculations. The calculations indicate that 1066 watts (700 watts estimated gamma heating and 366 watts electrical heating) will be required to maintain a specimen temperature of 345 C with a 0.065" helium annulus around the capsule assembly. The test showed that 944 watts of heat input to the capsule assembly would give a specimen temperature of 341 C with a 0.100" helium annulus surrounding the capsule assembly. The agreement between calculated and test data is excellent.

An attempt has been made to determine fuel corrosion rates of defected (0.025" diameter clad defects) coextruded rod within the temperature range 185-300 C. Fuel rods in the beta treated, water quenched condition were tested in an electrically heated water autoclave at 2000 psi. The autoclave heating rate to test temperature was so slow and inconsistent (3.5 to 6.0 hours) that the establishment of an accurate time scale was not possible. It appears, however, that at a temperature of 250 C and above a fuel corrosion rate of about one gram/minute may be expected for the given sample and test conditions. Corrosion rate determinations are now being made in an induction heated autoclave and the fuel corrosion will be correlated with hydrogen generation. A coextruded fuel rod has been exposed to flowing 300 C water while being electrically heated at a rate of 45 kw/ft for three hours without difficulty. Defected rods will be operated in this test facility to compare the failure behavior of power generating rods with the failure behavior of non-power generating rods in Elmo No. 4 loop.

A microscopic mechanism due to the anisotropic thermal expansion of uranium crystals may cause cracking in rapidly cooled irradiated uranium. An experimental investigation of the effect of cooling rate of irradiated uranium from the high α phase upon crack formation has been initiated. The rate of cooling will be controlled by varying uranium sample thickness. Transient thermal calculations have been made.

Component Fabrication. Before pressure drop data on cluster elements of various spider design can be interpreted intelligently, it is necessary to know the minimum pressure drop attainable. Three clusters utilizing the spider which appears to have the least flow restriction have been assembled and will be flow tested to establish a base for pressure drop evaluation of other spider designs. Two other spider concepts which offer advantages in fabrication and mechanical strength have been developed and will be tested on mock-up elements.

Metallurgical Development. Contract negotiations are under way with Magnethermic Corporation and Ohio Crankshaft Company (Tocco) to perform heat treating studies on coextruded material. The contract will consist of three steps. First, basic heat treating studies to determine proper heating rates, cooling rates, etc.; second, to develop a piece of equipment with appropriate scanning devices and hydraulic stretch straightener; and third, to prove the equipment will satisfactorily work and to supply us with the working unit.

A series of casting tests have been completed to evaluate various crucible preparations and mold conditions. Crucible coatings consisting of zirconia, flame sprayed zirconia, and magnesium zirconate with thoria have been used with molten uranium at 1500 C. Holding times of 10 and 30 minutes have been investigated. Spectrographic analysis indicated a slight increase of iron in the uranium cast from the flame sprayed crucible. Final evaluation awaits the return of carbon and nitrogen results.

Work has begun in determining the mechanism of forming a metallurgical bond between uranium and zirconium in casting. Portions of cast pieces are often bonded while other portions are unbonded. Impurities are thought to be the controlling factor in the bonding process. Various substances are placed on the inner surface of the Zircaloy container, heated to 1000 C, and the molten uranium is poured. The sample is then examined to determine the effect of the impurities. Results to date indicate that trace amounts of carbon aid the bonding process. The effect of ZrO_2, UO_2, U_3O_8, and N_2 additions have not been evaluated at this time.

A group of uranium fuel cores have been produced with closely controlled heat treatment to produce defined volumes of untransformed metal at specified locations within the core. The material is required for establishing limits of detection for the ultrasonic transformation tester and to provide standards for calibrating the test equipment. Both ingot and dingot metal was used to provide solid cores, "O" size I & E and "C" size I & E cores with untransformed regions approximately 1/8-inch deep at the interior or exterior surfaces in specified locations.

The results of studies conducted to date on the solution rate of A-2, C-64, and X-8001 jacket alloys in eutectic AlSi (12.5%) indicate that all three, especially X-8001, dissolve more rapidly in the molten bath than does 2S aluminum, and that the solution rate for the alloys increases more sharply with increasing temperature than that for 2S. This implies that temperature control of the canning bath may be more critical

when using the alloy cans if excessive wall penetration is to be avoided. Studies on the effect of different silicon concentrations are in progress.

Design Analyses and Computations. Reactor fuel elements encounter skewed heat distributions and eccentric placement in flow channels. These non-concentric thermal and hydraulic conditions cause mechanical warpage and further eccentricities. Bipolar coordinates are being used to express skewed temperature and heat generation distributions. A Green's function for temperature distribution from a skewed ring source and a method of determining the heat generation for temperature distributions which are dependent upon the radial bipolar coordinate have been found.

Facilities and Equipment. The neutron flux available in the ETR 6x9 loop may be higher than is desirable for some fuel tests. The use of a boron sleeve to control flux levels is being studied. A sample of 1.5 percent boron 304 steel was welded into tubing by M and C Nuclear. A sample from this tube was autoclaved in 350 C water for 120 hours to check the possibility of boron leachings. Aluminum alloy coupons sandwiched with the boron steel pieces were analyzed for boron pickup. The steel pieces had no significant weight change. The aluminum pieces had typical weight gain. The surface boron content of the aluminum increased only from 0.00125 percent to about 0.00140 percent. The latter concentration will have no significant poisoning effect if present in 6x9 loop plumbing.

The shroud tube failed on the ETR 3x3 in-reactor section because of a faulty circumferential weld. The tube was removed and the standby tube inserted. A third tube has been redesigned and is out on bid.

The revision to Project CA-681 to design the loops for the study of failures and to develop instrumentation for the ETR has been approved. Present estimates indicate that the work will be completed by October 1, 1959.

2. REACTOR PROGRAM

Coolant Systems Development

Rupture Testing. Two tests were completed during the month in the Heated Slug Rupture Prototype in 185-D Bldg. Both tests were made on a single coextruded uranium rod, 0.593" o.d., clad in Zr-2. The first test was run with an undefected rod at a water temperature of 300 C, a water flow velocity at about 20 to 30 feet per second, and a power generation rate in the rod of 37 kw/ft for the first two hours and 45 kw/ft for the final hour. This rod was then defected with three 0.025" pinholes and recharged. It was then retested in 300 C water for 30 minutes at a power generation of 30 kw/ft. The only damage to the rod was a slight 1/8" diameter raised area at two of the pinholes. There was essentially no difference in rupture rate between this rod and the unheated rupture tests in Elmo-4. The braze joint between the fuel rod and copper connector came apart after the test and will have to be repaired before rerunning. Another co-extruded rod with isothermal beta treatment will be tested shortly.

Tests in KER In-Reactor Facilities. The pressure drop across the in-reactor portion of KER Loop 1 increased sharply at the start of a reactor outage to a degree that caused reduction in loop flow. Because of this condition, the loop was operated about three weeks at reduced temperature, during which time the pressure drop fell slightly. At the next outage both the rear and the front diffuser rings were removed and examined. There was no evidence of plugging. On starting flow after the inspection of the front ring, the pressure drop and flow rate returned to normal. The temperature was returned to normal. However, at the next outage on startup and change from process to loop water, the pressure drop again increased and the flow rate fell off. It is concluded that there may be a flow blockage lodged somewhere in the charge, which was temporarily relieved by a small back-flow when the front end cap was removed. Because of the uncertainty of flow over the fuel elements, operation is now at reduced temperature, and premature discharge may be required. The loop contains seven 1.6%-enriched 7-rod clusters with 20-mil and 30-mil Zircaloy-2 jackets. These had been charged January 14, and were scheduled to be exposed to 4500 MWD/T or until about August 1959.

The cladding temperature on the X-8001 aluminum clad Doe thermocouple element charged from the front face of KER-2 increased 45 C after 220 hours of operation in 220 C water at pH 4.5. The temperature had leveled off at 288 C when the last good thermocouple failed, the other two thermocouples having failed previously. Instrumentation checks revealed all thermocouples to be open-circulated. From this it is assumed that vibration caused by flow around the unsupported thermocouple wires broke the 30-gage thermocouple wires. Future designs for leading thermocouples from the front face will be modified to protect the wires from excessive vibration.

A possible rupture in KER Loop 2 was detected March 16, when the delayed neutron monitor went up as the water temperature rose during reactor startup. The temperature was brought down to 100° without scramming the reactor. The activity was reduced to that of normal operation. An indication of bromine fission product was found in the water. The loop contains four enriched 7-rod clusters, one enriched 3-rod cluster, and two UO_2 7-rod clusters, all clad with Zircaloy-2. These had been irradiated since December 9, at 205 C outlet, pH 10 LiOH. The loop was discharged on March 26, and filled with dummies. This loop is scheduled for decontamination and tube replacement during the extended outage next month.

Non-Uniform Corrosion Studies. The caustic embrittlement test on A-212 carbon steel was terminated after 1000 hours, with no cracking observed. The sample had been exposed to pH 10.0 water at 290 C under conditions where concentration of the water occurred in a stressed area. LiOH was used for pH adjustment.

A test apparatus has been designed to observe the effects of local boiling with solids deposition in stressed areas of heat exchangers. Dual objectives from this test are the procurement of information on

caustic cracking at high temperatures, plus information on the feasibility of raw water cooling of stainless steel tubes under boiling conditions.

Zircaloy-2 fretting corrosion testing at 290 C, pH 10, has been under way for eight weeks. Although to date no attack has been produced by a Zr-2 coupon rubbing on a Zr-2 spring wire, the magnitude of the deflection is unknown, and it is possible that the conditions are not sufficiently severe to cause fretting corrosion. The condition whereby fretting corrosion is usually determined - movement under measured load - is difficult to set up in high temperature water. However, several methods are being tried which will investigate this type of corrosion as well as mechanical wear.

Decontamination Corrosion. The Elmo-6 loop was subjected to a "decontamination" using the Turco 4501 process. Welded and non-welded Zr-2 coupons were put in a Zircaloy-2 tube and were exposed with aluminum coupons. The intent was to duplicate the proposed KER-4 decontamination at the extended outage at KE in April, in which the in-reactor tube would be decontaminated. This tube contains aluminum coupons.

Following the rinsing, the Zr-2 coupons were weighed and found to have lost 39-66 mg/dm^2 (0.024-0.040 mil) during the decontamination. The loop was operated for 291 hours at 300 C, pH 4.5, with these coupons, plus control coupons which had been treated with the Turco 4501 process with no hydrogen evolution. Coupons with no treatment were also included. The Zircaloy-2 coupons, welded and non-welded, exposed to the decontamination solution in Elmo-6 with hydrogen evolution, all showed heavy white corrosion product and additional weight gains of 35-47 mg/dm^2. All the other Zr-2 coupons used for controls showed no white corrosion product and had weight gains of only 10-12 mg/dm^2. In addition, the Zircaloy-2 tube also had heavy white corrosion product after 291 hours. Examination of a Zr-2 coupon following the decontamination revealed no ZrH_2 metallographically, but the coupon did have a changed surface which could have been due to an extremely thin hydride layer.

The results of the test indicate that no hydrogen can be present during decontamination of Zircaloy-2 without risking the destruction of its corrosion resistance. A report, HW-59707, is being written covering the details of this test.

In order to investigate the results of repeated decontamination cycles on corrosion, two loops (CEP-1 and CEP-4) are being utilized to study 304 S/S, Zr-2, stellite 6 and 12, and A-212 carbon steel corrosion. Stress and crevice specimens as well as stainless steel and Zircaloy-2 welds also will be studied. The loops will be operated with weekly "decontaminations" and will investigate the resulting corrosion over a six to twelve-month period.

Decontamination. The stainless steel triangular dummies discharged from KER-2 and KER-4 Loops were decontaminated in the Metal Examination Facility dissolver at 105 C, employing the Turco 4501 decontamination process. The first test was unsuccessful since it was impossible to maintain the solution temperature above 122 C. The heating steam pressure was then raised from 50 to 90 psig. This permitted the solution temperature to reach 125.5 C. About 1/3 of these dummies were cleaned satisfactorily. These dummies will now be subjected to the APACE Process for further decontamination.

Effects of Decontaminants on Corrosion Rates. Tests to determine uniform corrosion rates of sensitized and non-sensitized 304 stainless steel following a Turco 4501 process decontamination have been completed. No effects of the Turco solutions on subsequent uniform corrosion rates were found. Coupons pre-treated in the Turco 4501 decontamination process were charged into two recirculating loops, one operating with pH 10 (LiOH), 290 C water, and the other operating with pH 4.5 (H_3PO_4), 300 C water. Uniform corrosion rates of the Turco treated coupons and emery polished control coupons were 0.048 mil/year in the pH 4.5 water and 0.0044 mil/year in the pH 10 water. The filmed coupons were stripped of their films in the decontamination solutions and recharged into the pH 10 loop to determine whether a second decontamination has any effects on subsequent corrosion behavior.

A test to determine corrosion rates of welded Zr-2 coupons pre-treated in the Turco-4501 and APACE decontamination processes in pH 4.5, 300 C water has begun. Coupons are welded by both the heliarc and electron beam methods.

Carbon steel coupons pre-treated in the Turco 4512 carbon steel decontamination solution (inhibited H_3PO_4) and non-treated control coupons were discharged after 239, 516, and 791 hours. Numerous pits approximately one mil in diameter by one mil deep were found on the phosphate treated coupons at the first discharge. However, these pits have not increased in size after the second and third discharges.

Corrosion of Aluminum Under Heat Transfer Conditions. One set of experiments has been completed in the heat transfer loop at San Jose. Corrosion measurements on the X-8001 unheated aluminum coupons exposed for 1000 hours at 260 C and pH 6.6 disclose rates of 1.1 mils/month. Tubes of X-8001 operated under a heat flux of 1.4×10^5 Btu/hr-ft^2 and average surface temperatures of 268 to 270 C exhibited corrosion rates of 1.8 mils/month. The hot, flowing water leaving these heated tubes at an average local water temperature of 260 C then flowed past the unheated coupons mentioned above. Additional experiments are being planned to determine the effects of water quality, surface condition, and other variables on the corrosion rate and film thickness. After the initial experiments with aluminum, similar experiments will be conducted with Zircaloy-2.

Surface Treatment of Aluminum. Applying a thin nickel plating to aluminum is considered as a possible method for increasing its corrosion resistance in neutral pH water. Type 2S aluminum clad fuel elements were plated with one-mil nickel plates applied, respectively, by electrolytic and chemical processes. After one week at 300 C at neutral pH, the electroplated elements began peeling on the ends apparently at the locations where the slugs had been supported in the plating bath. No evidence of peeling was observed on the chemically plated elements. The high temperature scale could be easily removed by wiping the chemically plated elements while it could not be removed from the electroplated elements. Because of the questionable integrity of the electroplated elements, they were not recharged for further testing.

NPR Component Testing. A Canadian NPD reactor rolled joint nozzle-tube seal considered for possible NPR use has been cycled 850 times from 300 to 525 F at 1530 psi with no detectable leakage. After satisfactory completion of about 1000 cycles, the maximum test temperature and pressure will be raised to 580 F and 1900 psi to determine whether the joint will perform satisfactorily at approximate NPR conditions.

Corrosion of Materials in Organic Coolants. A test run of 520 hours at 700 F and water concentrations from 45 to 65 ppm was completed in organic test loop ORA-1. The corrosion rates of the magnesium alloys (AZ-31 and 98.8% Mg) increased to about four mils/month while the Magnox increased to about three mils/month, compared with a previously reported one mil/month at a water concentration of 20 ppm. The X-8001 aluminum and the carbon steel coupons were essentially unchanged. Very little radial or thrust bearing wear on the Graphitor 14 bearings was evident on visual inspection of the Chempump after 2000 hours running time.

Structural Materials Development

Zircaloy Process Tubes. Negotiation to obtain development contracts for the fabrication of Zircaloy-2 process tubes for the retubing program and for the NPR were continued. Essential agreement was achieved with Harvey Aluminum, Mallory Sharon Metals, Superior Tube and Tube Reducing Corporation for the fabrication of 75 two-ribbed BDF-type process tubes. Competitive bids for the fabrication of 100 smooth bore BDF-type tubes have been evaluated, and it is expected that one or more will be placed with the low bidders.

Nonmetallic Materials Development

Thermal Annealing of Graphite Contraction. If radiation-induced high-temperature contraction of graphite results from a relief of stresses frozen in during fabrication, annealing should not cause an increase in length to the original value. The first annealing experiments on pitch coke samples which contracted at a higher rate than reactor grade graphites indicate that contraction does not anneal. This substantiates but does not prove the current theory of the contraction mechanism. Four pitch coke graphite samples which had contracted from 0.02 percent to

0.05 percent during 742 MD/AT reactor irradiation at 450 C were annealed to a maximum temperature of 2600 C in about 500 C intervals. The lengths of the samples remained constant through step anneals of six hours each at 1000 C, 1580 C, and 2220 C. After thermal treatment of 2600 C for 1.25 hours, all samples contracted approximately an additional 0.01 percent. This temperature exceeded the original graphitization temperature, however, and the contraction is assumed to be due to further graphitization. Only minor oxidation, 0.15 percent to 0.20 percent weight loss, occurred in the samples during all the heat treatments.

An unirradiated pitch coke sample, used as a standard, showed a small increase in length of 0.02 percent after heating at 1580 C. It then contracted 0.03 percent at 2220 C and an accumulated total of 0.10 percent after exceeding the original graphitization temperature at 2600 C. The standard sample shape differed from the irradiated sample, allowing greater oxidation (0.44 percent) during the heating. This greater oxidation may account for its slightly higher initial growth.

Compression Set in Graphite. Compression set in graphite samples of the type prepared for Hanford and ETR irradiations has been observed. In making coefficient of thermal expansion determinations, it was noted that samples were approximately 0.02 percent longer than the original length after heating to 425 C and then cooling to room temperature. On subsequent runs to the same temperature no further annealing was observed. Samples annealed to 2600 C in 500 C steps continued to elongate until at 2600 C the total elongation was 0.19 percent of the unannealed length.

This "compression set" is attributable to a method of sample preparation in which the rough stock is mounted between holders which apply a compressive force. The graphite is drawn through a set of cutters to form a cylinder. Samples prepared on a lathe with a minimum of compressive restraining force exhibited a maximum increase in length of only 0.003 percent when annealed to 425 C. Studies are now being made to determine the amount of force exerted during sample preparation and the relationship between permanent set and compressive force. Irradiation tests are also planned to determine whether the initial expansion before contraction observed, for high temperature irradiations, is the result of annealing a compression set. To insure that future high temperature irradiation samples will not contain any compression set, samples will be pre-annealed to at least 50 C above the expected irradiation temperature.

High Temperature Graphite Irradiations. Four graphite samples, two of Continental coke and two of CSF, in the high temperature irradiation GEH-9-8 are operating at 750, 750, 1000, and 975 C. Lack of sufficient gamma heat at sample number three prevented attainment of the planned 1050 C.

Installation of the first test capsule in the ETR high temperature graphite experiment GEH-13-1 has been delayed due to irregular operation of the reactor the past few weeks. Everything is in readiness for charging the capsule into the N-14 position. The second capsule, intended

for the E-5 position, will be completed during the next few weeks. These capsules contain CO and CSF graphites.

Work is progressing on the L-48 modified MTR shim rod containing a high temperature graphite experiment, GEH-19. The target date for completion is early April. Development and testing of a number of the shim rod components have been completed. Control instruments for GEH-19 have not yet been shipped to Hanford due to a strike at the vendor's plant. The possibility of procuring the instruments on a government priority is being explored. In the event of an extended delay, consideration will be given to starting the experiment on manual temperature control.

Intermediate Temperature Graphite Irradiation. Controlled temperature irradiations at 80 C were started in the 2B test hole at KW Reactor. Samples of CSF and Continental coke graphites were charged with cobalt, cadmium-cobalt, and nickel flux monitors. The samples will be discharged after about 1000 MWD/AT.

Reactor loading of IP-22A, the 200 C and 300 C controlled temperature irradiation experiment, will be made in about one month.

Neutron Flux Measurements in Water-Cooled Test Holes. Results of foil activations during irradiations in the Snout II facility in KW Reactor indicate that conversion factors used to obtain neutron flux from exposures in MWD/AT require significant modification for irradiations in cooled test holes. Data from the activation of nickel foils for the fast flux and aluminum-cobalt alloy for the thermal and epithermal flux are presented in the following table:

Total Exposure MWD/AT	Fast Flux >1 mev nvt per (MWD/AT)	Thermal and Epithermal nvt per (MWD/AT)	Total nvt per (MWD/AT)	Cobalt-Cadmium Ratio
5	3.0×10^{16}	1.5×10^{17}	1.8×10^{17}	20
10.5	2.8×10^{16}	1.8×10^{17}	2.1×10^{17}	19
27.7	2.7×10^{16}	1.7×10^{17}	2.0×10^{17}	21

These results may be compared with the conversion factor 6.5×10^{17} nvt (total) per MWD/AT which is currently used for cooled test hole irradiations. Since the foils in the Snout II facility were surrounded by a 1-1/2 inch layer of water, it is believed that the greater moderating power of water compared with carbon is partly responsible for the disparity between the fluxes obtained here and the conversion factor used for the cooled test holes. As a result of these measurements, however, the conversion factor now used for irradiations in cooled test holes will be re-examined and, if necessary, appropriately modified.

Radiation Copolymerization. Silicone elastomers are noted for their resistance to heat aging but are generally limited to service where radiation doses are less than 1×10^8 r. In an attempt to produce a

more radiation-resistant, high-temperature elastomer, attempts are being made to copolymerize silicones and styrene by means of radiation. Two copolymers have been cured by a radiation dose of 2.2×10^7 r, one from a dimethyl silicone fluid and styrene monomer and the other from a methyl vinyl silicone gum and styrene monomer. The resulting rubber materials from these two systems are being checked for resistance to radiation and heat aging. The first tests indicate that both materials are superior in radiation resistance to their silicone counterparts and possess good heat aging resistance.

Thermal Hydraulics Studies

Reactor Flow Hazard Studies. Laboratory heat transfer experiments were performed to determine the validity of the present outlet water temperature limits at K Reactor for conditions of low front header pressures. Twenty-four transient runs were made at a front header pressure of 240 psig where a flow reduction was induced by a simulated plugging upstream of the Panellit pressure tap.

A partial analysis of the experimental data shows that critical flow takes place in the discharge fittings and a high degree of pressurization takes place. Nearly all the runs terminated with a Panellit pressure nearly equal to the front header pressure. Under these conditions plugging incidents upstream of the Panellit tap which did not result in the Panellit pressure dropping below the low Panellit trip pressure would go through a high Panellit trip in time to prevent excessive slug temperatures.

These results are not different from those found for the case of normal front header pressures of about 350 psig except in two respects. With the lower front header pressure the progress of the transient to boiling burnout conditions was faster. Once boiling burnout conditions were reached, the rod surface temperature rose at a much faster rate, as much as 150 C per second. The experimental program encompassed conditions as extreme as a plug to about two gpm to a tube operating at 1250 kw and an outlet water temperature of 125 C.

Fifteen runs were made to determine the adequacy of the protection the Panellit system offers to flow reductions caused by plugging incidents to a tube operating with a missing rear pigtail. This information is desirable because the immediate consequences of the rupture and loss of a rear pigtail are not drastic, and it might be desirable to continue operation of the reactor until a shutdown would be convenient. Continued operation of the reactor requires that the Panellit system continue to offer protection against plugging incidents.

A partial analysis of the experimental data shows that the behavior of a tube without a rear pigtail is not significantly different from the normal case, and the Panellit protection procedures would still apply.

Experiments were also performed to determine the possibility of damage to a reactor if a front hydraulic connector should fail. Such an incident would result in a scram within two or three seconds. However, the heat generation does not immediately drop to zero but rather decays in a manner dictated by the poison strength of the VSR's and by fission product decay heat generation. While this post-scram heating is small, the only coolant available to a tube without a front connector is hot water pushed backward through the tube from the rear header. At the low rear header pressures this flow is small and may be inadequate to prevent melting of slug jackets.

Eleven experimental runs were made, directed toward determining the rear header pressure necessary to cause sufficient flow to prevent excessive slug temperatures. An arbitrary upper limit of rod surface temperature of 450 C was set to prevent damage to the experimental test section, and the runs were terminated if the rod surface temperatures exceeded this value. The experimental data indicated that a rear header pressure of about 35 psig was necessary to prevent the rod surface temperatures from exceeding the 450 C limit if the tube were initially operating at 1000 kw. For an initial tube power of 750 kw, a rear header pressure of about 25 psig was necessary. These conclusions are tentative and the pressures required are possibly higher than would be required for a reactor. These pressures are thought to be high for the following reasons:

1. The test section heater rods were made to generate all of the heat going into the tube. In a reactor up to 20 percent of the heat would be generated in the graphite. In the experimental case, therefore, the experimental heat flux was up to 25 percent too high and, consequently, the rod to coolant temperature difference would be 25 percent too high. Furthermore, with the high slug temperatures reached, in a reactor a large share of the 20 percent of the heat generated in the graphite would be dissipated into other tubes which are at a lower temperature than the affected one.

2. Coolant flows in the order of one to two gpm were established. This should be sufficient to effect adequate cooling. There is some evidence, however, that this small flow did not fill the tube, but instead ran along the bottom of the tube between the ribs. This left at least part of the rod above the coolant flow and the top of the rod would get hot. Furthermore, there is evidence that, in spite of the fact that three equally spaced hold down pins were used, the rod bowed upwards between the pins thus aggravating the stratification effects.

3. The arbitrary upper limit of 450 C rod surface temperature is about 200 C below the melting point of aluminum.

The experimental series was terminated by the destruction of the electrical insulating varnish used on the inside of the process tube due to high temperatures, in spite of the 450 C rod surface temperature limit. This resulted in an electrical short and the melting of a hole in the process tube.

Hydraulic Studies. Service work in the Hydraulics Laboratory included the following: calibration of three flow venturis for D Reactor, flow tests to determine the relative channel flow ratios for a tube and tube fuel assembly planned for MTR irradiation, and preliminary runs to determine critical flow and temperature monitoring effectiveness of a slip joint Y fitting and pigtail assembly for the BDF-type reactors.

Project CG-661. The project to install additional heat generating capacity in the 189-D Heat Transfer Laboratory by the use of large silicon rectifier units was approximately 55 percent complete. All heavy equipment including rectifiers, transformers, saturable reactor, and switch gear have been moved into the 185-D Building. Electrical intertie work between the various pieces of equipment was started.

Critical and Two-Phase Flow Studies. Additional experimental data were obtained for the flow of two-phase mixtures of steam-water under conditions of critical flow. Data obtained for low quality mixtures through a 0.622 inch diameter pipe was extrapolated to predict critical flow values for saturated water. The results indicated actual flow rates about sixteen times greater than would be predicted from theoretical considerations.

NPR Heat Transfer Experiments. Experiments were run to determine heat transfer characteristics of seven-rod cluster fuel elements without special provisions for mixing of the coolant between the individual rods. The electrically heated test section consisted of seven 0.625 inch o.d. rods with a 0.045 inch spacing in a 2.067 inch i.d., by 45-inch long process tube. Results of experiments at 100 and 150 kw/ft indicated excessive temperatures along the center rod. It was concluded that seven-rod cluster fuel elements with such close spacing are not feasible without special provisions for flow mixing.

Design was finished on a test section more prototypical of the actual NPR fuel elements. This test section consisted of 0.704 inch o.d. rods in a 2.700 inch process tube. This 45-inch long test section will be run with and without special provisions for flow mixing.

A design of a 20-foot long electrically heated seven-rod cluster fuel element was completed. This section which is to be run at NPR pressures and temperatures will have a heat generation approximating the downstream part of a fuel charge.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 Facility operated for 216 hours during the month at temperatures between 300 and 350 C, using the terphenyl-MIPB eutectic mixture as a coolant. Inspection of the facility's chempump revealed no damage to the bearings after approximately 4000 hours of organic coolant operation. Three mechanical seals were installed on the facility with Hycar rubber gaskets as a shaft seal instead of the previously used teflon gaskets.

Reactor Technology Development

Attenuation Measurements. The second set of foils from the ferrophosphorus concrete baked at 320 C have been irradiated and are being counted. The ionization chambers were moved to various positions to obtain a complete gamma traverse through this material. The data from the first test on ferrophosphorus concrete baked at 320 C are being analyzed.

The foils from the final test on ordinary concrete baked at 300 C are being counted. This will complete the program for testing the neutron attenuation properties of ordinary concrete.

A second test on pure iron is being run, and the data from the first test are being analyzed. A perforated shield experiment was designed for the test wells atop the DR Reactor. The test slabs are being fabricated at the present time.

A preliminary calibration of the E-hole at F Reactor was made in terms of absolute flux.

Cleanup and installation of the experimental assembly for the boron steel thermal shield test is being attempted at month end during an extended C Reactor shutdown.

Shielding Instruments. Leaks in the neutron spectrometer chamber have been sealed, and an effort is being made to evacuate the chamber to a pressure of 10^{-5} cm before the introduction of the methane. As soon as these efforts are successful, the chamber, 100-channel analyzer, and all associated electronic equipment will be moved to the positive ion accelerator for calibration. A revised version of the setup and calibration procedures for the 100-channel analyzer is complete, and the instrument is now being utilized by Lattice Physics personnel for spectrum analysis in the exponential pile.

The ion chambers for shielding studies completed additional testing at high gamma dose rates and high neutron fluxes. Performance was satisfactory, and this testing program is complete.

B. WEAPONS - 3000 PROGRAM

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

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. It has been reported previously that mixed crystals of PuO_2 and UO_2 have a higher sintering rate than UO_2 alone. However, results to the contrary were obtained on addition of 1/4, 1/2, 1, 2, 5, and 10 w/o PuO_2 to PWR grade UO_2. Pellets of the above concentrations were heated for one hour in hydrogen at 100 C intervals from 1000 to 1600 C. The data indicate that sintered density is definitely a function of composition, and marked density decreases were observed with as little as 0.25% PuO_2 additions. Plots of density versus composition were parabolic up to one percent PuO_2 and nearly linear from one to 10 percent PuO_2 with slope increasing slightly with temperature. It was found that densification occurs very rapidly in the interval 1200-1300 C. Pellets of UO_2 held for one hour at the above temperatures resulted in densities of 67.5 and 81.5 percent of theoretical, respectively, with a density of 92.3 percent when sintered at 1600 C for one hour.

In an effort to prepare plutonium carbide, PuO_2, and graphite in the correct stoichiometric proportions were heated to 1100 C in vacuo. A diffraction pattern showed evidence of partial reduction of PuO_2 and the formation of several other phases. The pattern indicated the presence of PuO_2, Pu_2C_3, HCP Pu_2O_3, and PuO or PuC. The cell constants of the latter two are so close that it is difficult to determine which phase is responsible for the reflection. There was no evidence of BCC Pu_2O_3.

Physical mixtures of UO_2 - 70, 80, and 90 w/o PuO_2 were fired at 1600 C for eight hours to provide the final data on solubility in the system UO_2-PuO_2. Over the entire range of compositions, x-ray diffraction yielded lattice parameters which prove the formation of a single phase during high temperature sintering. A slight negative deviation from the ideal curve may exist at higher PuO_2 concentrations.

Fabrication Studies. Compacts of Al_2O_3, MgO, and ZrO_2 have been sintered to densities ranging from 80 to 90 percent of theoretical. Matrices of these types impregnated in the PuO_2 will be irradiated when physics calculations become available.

An additional sixty Al-Pu billets 2-1/2" diameter and 9-1/2" long and weighing approximately 2000 gs were cast during the month. These billets contained various concentrations of plutonium as required for: PRTR spike elements, critical mass elements, and PCTR elements for Physics Research and a variety of alloys for corrosion tests. Melt and billet analyses have been held within five percent of the nominal desired composition.

Billets of the following compositions were cast in order to obtain fabrication and corrosion data on Al-Pu alloys of modified matrix composition.

Aluminum Base Alloy Number	Nominal Composition	
	% Pu	Other Alloy Additions
1. AlSi	2	11 w/o Si
2. 1245	2	5 w/o Si
3. 1245	2	1 w/o Si
4. 1245	2	3 w/o Zr
5. 8001	2	0.1 w/o Ti, 1.4 w/o Ni
6. 8001	2	0.1 w/o Ti
7. 8001	2	
8. 8001	2	2 w/o Ni
9. 8001	2	1 w/o Si

The extrusion of nominal 1/2 inch diameter Al-Pu rods is continuing. Twenty-seven 5 w/o Pu, four 1.3 w/o Pu, and twelve 0.5 w/o Pu extrusions were produced. Extrusion conditions for all compositions were: 500 C billet and container temperature, 350 C die temperature, and extrusion speed of 20 inches per minute. Extrusion forces ranged from 220 tons for the five w/o Pu alloy to 140 tons for the 0.5 w/o Pu alloy.

The rod-straightener hood has been sealed for operation with plutonium, and Pu-Al extrusions have been satisfactorily straightened.

Five nominal 1.0 inch diameter coextrusions containing six w/o U in Al and clad in 2S aluminum with integral end caps were made at a 6.7 to 1 reduction in area. The ideal billet end configuration appears to be a 30° taper blended into a 0.890 inch radius.

Destructive tests show that good bonding exists between the core and cladding after extrusion. Decontamination of cladding surfaces has been accomplished by caustic etching.

Twelve full PRTR length aluminum rods clad with Zircaloy tubing have been tested to investigate assembly, wrapping, autoclaving, and warpage problems. The tubing on some were sized onto the cores by swaging or drawing. On others, the rods were inserted into as-received tubes and some were fabricated by inserting rods into tubes which had been presized on the rod straightener. The conclusions of this first experiment were as follows:

1. It is not practical to insert fuel rods into as-received or presized tubing and maintain the required maximum diametral clearance of 0.0035-0.004 inch.

2. The most practical method of assembly is to insert undersized rods into a tube and control the diametral gap by sizing the tube onto the rod.

3. Swaging is the most satisfactory method of sizing. Due to the non-uniform wall thickness of the tubing, drawing causes the elements to bow.

4. There is no apparent correlation between the amount of, or the manner in which the end clearance between the rod and end cap is distributed and the behavior of the elements in the autoclave.

5. Satisfactory quality welded end closures on eight-foot elements can be made using the head weld design.

6. Elements can be satisfactorily etched, cleaned, wire wrapped, and autoclaved in that order.

7. The spot fusion weld for attaching the wires does not need to be cleaned prior to autoclaving.

8. Some of the elements warped due to autoclaving; however, there was no apparent correlation between warpage and fabrication method. It is suspected that warpage is caused by an interaction between the aluminum rod and the Zircaloy tube. More work is scheduled to evaluate this problem.

Another group of ten elements were fabricated and tested. These were fabricated by inserting undersized aluminum rods into Zircaloy tubes, welding end caps in place and sizing the tube onto the rods by swaging. No end clearance was allowed between the rods and caps before swaging because the tubes were expected to lengthen more than the rods, thus leaving the desired end clearance after swaging. Too great a reduction was made during swaging, however, and the rods were worked to such an extent that there was no end clearance and very little diametral clearance. Again, it was demonstrated that the elements could be successfully wrapped after etching and before autoclaving. Two of the elements failed during the autoclave test and their failure was attributed to the fact that there was no end clearance. Bonding was observed between the end of the aluminum rod and the end cap after exposure to 400 C for 72 hours. Four of the remaining elements were straight and had tight wires after autoclaving whereas the other four were warped and had loose wires. It is felt that the results of this test are inconclusive because there was no room allowed for the greater volume increase of the aluminum rods during heating in the autoclave.

An additional group of ten elements is now being processed in which end clearance was allowed before swaging and in which smaller reductions will be made during swaging in an effort to control the diametral gap while not working the aluminum core.

A group of 108 Zircaloy-2 tubes for Mark I clusters for the first PRTR charge was examined by Radiographic Testing Operation with the following conclusions:

1. No tubes were rejected for Eddy Current Test indications.

2. The dye penetrant test detected surface imperfections, tears, laps, pits on 22 tubes.

3. Wall thickness measurements rejected 12 tubes for being below the specified minimum.

4. One definite conclusion was reached that the tubing i.d.

The first lot of Zircaloy tubing for fabricating PRTR fuel elements has far better physical properties than any previously received material from Wolverine. Large reductions in cross section can be obtained by swaging even empty tubing under conditions which frequently caused cracking of a previous lot of Wolverine tubes.

A new method of producing end closures is being investigated. It is a resistance welding process using a "Magnetic Head" welding machine developed by Precision Welder and Flexopress Company in Cincinnati, Ohio. The machine provides excellent control of the three variables, time, current, and joint resistance during the welding cycle. Complete large area welds can be performed in a fraction of a second. This extremely short time minimizes the absorption of gas impurities in Zircaloy.

A contract request has been initiated for the research division of Sciaky Bros., Inc., to perform resistance welding investigation on three separate applications. These applications pertain to:

1. Hanger fittings for 19-rod cluster elements,
2. Seam welding end closure on the Mark II C tubular fuel elements, and
3. Attaching ribs to tubing to provide the proper tube spacing on tubular fuel elements.

The twenty-rod fixture has been installed in the vacuum welding box. This fixture holds twenty fuel rods and allows each rod to be indexed into the welding position. The welding box is also equipped with two welding torches. Current for each torch is supplied by a separate machine. One torch is used to make circumferential weld, and the second torch is used to seal up the out-gas hole.

The first 19-rod cluster fuel element for PRTR irradiation was assembled this month, and enough additional rods have been processed for assembly of two more fuel elements. Other rods are being processed through the various steps of swaging, welding, testing, and autoclaving. Very few rods were swaged during the month because of mechanical problems in powder preparation. The density of the sintered powder was low, and this led to a low swaged density. Improvements have been made to powder preparation equipment so the sintered powder is acceptable.

In order to establish standards for rejection at the Zyglo inspection and eddy current test and to obtain more information about causes of rejects, several rods have been sectioned. The depth and character of the defects are being investigated by metallographic means. An optical comparator is being studied to see if it can be used for surface investigation as well as an inspection tool for non-destruction testing.

Vibratory compaction of high density UO_2 grains into metal tubes is being studied as an alternate method of fabrication of fuel elements. Fused uranium dioxide powder has been packed to 82% of the theoretical density, employing the following particle size composition:

60% minus 6 plus 10 mesh
15% minus 35 plus 65 mesh
25% minus 200 mesh.

A one-foot long, 4-rod cluster fuel element containing vibratory compacted UO_2 of the above particle size distribution has been fabricated for irradiation in the MTR, as test number GEH-4-38. A three-foot long, 7-rod cluster is being fabricated for irradiation in the ETR.

Powder packed to a high density may also provide an improved starting material for fabrication of swaged or isostatically pressed elements. After vibratory compaction, Zircaloy-2 tubes (0.750" o.d.) containing powder of the above composition were swage compacted to 90% of the theoretical density with a 32% reduction in cross sectional area.

Development of the technique to produce back extrusions of Zircaloy-2 end closures for UO_2 PRTR fuel elements has been completed. All dimensional requirements have been met, and this can be done consistently in a simple and economical procedure. It has also been shown that these flat bottomed cups (end closures) can be back extruded from ingot stock just as well as from the much more expensive rod stock.

Producing a 10° taper and a 2-1/16 inch diameter cylindrical section on the end of a PRTR process tube can now be successfully done by warm swaging. A collapsible mild steel mandrel is used, as before, but the swaging temperature has been increased from 440 F to 600 F. At this temperature a reasonable degree of wall thickening occurs during the swaging operation and internal tube wall wrinkling is kept to an acceptable minimum.

Fuel Evaluation. Post-irradiation examination of a swaged UO_2 capsule which received an exposure of approximately 3000 MWD/T revealed a 5/32" diameter, central void in the 0.75" diameter fuel capsule. Large columnar grains extended from the core to approximately 0.16 inch from the cladding.

Post-irradiation examination of a 1" o.d., 12" long, UO_2 powder fuel element ("ashcan"), which was irradiated at a maximum heat flux greater than 1,000,000 BTU/hr/ft/°F, has revealed a partial collapse of the cladding to form an elliptical tube, and a hole through the cladding wall, midway between the ends. The hole developed at the intersection of the surface with the long axis of the cladding ellipse. Heat marks were formed on this area of the Zr-2 surface. This strongly indicates a "pinching off" of coolant flow, followed by steam blanketing and a high temperature, solid state reaction between UO_2 and Zircaloy. A central core, ~1/4" in diameter, developed through approximately 3/4 of the length of the UO_2 fuel. Radial, columnar grains extend from core to cladding.

Irradiation of a series of six capsules of swaged UO_2 continued in the MTR and ETR. The maximum exposure is approximately 6000 MWD/T.

Two, 18" long, 7-rod clusters of UO_2 swaged in 0.030" wall Zircaloy-2 tubes, with unbonded spirally wrapped spacer wires, were discharged from a high temperature KER loop after an exposure of three and one-half months. Preliminary visual examination in the reactor basin revealed no indication of fretting or other types of corrosion on the external cladding surface. Detailed examination will be performed in the Radiometallurgy facility.

Basic Studies. The purpose of a joint HLO-BMI study is to measure the irradiation induced deterioration, if any, of the thermal conductivity of UO_2. A second lot of six irradiated (125 MWD/T) UO_2 thermal conductivity specimens were shipped to BMI for conductivity measurements scheduled to begin during the week of April 6-10, 1959.

A simplified method is being developed for measuring high temperature thermal conductivity of ceramics by optical pyrometric methods. Preliminary studies on graphite and UO_2 produced values falling within 20% of reported and extrapolated values. Further refinements are planned. The method promises to be useful in application to irradiated specimens.

The mechanism of irradiation damage in sintered UO_2 is being studied by microscopy studies of fractured surfaces and precharacterized surfaces of irradiated UO_2. Specimens irradiated to exposures ranging from 40 to 125 MWD/T have been discharged, and post-irradiation examination has begun.

Short sections of swaged or sintered UO_2 rods clad in various sheath materials are being heated by a centrally located tungsten filament to partially simulate in-reactor phenomena. The extent of crystal growth and other physical changes is being viewed microscopically and recorded photographically for later study. Radial, columnar grain growth often observed in irradiated UO_2 has been reproduced ex-reactor.

Etching and Autoclaving Zircaloy Components

Heat of Reaction of Zircaloy-2 in HNO_3-HF Etch Solution. The heat evolved during the etching of Zircaloy-2 has been measured as 2630 cal/g of Zircaloy-2 dissolved, based on temperature-rise measurements in a calibrated Dewar flask. Converted to English units, the value is 1.1 Btu/(sq in.)(mil etched). Although the absolute accuracy of the measurement may not be better than ± 20 percent, it should be adequate for engineering purposes in designing and operating Zircaloy etching equipment.

Precipitate in HNO_3-HF Etch Bath. A white crystalline material which has twice been observed in the bottom of a horizontal bank after about two weeks use for etching Zircaloy parts appears, by laboratory analysis, to be impure $H_2ZrOF_4 \cdot 2H_2O$. Since this compound is obviously insoluble in the etch solution, it may be related to the "acid staining" produced on Zircaloy-2 on which etch solution has dried.

PRTR Tubes - Depth of Etch Necessary. A sample from each end of a PRTR Zircaloy process tube was cut into 1/2" thick sections. These sections were pickled to depths of 0, 0.5, 1.0, 1.5, 2.0, 3.0 mils off of the tube wall thickness. The results showed it was necessary to etch at least 1.5 mils in order to achieve a black oxide film on both the inside and outside of the tube.

PRTR Process Tubes Autoclaving. Assistance has been given during the month to Facilities Engineering in establishing the scope and initiating the design of a 20-foot long autoclave. Optimum size was established to be 16" diameter, which allows six PRTR process tubes to be autoclaved at once. Operating conditions are specified as 400 C, 100 psi superheated steam for 72 hours. The present schedule requires that the autoclave be ready to operate May 18, 1959, in order that approximately 85 acceptable autoclaved tubes can be delivered to the construction contractor by August 15, 1959.

PRTR Component Testing

A test section incorporating all of the final seal designs for the PRTR process tubes was thermally cycled 850 times between 300 and 525 F at 1530 psi in test loop Elmo-7. Leakage was noted on the Flexitallic gasketed nozzle-to-tube connection after about 300 cycles. The gasket was replaced after 370 cycles and has remained leak free. No leakage was noted on any of the other connections.

A pressure drop of 9.9 psi at 123 gpm was measured at room temperature for the Plutonium Metallurgy Mark I-C 19-rod cluster fuel element. This element has been placed in the Elmo-7 test loop to continue determination of stability and integrity after thermal cycling.

Structural Materials Development

Fabrication of Zircaloy-2 PRTR Process Tubes. The first twenty Zircaloy-2 PRTR process tubes have been inspected and accepted at the Tube Reducing Corporation and will be shipped to Hanford during April. The over-all progress made by the Tube Reducing Corporation, and subcontractors, on the 100 PRTR Zircaloy-2 process tube order is good. All extrusions expected to be processed have been given the first tube reduction. Subsequent vacuum annealing of tubes is nearly complete and is expected to be finished by the first of April. The tapering of 40 of the last 82 tubes has started. Weld porosity has necessitated the reflanging of three of the first seven completed tubes. Work is being conducted to determine the seriousness of these defects, and experiments are being conducted to develop a welding technique which will avoid this.

Hunter Douglas Aluminum Company has completed the first cold extrusions under their contract to produce five Zircaloy-2 PRTR process tubes. The test extrusions which were approximately three and five feet long, exhibited poor surface quality. Die pickup had galled the inside diameter surface, and there were distinct areas of rough surfaces on both the

inside and outside of the tube. The container out of which the Zircaloy was extruded was found to vary in cross sectional area and probably contributed to causing the surface defects. More test extrusions for improving surface quality will be made before attempting to extrude the full length PRTR tube.

Fabrication of Aluminum Alloy PRTR Process Tubes. Alcoa is under a DDR contract to fabricate 10 PRTR process tubes of C-94 aluminum alloy of T-6 temper. Tubes with a nine-inch long taper have been successfully fabricated, and the threaded ring flanges are now being attached. Delivery of tubes is expected during April.

PRTR Jacket Tubes. The principal problem remaining to be solved in the production of ribbed fuel jacket tubing for the PRTR is that of sizing and forming the tube to its final specified configuration. Thus far the welding on of ribs or the extrusion of a ribbed tube has left the piece out of round or bowed or otherwise slightly distorted. Efforts to correct this condition have not as yet been entirely successful.

A relatively new method, explosive forming, is proposed as a possible means of correction. In this method the tube would be placed in a mold of the proper configuration, submerged in water, and a carefully designed explosive charge detonated within it to expand it against the mold wall. This process has been successful with conventional alloys in forming parts to very close tolerances. On the basis of scouting tests performed by Aerojet General Corporation during the month it is tentatively concluded that the explosive forming characteristics of Zircaloy may be favorable for performing corrective sizing operations on PRTR jacket tubing by this process.

Radiometallurgy Laboratory Studies

Examination was begun on a four-rod Zr-2 clad, Al-Pu alloy fuel element cluster which was irradiated (IP-186-A) to approximately 2000 MWD/T. A fractographic sample was finally obtained, at dry ice temperatures, from a wafer of Al-Si-Pu alloy which had been irradiated to approximately 50 a/o burnup, but another similar wafer of Al-Pu alloy has resisted all efforts to obtain a fractographic sample. The examinations of a swaged UO_2, three-rod cluster (GEH-4-33) and the three-rod cluster PuO_2-UO_2 powder fuel element (4-28) were completed, and samples were submitted to the Analytical Laboratories for burnup analyses. Metallographic studies, replication films, fission gas collection and samples for burnup analyses were obtained on a swaged UO_2 capsule (GEH-3-50), a 12" UO_2 powder fuel element (GEH-4-34), and one of eight samples of UO_2 capsules (IP-149-D) which are 1/8" in diameter and three inches long. The results and conclusions from this work will be reported in connection with the respective development program.

Thermal Hydraulics Studies

Heat Transfer Characteristics of the PRTR fuel Element. Additional data were obtained from heat transfer experiments on a full scale electrically heated mockup of the Mark II element. Results from experiments at heat generation rates corresponding to tube powers of 500 and 700 kw indicated satisfactory performance of the element even when the flow was reduced to bulk boiling conditions. No serious variation in the flow split between flow channels was experienced.

At the start of a run planned for heat generation of 900 kw, the controls on the motor generator set malfunctioned and the test section was subjected to a large power surge. Subsequent investigation revealed that a weak weld in the test section failed during the surge. The test section was removed for repair.

Assembly of the parts for an electrically heated mockup of the Mark I element was continued and is about 30 percent complete. Problems encountered with welding between copper and Inconel pieces of the test sections were solved, and thermocouple installation was started.

Water Loss Hazard Calculations for the PRTR. The revised calculations of water loss rates following a piping failure in the PRTR were completed with consideration of ruptures of the top header, top jumper, and bottom jumpers.

The results indicate that following a top header rupture (area equal to pipe cross section) blow down will occur in the heat exchanger leg in nine seconds and in the reactor leg in 27.5 seconds. Following the water blow down of the reactor leg, it is estimated that steam will flow past the fuel elements for an additional 18 seconds.

The next case considered was that of a complete parting of a top jumper on a maximum flow tube followed by failure to depressurize the steam drum and failure to depressurize the steam drum and failure of the light water backup system. Initial heavy water loss rates are 95.6 lb/sec and 30.8 lb/sec from the ring header leg and the process tube, respectively. The total flow loss rate is 1025 gpm after the failure occurs and increases to a maximum of 1285 gpm at 40 seconds after failure. It is estimated that the pumps will vapor lock 52 seconds after the failure. Until this time the flow through the reactor is nearly normal with the exception of the high flow in the failed tube. Shortly after the pumps stop circulating the primary coolant bulk boiling commences. The tops and bottoms of the fuel elements will be exposed to steam at 124 seconds and 210 seconds, respectively. Blow down will be complete at about 255 seconds following the failure.

The last case considered was that of a bottom jumper break using the same assumptions made for the top jumper break. The results indicate that there is little difference between the two breaks as far as blow down times and rates are concerned. For purposes of comparison, the following

information concerning a bottom jumper break is given: initial flow loss rate is 1190 gpm, pumps lock at 58 seconds after the break, top and bottoms of the fuel elements become exposed to steam at 137 seconds and 200 seconds, respectively, and total blow down at about 300 seconds after failure.

Air Cooling Experiments for PRTR Type Fuel Elements. Equipment was assembled to check the air cooling requirements for the PRTR fuel elements in the fuel examination cell. Results of preliminary experiments indicated that the design of the air ducts would require slight modification to provide for proper flow distribution of air over the fuel elements.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. The detailed design of the mockup was begun and will be completed in April. Scoping of special tools for use during charging and discharging of the reactor was started.

Design Test PR-10 - Primary Loop Mockup. Cold performance tests on the four PRTR pumps were completed at the Byron Jackson Pump Company plant. The average dynamic head at rated flow conditions was 294 feet. The first one hundred-hour hot test with a full size pump failed due to a lack of cooling facilities on the Byron Jackson test loop. This test was rescheduled for early April following the addition of larger heat exchanger capacity.

Construction of the stainless steel piping portion of Phase II of the Single Tube Prototype Mockup (STPM) was complete except for two 10-inch welds. All other welds have been x-rayed and passed inspection except for two five-inch weld sections. These two sections will be repaired and reinspected.

Design Test PR-15 - Injection Pump Test. A new type packing was installed with Type 17-7 PH stainless steel plungers in the second Aldrich pump. After 241 hours of operation, the combined leakage from the three plungers was approximately 500 milliliters per hour. Visual examination of the plungers and the babbitt inserts on the crankshaft showed acceptable wear.

Design Test PR-20 - Calandria Characteristics. The calandria mockup was modified during the month to provide a means of pulsating the moderator level to determine the effects of vibration frequencies. To minimize the space occupied by the mockup, the recirculation pump was relocated.

Design Test PR-24 - Shroud Tube Bellows. New six-inch bellows were received from the Solar Aircraft Company for testing. These bellows successfully passed a 13,000-cycle flexure test at 2 psi and 660 F, and a 48-hour static pressure test at 15 psi. It was recommended that these bellows be accepted for reactor use.

Design Test PR-40 - Shim Control Mockup. A major change was made in the design of the shim control assembly during the month. Each shim assembly will contain three half rods instead of the previous two half rods. Design of the new assembly will be based on the positive drive, lead screw concept and will be completed by May 1.

Design Test PR-50 - Reactor Piping Seal Testing. The fully prototype Process Tube Assembly "C" was installed on the Elmo-7 loop. After approximately 350 cycles, a leak appeared in the nozzle-to-process-tube joint. This seal was disassembled, and a new spiral wound gasket installed. The assembly has undergone 2500 additional thermal cycles from 250 to 500 F at a pressure of 1350 psi without leakage. The final report on the design test is being prepared.

Design Test PR-51 - Reactor Piping Structural Integrity. The shortest outlet jumper installation on the thermal heating loop was completed and testing begun. The test program will consist of heating the jumper to 500 F and flexing the jumper a distance of one-half inch. The final report on the design test is being prepared.

Design Test PR-52 - Process Tube Thermalcycling and Pressure Testing. Testing of the stainless steel simulated process tube at PRTR conditions started on March 2. The tube was operated at 1100 psi and 500 F for a period of 450 hours during the month. No excessive signs of leakage were evident.

Design Test PR-80 - Air Cooling Duct Test. Fabrication of the air cooling duct was approximately 90 percent complete. Minor modifications in the design are being made to permit better adapting of the air duct mechanism to the fuel examination cell manipulator.

Single Tube Prototype Mockup. Continuous operation of the mockup was begun on March 2, and approximately 450 hours of operation was completed during the month of March. The operating conditions were: pump suction pressure - 1050 psi; main loop temperature - 500 F; and main loop flow - 126 gpm at 107 psi dynamic head and a pump speed of 2400 rpm. The mockup was thermocycled seven times during the month from 500 to 200 F. Leakage of the primary pump seal during isothermal operation decreased from 20 liters per day during the first week of operation to 200 milliliters per day during the fourth week of operation. A total of 450 milliliters of leakage from the secondary pump seal was collected during the month's isothermal operating period. Oil was observed in this secondary seal leakage during the fourth week of operation. The current oil leak rate is approximately 50 milliliters per day.

Inconel "X". The first Inconel "X" tube tested at 1100 F and 4500 psi failed after five hours of operation. Metallographic examination revealed the failure was caused by stress corrosion.

Reactor Technology Development

PRTR Instrumentation. Preliminary arrangements have been made to test the first resistance temperature detectors procured for PRTR. Vendors are now conducting performance tests on these units. A test section is being assembled on the full scale mockup of the PRTR Loop in the 314 Building.

Information is being gathered to indicate the size of a data handling system needed for use with the PRTR. It is intended to propose an eighty-five tube power calculator and the necessary fundamental components of a data handling system, as the two are complementary.

PRTR Physics Evaluation. Results of a recent three-group vertical analysis of the PRTR are now available in the issued report, HW-59373, "The Effect of Moderator Height on Reactivity and Vertical Flux Distribution in PRTR."

Continued efforts are being made to obtain, and prepare for use, several possible reactor codes for the IBM-709 computer. A FORTRAN language version of the SNG reactor code which has been written at Argonne will become available shortly. This code, written as a one-dimensional multigroup version, will supplant the VALPROD used on the IBM-650 computer. The Sn method is sufficiently accurate that its results may be used to check the untried RBU (Reactor Burnup) code which is expected to be ready for use within a few months. Also, a two dimensional, multigroup diffusion theory reactor code, CURE, is being investigated for availability and usefulness.

Whole-reactor effects of xenon on reactivity have been obtained from a twelve-region simulation performed on the "GEDA" analog computer. Equilibrium xenon concentration was found to have a poisoning effect of about 40 mk for 70 megawatt operation, and an additional 45 mk allowance is needed to over-ride the buildup of xenon to two hours after shutdown. Other results are available, such as:

1. Reactivity allowance for equilibrium xenon concentration as a function of power level.
2. Allowances for over-ride after shutdown from any power level.
3. Allowances following startups after shutdown from any power level.

A study to evaluate the effect of in-reactor test loops on the Plutonium Recycle Program is nearly completed. The effects on reactivity of the PRTR, program schedules, physics data and analysis, and reactor operation are considered in detail. A document (HW-59691) describing this work will be issued early in April.

Neutron streaming through the large penetrations of the bottom primary shield was re-estimated on the basis of recent core flux calculations for Pu spike loadings.

Containment Study. Some delay in preparing the final draft for publication has been caused by the necessity to repeat the dosage calculations for single tube fission product release and the establishment of minimal emergency system cooling capacities. The latter can be determined from the Battelle Memorial Institute coolant loss accident study. The radiation dosage calculations indicate thyroid doses about 1000 times greater than those initially estimated and are therefore being rechecked.

Process Specifications. Evaluation of limits to be established by Process Specifications has continued with emphasis on instrument settings necessary to prevent serious nuclear accidents. Further analogue studies are planned to simulate the reactor behavior with varying reactor loading, rate of reactivity addition, temperature coefficients, and rate of reactor heat removal.

Hazards Survey - PRTR Gas-Cooled Loop. A hazards survey of the preliminary scope design of the PRTR Gas-Cooled Loop has been made. This loop in the PRTR should have no adverse effect on the nuclear safety of the reactor. Insertion of the gas loop test section in the reactor core will have a slight effect on the reactivity of the core - 5 mk. This negative reactivity will be compensated for by charging one additional spike enrichment fuel element. Adequate safety features have been incorporated in the design. They are:

1. Calandria shroud tube cooling loop
2. Electric power backup
3. Emergency water coolant injection
4. Reactor safety circuit trips.

In the event of an accident in the gas loop, no injury or crop damage should occur as a result of fission product release to the environs.

Design Development

Phase I PRTR Construction Status. The Phase I PRTR contractor is approximately 86% completed versus 96% scheduled. Erection of the containment vessel is completed except for the top "dollar" plate. Some difficulty has been encountered with buckling of the dome, probably due to excessive amount of welding and repair of the vertical seams.

The contractor's pressure test procedure for the containment vessel has been reviewed. It appears that the contractor will run the three-pound soap test beginning April 17, with the pressure test and final leak rate test about the first of May. It is anticipated that essentially all concrete will have been placed inside the containment vessel prior to the leak rate test.

Phase II PRTR Construction Status. The Phase II PRTR contractor is 84% completed versus a scheduled 90%. Acceptance testing will begin around the middle of April.

Phase II-A PRTR Construction Status. The Phase II-A contractor is estimated to be 58% completed versus 58% scheduled.

Phase III PRTR Construction Status. The contractor is submitting detailed information on equipment for our approval.

Design Analysis. The IBM-650 program for evaluating fuel element heat transfer transient cases was reprogrammed for the IBM-709. Machine calculation time was reduced by a factor of several hundred. Debugging of the program is apparently complete. Preliminary results indicate that the time constant of the heat transfer lag is not as short as the IBM-650 calculations had indicated. Actually, a second or third order lag exists rather than the first order lag assumed as a first approximation. The rate of change is initially much steeper than would be predicted by a first order lag. Since the IBM-650 calculations covered only about a 3.5-second interval, assuming a simple exponential relationship with a first order lag led to too short a time constant. The actual transient relationship between heat generation and heat passing the fuel element boundary can be represented as the sum of a series of exponentials in which the leading term dominates after the first two seconds. The "time constant" varies from two seconds at the beginning to a fairly constant value of nine seconds thereafter.

The computer program presently available at HAPO, for calculating piping stresses, was found to be inapplicable to certain portions of the PRTR primary cooling system. Arrangements are being made to contact a consultant in the stress analysis field in order to have the suitability of the primary system layout checked independently.

Recalculation of the requirements for internal steam relief after PRTR scram show an increase in the nominal "escape time". Sparger nozzles sub-merged in the transfer pit allow condensation of steam for 4-1/2 hours before the water will boil. The increased times are the result of:

1. The new shutdown power curve.
2. Including the time required to bring HX-1 and its contents from 425 to 450 psia (safety valve setting is 435 psig).

Reactor and Process Piping. Additional steam venting will be provided for the steam generator in the region of the shell skirt by removing the top four rows of tubes from the tube bundle and adding three steam vent pipes between the top of the skirt and the steam space in the shell.

Heavy water volume-reduction pieces in the high-pressure closure were redesigned to eliminate hollow-box construction and provide improved flow distribution in the inlet and exit channels.

The first seven process tubes completed by Tube Reducing Corporation were inspected. Of these, four were accepted and three rejected for weld porosity on the flange. There are no major fabrication problems remaining, but production of the required number of tubes from the existing extrusions will require an increase in yield of acceptable tubes. Straightness of the tubes is well within specification. Permission was given to the fabricator to repair two defective sections of 10-inch pipe for use in the ring headers.

Fuel Handler. Authorization was given to Willamette Iron and Steel Corporation to proceed with design modifications to the fuel handler and with an engineering review of the design to find any remaining errors or omissions. Fabrication work has not begun.

Instrumentation and Control. The automatic controller is about 62% completed versus 65% scheduled. The delivery date on the automatic controller may be affected by a strike at Minneapolis-Honeywell's Philadelphia plant, currently in its third week.

The fuel element rupture detection system design criteria was revised and will be distributed for comment the first week in April.

The adoption of a split moderator inlet flow and the piping changes resulting therefrom caused minor changes to the power calculator system, including relocation of the moderator bulk flow orifice and the addition of a manually operated valve (remote) and flow indicating instruments for the added moderator inlet flow path.

To provide an adequate "power level" signal from the power calculator to the automatic controller, it has been necessary to add a servo system to the power calculator. The servo unit receives its input signal directly from the "total power" signal circuit in the calculator and incorporates a retransmitting slidewire which furnishes a signal to the transformer.

Fuel Element Examination Facility. The bid of the W. F. and John Barnes Company to design, construct, and test the Primary Manipulator was accepted. The bid price was about $100,000. The specifications for the procurement of the cast iron and steel shielding were completed and approved. An additional specification, covering the procurement, installation, and testing of the ventilation and services, and the installation of the cast iron and steel shielding, was also approved.

An operating mockup of the prototype warp measuring components of the combined profilometer and 5X viewer was successfully tested. The feasibility of attaching a print-out mechanism for recording the data was demonstrated. Such a mechanism could be added to the equipment to be installed in the PRTR.

A "Report of Invention" describing a duct design to be used in the Fuel Element Examination Facility to permit the controlled outlet of air from a duct at any desired point along its length, was submitted for evaluation.

High Pressure Loop and Critical Reactivity Measuring Facility. The preliminary project proposals on the High Pressure Loop and the Critical Reactivity Measuring Facility have been forwarded to the AEC for approval.

Rupture Testing Loop Project Proposal. Preparation of a preliminary project proposal to request funds for scoping and preliminary design of a rupture testing loop to be installed in the PRTR was started.

Plutonium Fabrication Pilot Plant

Phase II Construction. Completion of work under the Phase II contract is estimated at 89%, compared to 97% scheduled. Little progress has been made in producing a satisfactory decontaminable coating in the process portion of the building.

Phase III Construction. The Phase III contractor claims 6% completion under their contract. The contractor's schedule has been submitted but not yet approved. The swage and hood, the billet lathe and hood, the 30 kw vacuum furnace and hood, and the canning hood have been moved into the building and set in place.

Procurement. All GE-AEC procured material required for the Phase III contract is on schedule at present.

2. BASIC SWELLING STUDIES PROGRAM

Irradiation Program

Electrical heaters for the swelling capsule have been fabricated in the laboratory since heaters and thermocouples from the off-site vendor have not been delivered. Tests on these heaters indicated that their power rating was too low for the ultimate requirements of the capsule. New heaters have been designed and fabricated and are now ready for testing. The temperature controllers have been delivered and will be tested in conjunction with the heaters for the controlled temperature irradiations.

Capsules are being designed for irradiation of unrestrained uranium specimens in the MTR and ETR. The purpose of these irradiations is to obtain preliminary swelling information on uranium somewhat in advance of the current irradiation schedule at Hanford.

Six capsules without temperature control, each containing a 14-gram cylindrical specimen of natural uranium immersed in NaK has been charged in the MTR for irradiation. As described in HW-58978-RD, "Proposed Irradiation of Uranium Metallography Specimens GEH-14-33 through 38," three specimens will be irradiated to an exposure goal of 0.03 a/o burnup and the remaining three to 0.1 a/o; estimated irradiation temperatures are 120 C, 350 C, and 650 C. One specimen from each exposure goal will be subjected to a flux of 4, 40, and 80 x 10^{12} nv. Since the irradiation temperatures will differ according to the flux, the irradiation will provide an indication of the effect of temperature, burnup rate, and total exposure on the structure of the uranium. Prior to the irradiation of the specimens, each specimen was carefully precharacterized as to (1) geometry, (2) density, (3) microstructure, (4) microhardness, and (5) x-ray diffraction peak widths; after irradiation identical measurements will be made to ascertain the extent of the irradiation induced changes. The specimens will also be used to evaluate the effect of post-irradiation annealing on the swelling in unrestrained specimens.

Design calculations were made during the month for an instrumented temperature controlled capsule for a similar irradiation in the ETR. The high flux available in the ETR is desirable, in that relatively short time irradiations will give reasonable burnups; however, the resultant high power generation complicates the problem of capsule design. There is considerable doubt about the power rating of available heating elements and their ability to maintain such a capsule at a constant temperature during reactor off periods.

Simulated Swelling Experiments

Uranium swelling has been simulated in the laboratory by the introduction of xenon gas into uranium by cathodic glow discharge at high temperatures. Apparatus for expanding the study of this phenomenon is approximately thirty percent complete. The original apparatus is now being used to investigate the mobility of xenon in uranium.

The simulated swelling experiment was repeated again this month with two 1/8 inch thick discs at 800 C (1472 F). Xenon gas was introduced into one disc during two days of discharge at temperature. The second disc received a similar treatment but was shielded from the discharge. Subsequent density measurement gave the over-all density of the control sample as 18.94 g/cm^3, and the density of the swelled uranium disc as 18.88 g/cm^3. The uranium in the charged disc showed an over-all increase in volume of approximately 0.3 percent. The region in the center of the discharge underwent a considerably larger increase. A document entitled "A Laboratory Apparatus for Producing Swelling in Uranium," HW-59071, was prepared during the month. It contains a description of the apparatus used in these studies and a discussion of initial results.

Mechanisms and Theory

Diffusion of rare fission gases through the uranium lattice is important in both the rate of formation and the rate of pressure increase in pores. Mobilities of these gases in uranium are therefore being studied. Equipment for these studies has been installed. This equipment utilizes a uranium cathode which is shaped so that a glow discharge can be maintained in rare gases contained at reduced pressure in a thin walled cylindrical projection. According to previous studies the glow discharge should enable the rare gas to enter the uranium lattice. The gas should then diffuse through the uranium at elevated temperatures. Initial tests of the equipment were only partially successful due to a minute gas leak through the uranium.

For the study of formation of fission gas pores in irradiated uranium there is a need for solid surface tension values of uranium in the presence of inert gases at swelling temperatures. The solid surface tension data are being obtained by experimentally balancing the forces pulling down on a series of fine wires of uranium with the forces of surface tension pulling upward. Design, fabrication, and assembly of much of the apparatus has been completed during the past month. Vacuum and gettering equipment

was installed to maintain a clean surface on the uranium wires at elevated temperatures. Wire drawing dies have been obtained down to 0.001" diameter and several zirconium gettering wires were drawn down to less than 0.005" diameter. Preliminary swaging has been done for preparing uranium wires. The remaining pieces of equipment are on order and the apparatus is scheduled for operation during April. Optical and electron microscopy afford a direct means for studying certain aspects of swelling, namely the number and size of pores in uranium. Since pores vary in size and distribution as a consequence of the in-reactor environment, a realistic quantitative analysis requires application of statistical methods. Operation Research personnel are currently applying a statistical technique for estimating pore radii distribution and volumes associated with pores as a function of longitudinal and radial distances in a cylindrical, irradiated uranium specimen. In order to establish the effects of laboratory annealing treatments on the growth of small pores in uranium irradiated at 400 C to a burnup of 0.2 a/o, a specimen has been annealed at 880 C for 100 hours. The necessary metallographic preparation is now in progress.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility. A revision to the Gas Loop Project Proposal, increasing the maximum temperature from 1100 to 1500 F and requesting an additional $175,000 required by the temperature increase, was prepared and is being circulated for approval. The design criteria, including scope drawings for the high temperature gas loop (CAH-822), were completed. It is planned to place the ex-reactor portion of the gas loop for bid during April on a design and fabricate fixed price contract. The in-reactor section will be designed on site.

The in-reactor test section consisting of two concentric tubes and a large part of the loop piping external to the reactor will tentatively be fabricated from Inconel-X. Helium gas will flow in the annular space between the outer pressure tube of the loop and the aluminum shroud tube of the reactor. Loss of helium shroud cooling due to failure of electrical power and the steam turbine back-up will cause water to be injected into the primary loop. Water injection is required to prevent overheating the aluminum shroud tube. Instrumentation will be provided for automatic loop operation. A programmer will control the rate of temperature change during startup or shutdown of the loop. Preparation of design criteria by the Design Development Operation is continuing.

Graphite Oxidation Studies. Surface area and pore size measurements were completed on four TSGBF graphite samples prior to outgassing and reactor irradiation at 550 C in high pressure CO_2. The first outgassing tests on TSGBF graphite evolved approximately 1.74 cc of gas at STP from a 31.46 g sample in 16 hours at 950 C. The gas composition (percent by volume) was: 1.01 percent CO_2, $<$ 0.01 percent A, $<$ 0.01 percent O_2, 2.73 percent N_2, 6.06 percent CO, and 90.2 percent H_2. Further outgassing studies are planned.

The weight loss of CSF graphite in flowing CO_2 is linear after the first 0.85 percent. The rates are 1.23×10^{-5} gm/gm-hr at 700 ± 5 C, 1.73×10^{-5} gm/gm-hr at 750 ± 5 C and 4.94×10^{-5} gm/gm-hr at 800 ± 5 C. Stoichiometric relationships indicated that less than 0.01 percent of the total CO_2 was used for oxidizing the graphite (assuming the over-all reactor to be $CO_2 + C \longrightarrow 2\ CO$). Thus, under these conditions, small changes in gas flow should not be reflected in the rate of graphite weight loss. As a test, a sample was oxidized at 800 C while the gas flow was decreased to one-half the original value (from 0.4 cu-ft/hr to 0.2 cu-ft/hr). The observed weight loss was only six percent less than the value observed at the higher flow rate, verifying the assumption that the reaction is not sensitive to small changes in gas flow rate at these conditions. The specific surface area of the sample was 0.257 m^2/gm before oxidation and the sample will be checked for the change due to oxidation.

The samples in the weight loss equipment hang above the vertical center of the reaction tube. The graphite-imbedded thermocouple is at the vertical center. To ensure that the samples are at the same temperature as the thermocouple and that there are no large temperature gradients along the length of the samples, a second thermocouple imbedded in graphite was moved along the tube and the temperature was observed as a function of distance. The results confirmed that the samples are within the isothermal portion of the reaction tube.

Coated Graphites. Preliminary screening tests were completed on two coated graphite materials from the National Carbon Company. They were: (1) a siliconized "impregnated" material and (2) a siliconized material.

A sample of the siliconized "impregnated" material was heated to 1000 C in an atmosphere of helium. As the sample was brought to temperature a volatile product in the coating was evolved at ca. 300 C. The heating was continued and the temperature held at 1000 C for ca. six hours. After cooling in the inert atmosphere, the sample had lost 0.75 percent in weight. The sample was again heated to 1000 C for ca. six hours with a further loss in weight of 0.17 percent. After a third heating for the same period of time the weight became constant. A visible change in the condition of the coating was observable.

A sample of the coated "impregnated" material was tested for oxidation resistance. The equipment used was an oxidation balance on which the weight change could be continuously monitored. The sample evolved the volatile constituent as before. The entire run was made at 600 C, in air at 0.5 cfh flow. The sample lost 0.30 percent weight in twenty minutes and 18.3 percent after seventy-two hours. A visual inspection of the sample under the microscope showed holes and cracks in the surface of the coating. The main attack was through the ends of the sample where the coating was thin due to the method of application.

A sample of "siliconized" coated ATJ graphite was placed in a sealed aluminum tube along with an uncoated sample of the same graphite and irradiated to an exposure of 187 MWD/AT to determine the feasibility

of handling and testing coated, irradiated samples in existing equipment. Both the coated and uncoated samples were very radioactive, reading five rads at the surface. The surface appearance of the coated sample had changed to a black color from the unirradiated gray-green color. After "cooling" for forty days, the radiation level had not changed appreciably. The radiation levels of pure reactor grade graphites coated with these materials could not be evaluated from this test.

The above tests show that these coated materials in their present state of development would not be useful reactor materials. Improved materials will be obtained from National Carbon Company for evaluation. All samples of the above material will be eliminated from the test program.

D. CUSTOMER WORK

UO_2 Fuel Development

The Chemical Research and Development program of mechanical processing of non-production reactor fuel elements includes studies of the shearing of UO_2 fuel elements to determine shearing forces and to provide material for dissolution studies particulate matter generated during shearing. Thirty-one swaged UO_2 rods, approximately 0.563" in diameter and 34" long, were delivered to Process Equipment Development, Chemical Development, for these shearing tests. Fuel elements were supplied in both stainless steel and Zircaloy-2 jackets.

Corrosion Studies

Reactor Pigtails. The occurrence of pigtail failures on H Reactor during the latter part of 1958 frequently caused scramming of the reactor. The metallurgical examination of many of the failed pigtails showed cracks in the 304 stainless steel tube which resembled stress corrosion cracks. In order to help evaluate the condition of the pigtails at other reactors, about 58 pigtails from D and DR Reactors have been removed, cleaned, and dye tested for cracks. Three out of the 43 pigtails from DR Reactor gave crack indications, and three out of 15 pigtails from D Reactor gave crack indications. These dye test indications are being metallurgical evaluated.

Radiometallurgical Examinations

I & E Hole Failure - 2582-C (RM-249). The examination of the second element of enriched uranium from tube 2582 continued. The examination of the bonding of the male-end cap of the element showed that water entry to the AlSi layer surrounding the spire occurred through a welding or similar fabrication defect. The series of water channels surrounding the spire are between the male cap and about 1-1/4 inches from the female cap - a distance of about 4-3/4 inches. Water entry also appears to have been effected through the spire in the neighborhood of the corrosion area previously mentioned. Examination of a section of spire can wall has revealed at least five placed within a very small area where some type of erosive penetration occurred. These penetrations extend from the intergranular corrosion areas on the water exposed surface of the spire directly to water channels in the AlSi bonding layer.

PT IP-134-A Irradiation of Wafered U Fuel Element (RM-245). A 1.8" o.d., A-2 aluminum alloy jacketed, hot press canned, 1.6% enriched, wafered uranium I & E fuel element was irradiated to low exposure at high power. The element was sectioned longitudinally for half its length. Measurements of wafer thickness do not reveal any marked changes from the pre-irradiation state. Metallographic examination of a wafer is being started.

Preparation of Samples for Project C-791 (RM-267). Ten uranium bars, approximately 1/4" x 1/2" x 2-1/8" long, were sectioned from an I & E fuel element and canned for shipment to ORNL. This completes the request for 29 samples which will be melted to determine the quantity of fission product gas release in connection with Project C-791.

Aluminum Shroud Tube from ETR 3x3 Test Facility (RM-291). A section of the aluminum shroud tube which had cracked during operation of the ETR was received to determine the cause of failure. A two-inch long circumferential crack was found in one of the welds in the reducer section of the tube. Metallographic examination showed that the crack was caused by insufficient weld penetration and internal flaws in the weld which seriously reduced the weld strength.

Metallography Laboratories

Samples Processed During the Month:

Total samples processed: 206

Photographs

Micrographs	382
Macrographs	97
Total	479

F.W. Albaugh

Manager, Reactor and Fuels Research
and Development

FW Albaugh:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
FW Albaugh JJ Cadwell JC Tobin RE Nightingale	3/4-6	US-AEC, DRD, Washington, DC	Attend Radiation Damage Meeting	FK Pittman UM Staebler IF Zartman	Yes
JV McMaster	3/2-3	Mo. School of Mines, Rolla, Mo.	Technical recruiting	--	No
	3/4-6	U. of Missouri, Columbia, Mo.	"	--	"
JR Fishbaugher	3/3-6	Cummins Engine Co., Columbus, Indiana	Study PRTR emergency diesel equipment	RT Plaster	No
JR Fishbaugher JE Hard RD Widrig	3/9-13	Chalk River Project, Chalk River, Ont.	Discuss problems associated with operation of heavy water reactors.	DM Stewart	No
PA Scott GL O'Neill	3/19-25	Byron Jackson Pump Co., Los Angeles, Calif.	Technical consultation on PRTR pumps	S Winstein	No
	3/24	Parts Engineering Co., San Diego, Calif.	Technical consultation on PRTR expansion joints.	JJ Kinsella	No
DE Rasmussen	3/30	Saginaw Steering Gear, Saginaw, Mich.	Technical consultation on PRTR shim control.	JV Syring	No
WK Winegardner JC Fox	3/25-26	Willamette Iron & Steel, Portland, Ore.	Technical consultation on PRTR charge-discharge machine.	O Novak	No
JC Fox	3/9	Tube Reducing Corp., Wallington, N.J.	Inspect process tubes.	H Spittler	No
WA Burns	3/13	Yuba Heat Transfer, Honesdale, Pa.	PRTR boiler design conference.	WD Comley	No
	3/13-14	Struthers Wells Corp., Warren, Pa.	PRTR gas loop & small heat exchanger design.	HA Backstrom	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DJ Foley	3/2-4 3/13-15 3/30-31	Consolidated Western Steel, Los Angeles, Calif.	Discuss calandria shields.	DJ Bentley	No
MR Kreiter	3/13-15 3/22	Same as above	Same as above	"	"
RM Fryar	3/5	Williamette Iron & Steel, Portland, Ore.	Vendor discussions on PRTR fueling vehicle.	E Jennett	No
RM Fryar LC Lemon	3/29-31	Consolidated Western Steel, Los Angeles, Calif.	Discuss PRTR calandria order.	DJ Bentley	No
JA Ayres JE Minor MK Millhollen	3/16-18	duPont Savannah River Proj., Aiken, S.C.	Attend Sheath Meeting	P Permarr TC Evans	Yes
JA Ayres	3/18	Chicago, Illinois	Attend Corrosion Equipment Show	--	No
RB Richman	3/16	Chicago, Illinois	Attend 15th Annual Conf. Natl. Assoc. Corrosion Engrs.	--	No
HH Yoshikawa RE Nightingale	3/3	GERL, Schenectady	Discuss possible R&D work; radiation damage in graphite	JE Burke DW Lillie	No "
	3/6	Natl. Carbon Co., Cleveland, O.	"		"
HH Yoshikawa	3/5	Speer Carbon Co. & Great Lakes Carbon, Niagara Falls, N.Y.	"		No
JW Riches RL Knecht	3/9	Tube Reducing Corp., Wallington, N.J.	Consultation on fabrication of zirconium	EH Fisher	No
	3/10	Chase Brass & Copper, Waterbury, Conn.		DK Crampton	No
	3/13	Hunter Douglas Corp., Riverside, Calif.		RA Quadt	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Riches	3/11-12	Allegheny Ludlum, Pittsburgh, Pa.	Consultation on fabrication of zirconium	TT Magel	No
	3/31	Bridgeport Brass, Bridgeport, Conn.	"	SN Randall H Rubenstein	No
RL Knecht	3/11	Aluminum Co. of America, New Kensington, Pa.	"	KD McCracken	No
RC Aungst EA Smith	3/19-20	Los Angeles, Calif.	Attend ASM Metals Show	--	No
RC Aungst	3/23	Aerojet-General Corp., Azusa, Calif.	Consultation on fabrication of zirconium	L Zernow	No
JP Pilger	3/2	Buckner Weatherby Co., Seattle, Wn.	Investigate the Jaypax process.	J McCullough	No
TK Bierlein JC Tobin	3/2	U. of Michigan, Ann Arbor, Mich.	Discuss electron microscope work.	Mr. Bigelow	No
	3/3	GERL, Schenectady	"	V Phillips RE Keith	No
		GEL, Schenectady	Discuss contract on temp. measuring system.	H Robinson	No
TK Bierlein	3/4	KAPL, Schenectady	Discuss electron microscope work.	Mr. Fisher	Yes
GS Allison RS Kemper	3/3-6	NMI, Concord, Mass.	Discuss coextrusion program.	P Loewenstein	Yes
JE Minor	3/20	"	"	"	Yes
PA Ard	3/9	East Side Tool & Dye Wks., Portland, O.	Inspect die container pieces & observe assembly.	TL Stoudt	No
HW Newkirk	3/18	Giannini Plasmadyne Corp., Los Angeles, Calif.	Discuss operation & characteristics of hi temp. generating equipment.	--	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DC Kaulitz RG Wheeler	3/12	Res.Welding & Eng. Co., Compton, Calif.	Discuss welding developments on zirconium.	G Garfield	No
	3/13	Sprague Engineering, Gardena, Calif.	Discuss hi pressure gas systems for in-reactor tests.	WI Satler	No
	3/14	Convair Equipment Div., Pomona, Calif.	Discuss tools & dies for hi energy rate forming.	J Ottestad	No
	3/16	Raymond Wooldridge, Inglewood, Calif.	Discuss dissimilar metal joining properties.	--	No
	3/17	Allied Engineering, Oakland, Calif.	Discuss fabrication of cast for ETR.	--	No
	3/18	APED, Vallecitos Pleasanton, Calif.	Discuss Hi pressure loops & GETR.	E Lee	No
LE Mills	3/12	Sciaky Bros., Inc., Los Angeles, Calif.	Consultation on welding application.	CA Carlson	No
	3/13	Res.Welding & Eng. Co., Compton, Calif.	"	G Garfield	No
SH Bush	3/13	Magnethermic Corp., Youngstown, O.	Discuss induction heat treating of uranium.	N Ross	No
	3/16-17	U. of Michigan, Ann Arbor	Technical recruiting	--	No
	3/18	Aeroprojects, Inc., West Chester, Pa.	Discuss ultrasonic welding contract.	WC Potthoff	No
JC Tverberg	3/13	Magnethermic Corp., Youngstown, O.	Discuss induction heat treating of uranium.	N Ross	No
	3/16	Ohio Crackshaft Co., Cleveland, O.	"	NB Osborn, Jr.	No
EA Smith	3/20	APED, San Jose, Calif.	Discuss Zr-clad fuel element testing techniques.	EW O'Rorke	No
MK Millhollen	3/19-20	Portland Copper & Tank Wks, Portland, Maine	Discuss fabrication of PRTR fuel element end fittings.	CB Smith	Yes
RV Bowersock	3/29	APED, San Jose, Calif.	Inspect Zr cleaning & autoclaving.	CN Spalaris & EW O'Rorke	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RE Olson	3/29	Perrine Machinery Co., Seattle, Wn.	Discuss purchase of equipment for PRTR fuel element fabrication.	RH Johnson	No
		DL Snellman Co., Seattle, Wn.		DL Snellman	No
DC Kaulitz	3/31	Phillips Pet. Co., Idaho Falls, Ida.	Discuss Project CA 681.	R Neidner	Yes
OJ Wick	3/1-3	Lawrence Rad. Lab., Livermore, Calif.	Attend conference on trans-plutonic elements.	I Perlman	No
OJ Wick RW Stewart	3/17-18	"	Discuss Project Whitney.	WJ Ramsey	Yes
WB Weihermiller	3/16-20	Hughes Aircraft, Los Angeles, Calif.	Visit gaging facility.	J Birch	No
		Convair Pamona Plant, Los Anglees, Calif.	"	--	No
		Los Angeles, Calif.	Attend ASM Meeting.	--	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldg. Visited
C Yaindl	3/10-12	Aldrich Pump Co., Allentown, Pa.	Consult on PRTR injection pump.	WA Burns RH Purcell	No	700, 760 300, 314
R Grunsfeld	3/10	Snap-on Tool Corp., Seattle, Wn.	Consult on PRTR tool development	RH Purcell DE Rasmussen	No	300, 314
WJ Taylor EB Sullivan	3/18	W.F. & John Barnes, Rockford, Ill.	Consult on PRTR fuel examination cell.	WS Kelly RH Purcell	No	700, 760 300, 314
J Morton	3/12	GE, Schenectady	Tour of PRTR.	HE Hanthorn	No	PRTR Site

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
FJ Leitz FE Cooke AE Galson P Greebler RK Anderson	3/23-25	APED, San Jose, Calif.	Discuss PRTR audit.	RM Fryar H Harty et al	No	700, 760
RD Bennett	3/24	Vallecitos Lab., Pleasanton, Calif.	Discuss KER Loops.	JA Ayres	Yes	1704-K, 100-K
ML Jackson	3/17	U. of Idaho, Moscow	Discuss research facilities for his thesis.	KD Hayden	Yes	100-D, 185-D, 100-H, 105-H-12
EW Placek	3/3	Air Supply Co., Seattle, Wn.	Demonstrate flexible hoses.	JM Davidson TJ Clark	No	300, 326
KA Trickett JV Neeley F Hunton	3/23-24	ACF, Washington, DC Kaiser Engineers, Oakland, Calif.	Discuss Gas-Cooled Reactor design.	RE Nightingale EM Woodruff DE Baker RE Dahl	No	700, 761
JM Atwood	3/9	DRD, US-AEC, Washington, DC	Discuss graphite studies for gas-cooled reactor.	RE Nightingale DE Baker	Yes	700, 703
T Scattergood P Berner	3/4	Fenn Mfg. Co., Hartford, Conn. Star Machinery Co., Seattle, Wn.	Discuss equipment for fuel fabrication hardware.	DC Kaulitz JE Minor	No	300, 326
J Ottestead	3/4	Convair Eqpt. Div., Los Angeles, Calif.	Discuss Convair Dynapak installation.	JE Minor DC Kaulitz RG Wheeler	No	300,326
RT Huntoon Mr. Marsh VI Montenyohl	3/2-5 3/5	duPont Savannah Riv., Aiken, S.C.	Discuss trans-Pu & Palm Fabrication.	OJ Wick	Yes	200-W, 231-Z, 2704-Z
MJ Sinnott	3/31	U. of Michigan,	Consultant Agreement 199.	SH Bush JE Minor JC Tobin	Yes	300-303, 326

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

MARCH 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety in the Fuels Preparation Department

A discussion was held with members of FPD regarding the handling and storage of highly enriched uranium fuel (enrichment > 90 percent). General Atomics plans to send fuel of this kind to FPD for testing in the 305 pile. Safe criteria were established for the storage and handling of this fuel together with normal fuel in the FPD operations.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

The experiments reported last month have continued. The additional data obtained confirm the previous results. Corrections to the results due to epicadmium fissions were computed on the basis of measured Gold-Cd ratios in the fuel elements. These corrections amount to a few percent at most.

Blocking Effect of Coolant

The measurement of this effect has been completed for a single column of 8-inch fuel elements in the TTR thermal column. The data are presented as the ratio of the average activity of 4 manganese foils mounted on a process tube to the average activity of 4 manganese foils mounted on an 8-inch natural uranium fuel element. These ratios are tabulated in the following table, for a dry annulus and an annulus filled with coolant water, at graphite temperatures of 292°K and 677°K. The canned fuel element is 1.44 inches in diameter with a 0.080-inch annulus between the fuel element and the process tube.

Ratio of Average Manganese Foil Activity

Case	Graphite Temperatures	
	292°K	677°K*
Dry	1.070 ± 1/2%	1.047 ± 1/2%
H_2O Cooled	1.314 ± 1/2%	1.180 ± 1/2%

* The 677°K data was presented in the February monthly report.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

As reported last month, an IBM 709 FORTRAN program is being written to obtain numerical results for the two more complicated infinite geometries for which analytic solutions have been found. The program is being divided into a number of subroutines, which may be debugged independently, and one main program. Of the two subroutines which have been written, one has been run successfully and the other is being debugged.

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

During the past month the theoretical investigation of the transfer cross section for neutron exchange between equilibrium thermal neutron energy distributions near a temperature discontinuity has been extended from the effective graphite mass range of 12 to 80 amu to the 80 to 250 amu range. In this range a mass of approximately 150 was found to yield a fairly good fit to the low temperature (108°K and 300°K) experiment. During the course of these calculations an investigation was made of the dependence of the "effective mass" or transfer cross section of graphite upon the experimentally determined albedo of the thermal flux. The results indicated a rather strong dependence of the effective mass of graphite upon the albedo. This result together with the sensitive dependence of effective mass upon the experimental constants of the slowing down flux have led to a rather drastic but essential modification of the methods of analysis. Heretofore a rather lengthy machine and hand calculation has been used to iterate towards a theoretical value of the transfer cross section. At present a new 709 FORTRAN program is approximately 90 percent completed. This program will iterate to the effective graphite mass which provides the best fit to the experimental data. The program has complete flexibility to allow the investigation of any parameter which might influence the experimental determination of the transfer cross section.

Effect of Cladding on Reactivity

Additional data from measurements in the Hanford Test Pile on the effects on reactivity of various cladding materials on I and E type fuel elements have recently been received. These data have been analyzed and the results of this and a previous analysis are being issued under report number HW-59809.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for 2.5- and 1.92-inch Fuel Elements

Material bucklings of graphite lattices with 2.5-inch solid natural uranium fuel elements measured this month are listed below.

Lattice Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios Al/U	H_2O/U	C/U
12 3/8 Wet	- 19	0.185	0.403	29.58
12 3/8 Dry	+ 79	0.185	--	29.58
14 9/16 Wet	- 73	0.185	0.403	41.58

These buckling values are tentative using an assumed extrapolation distance, λ, of 1.66 inches. Horizontal traverses have been measured to determine the actual λ, and final values for the buckling will be quoted when the analysis of these traverses is complete.

The measurement of the fast fission factor, ϵ, in a graphite lattice is required for comparison with existing values. The procedure for absolute standardization requires an argon filled, double chamber capable of receiving both uranium foils and deposits.

The foils and deposits will be natural uranium and 15 ppm depleted uranium. The deposits have been obtained and have 0.100 ± 0.005 mg/cm^2 uranium content.

Preliminary studies to check the reliability of the chamber and to become acquainted with its operation have been carried out using the deposits.

PCTR Measurements of k_{∞} and f of Selected Cluster Elements

Final values of k_{∞} have been determined from PCTR measurements of a 7-rod cluster of 0.924-inch diameter rods in a 10 1/2-inch graphite lattice. The results are compared in the table below with values derived from buckling measurements of essentially the same fuel assembly in a 10 3/8-inch lattice. To aid in the comparison, the exponential results have been adjusted to the geometry of the PCTR experiment.

	k_{∞}		Mole Ratios		
	Air Coolant	Water Coolant	C/U	Al/U	H_2O/U
PCTR	1.009 ± 0.005	0.998 ± 0.001	37.45	0.446	0.467
Exponential	1.013 ± 0.0045	1.001 ± 0.0045	37.01	0.482	0.466
Exponential, adjusted	1.016 ± 0.0045	1.003 ± 0.0035	37.45	0.446	0.467

It is apparent that the PCTR and exponential results are in agreement in each case.

The 1 milli-k error quoted for the PCTR water-cooled experiment is a standard deviation encompassing all known sources of error. In the measurement with air coolant, the large error quoted is due to the fact that the spectrum was never successfully matched through the test cell in the axial direction. The magnitude of the error is based upon the effects of changing spectral conditions on k_{∞} observed in the water-cooled experiment.

Preparations are being made to measure k_{∞} and f of the same cluster with uranium of 1.007 percent enrichment in a 7-inch lattice.

Coordinated Theoretical-Experimental Reactor Physics Program

The IPD Survey Code has been used to calculate bucklings for the various internally moderated 2.5-inch fuel element geometries which will soon be measured in the exponential piles. The results indicate that the present range of lat-

tice spacings (8 3/8 inch to 14 9/16 inch) will give adequate coverage for these geometries.

Calculations with the IPD code were also made for comparison to the previous measurements on fuel elements from 0.926 inch to 1.66 inches in diameter. The calculated bucklings for small diameter elements (0.925-inch to 1.36-inch diameter) are accurate at small lattice spacings and become high by about 20 microbucks at large lattice spacings (larger than the spacing for maximum buckling). For large diameter elements (1.66 inches and larger) the calculations are slightly low at small lattice spacings and become high by 20-30 microbucks at medium and large lattice spacings.

This series of calculations was used to correct for differences between lattices measured in the PCTR and in the exponential piles. Bucklings were then compared to available k_{∞} measurements with M^2 taken from the method of C. R. Richey (HW-56646). The resulting exponential k_{∞}'s were an average of 5 milli k high indicating a need for a change in the parameters used to calculate M^2. The exponential k_{∞}'s were also high compared to critical experiments, while PCTR k_{∞}'s compared favorably to critical values (averaged 1 milli k low), indicating the validity of PCTR measurements, at least for the small range of lattice geometries involved in critical measurements.

The calculation of differences also provided an opportunity to compare buckling measurements on 1.66-inch elements in both 4-foot and 8-foot piles. This comparison indicated that the extrapolation distance of 1.66 inches previously derived for the 4-foot pile measurement is too high. A value between 1.53 inches and 1.55 inches provides a better fit to the data.

Calculations of thermal utilization of a simple bare natural uranium-graphite lattice, using diffusion theory in the moderator and blackness boundary conditions at the fuel surface, give values that agree within 1 percent of the reference values for lattice spacings less than 7 1/2 inches. For larger spacings, the errors increase to almost 10 percent. Reference values are the HAPO exponential pile data corrected for aluminum content.

NPR Lattice Physics Program

The program of cold exponential pile measurements in support of NPR has been planned in detail and discussed with IPD representatives. The program includes measurements of buckling for 1.92-inch solid elements and 2.5-inch elements for various fuel geometries (solid, I and E, tube and rod, tube and tube, tube and tube and rod) in the 4-foot exponential piles. In addition, 8-foot piles will be used to check the extrapolation distance of a few of the cases measured in the 4-foot piles, as well as for measuring buckling of the exact NPR lattice and a condensed lattice (no void) with the same carbon-to-uranium ratio as NPR. Changes from the original tentative program involve timing, but not content. The only significant change is the scheduling of a tube and tube geometry as soon as the 2.5-inch elements, cored to 2 inches, are received.

A PCTR program involving lattice parameter measurements for some of the 1.92- and 2.5-inch fuel geometries has been planned along with the exact NPR lattice to supplement and check the exponential program. Measurements of k_{∞},

f, p, and ϵ will supplement the buckling measurements and permit a rough derivation of M^2.

Nuclear Safety in Handling NPR Fuel Elements

Nuclear safety in the design of an annular cask for the storage of NPR fuel elements was reviewed. Safe batch sizes for a 12-inch thick annulus, as well as safe geometries, were calculated. It is intended that such a cask be used in loading an annular dissolver.

Intercalibration of Graphite Purity

A direct measurement has been obtained in the PCTR of the absolute value of the absorption cross section for one particular bar of graphite. The bar selected is the same one which was used earlier in the calibration of the HTR (Hanford Test Reactor - 305 Pile), and the HTR purity index of the bar is known. The HTR measurements have previously yielded accurate differences in cross-section values between the various bars involved in the graphite exchange. The present PCTR measurement provides a reliable normalization for the HTR measurements and permits us to quote absolute values with a small margin of error.

The graphite cross-section measurement in the PCTR was a danger coefficient measurement. Reactivities were measured with the test cavity of the D_2O calandria empty, filled with graphite, and filled with graphite plus thin copper wire. The observed change in reactivity resulting from the addition of a known amount of copper defines a "cents/cm^2 of absorber" coefficient for this particular PCTR configuration. This coefficient enables one to interpret the initial reactivity change resulting from the insertion of the graphite alone in terms of the absorption cross section per carbon atom for that particular graphite. A known quantity of D_2O was also inserted into the test cavity in an attempt to experimentally determine the moderating effect correction. The correction appears to be about -0.05 mb and is small because relatively few fast neutrons exist in the sample environment. The final figure for the moderating correction depends upon the hydrogen content of the D_2O and will not be available until spectroscopic analysis of the D_2O has been completed.

The net result is that the U. S. values quoted last month should be corrected downward by about 0.20 mb. After the exact hydrogen content of the D_2O has been determined, it will be possible to quote all values to within about 1 percent. The value obtained for the test bar itself is σ_a (2200 m/s) = 3.60 mb. This value has been corrected for nitrogen absorption in the bar and for the estimated moderating effect.

Computational Programs and Services

The complete Exponential Data Program is now being debugged. Encouraging results have been obtained. The FORTRAN version of the P-3 subroutine has been written but has not been compiled.

Work was begun on a FORTRAN program which will take basic PCTR data as input, calculating k_{oo} and f, as well as performing a statistical analysis of the results. The two main objectives are flexibility and ease of input data preparation. When the methods to be used have been decided upon, they will be circulated among PCTR users for comment.

Mechanism of Graphite Damage

A series of measurements was completed of the energy loss of the Van de Graaff electron beam in thin aluminum foils. Aluminum is used instead of graphite because the mean excitation potential of aluminum is known so an estimate of the energy loss can be made with the Bethe-Bloch formula. The results were quite surprising. The energy loss increased linearly with the thickness of the foils and was within a few percent of the Bethe-Bloch value. It had been expected that multiple-scattering would result in a non-linear energy loss. The observed results may possibly be explained as balance between extra energy loss due to multiple scattering and decreased energy loss due to escape of delta rays. The observed result is pleasing because it indicates that fairly thick samples of graphite may be used in the Van de Graaff studies.

Instrumentation

Discussions were held with members of IPD and HLO concerning the role of RPIRDO in assisting in the selection and testing of a fuel element rupture detection system for NPR. Practical and development systems at other sites are being studied.

The investigation of new neutron detectors continued with emphasis on solid state devices. The Westinghouse miniature solid state neutron detectors are not in commercial production at this time. It will be four to six months before they will be available. An attempt is being made to make this type of a device available here sooner.

A recording two-color pyrometer system using a CdS photoresistor as the detecting element for graphite temperature measurement was given preliminary tests. One test made before wiring in the timer and recorder indicated satisfactory operation. With recorder and timer included the operation was erratic. Further tests are planned with the CdS cells as well as with the lead sulfide cell and photomultiplier. An arsenic trisulfide lens has been received for experimentation in the infra-red.

The printed circuit boards containing the circuitry for input address logic and core drive for the simple computer using magnetic cores have been assembled into a completed unit along with additional circuitry to complete this portion of the project and the unit as a whole is undergoing testing and debugging.

Necessary detector work was completed for investigative use concerning 100-H stack gas monitoring. The detection portion uses a 10-inch diameter hollow aluminum sphere with an inserted two-inch diameter by five-inch long closed cylinder. The cylinder contains an NaI crystal and phototube. A small portion of the stack gas will flow through the system--about two to five CFM. The calculated minimum detectable concentration of I^{131} in the stack gas is about 10^{-7} μc/cc without lead around the sphere and assuming no background problems. Only the photopeak of the particular isotope of interest will be counted. General energy analysis will be attempted for normal conditions and also following slug rupture if possible.

Consultation was given on a complete remote-area scintillation monitoring system for the NPR project. The circuitry involved is quite simple and reliable and has

been previously tested. Each local detector station contains a phototube, a terphenyl-in-polyvinyltoluene for gamma detection or a boron-zinc sulfide crystal for neutron detection, a meter-relay circuit with a local alarm. Each remote local station may be up to 1200 feet from the central station. A portion of each local station signal is sent, via the signal cable, to the central station where the signal from each probe is amplified and recorded. The central is provided with a stepping switch to receive, at one to 10-second intervals, the various remote station signals and record the same on a multipoint recorder. A central station high-voltage supply serves all remote units. One central station high-voltage supply, one amplifier, and one 10-point recorder can handle ten remote station monitors. A minimum of two cables, one for high voltage and one for signal, go to each remote station. The local remote station alarm has a 0.1 second alarm time and is not affected by the central station switching speed. Thus, the local alarm will always energize immediately. This system precludes errors caused by switching delays at the central station. The complete proposed system will be completely compatible with later development work for addenda reactor-area radiation monitoring equipment.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazard Specifications

Nuclear Safety in Hanford Laboratories Operation

S tudy of the nuclear safety in the storage and handling of 4 Pu-Be neutron sources, each containing 80 grams Pu, was made. The atomic ratio of Be:Pu in these sources is 13.5. Without further moderation the reactivity of these sources is less than that for the same weight of pure Pu. It is safe to handle these four sources independently of the degree of water moderation and reflection.

E-Metal Program

The study of the random loading of the E-Metal dissolver was continued to determine a realistic dissolver loading and the corresponding maximum safe batch size. The earlier study, based on cylindrical geometry indicated a maximum safe batch size in the range of 1.7 - 2.4 tons uranium. In the present study a conical loading was assumed in which the base was equal to the diameter of the dissolver crib (52 inches). With such a loading the maximum safe batch size is estimated to be 2.0 tons uranium.

Plutonium Critical Mass Laboratory

Modification 2 of Directive HW-455, dated March 23, 1959, was received from the AEC authorizing the General Electric Co. to incur costs in the amount of one million dollars for the construction of Stage I of the Plutonium Critical Mass Laboratory.

Current plans call for invitations to bid being issued on April 8, 1959, and for bid opening on May 6, 1959.

Criticality Studies in Support of Processing Power Reactor Fuels

An exponential experiment was used to determine the material buckling, and critical mass, for 3.063 percent enriched uranium rods of 0.300-inch diameter in a 0.500-inch hexagonal lattice. In the case of the 0.500-inch lattice there was an insufficient quantity of uranium available to determine the critical mass from the critical approach. A radial traverse of the neutron flux was made with a small BF_3 counter to evaluate the extrapolation length for the lattice. The results of these measurements are given as follows:

Lattice Spacing	H_2O/U (Volume Ratio)	Extrapolation Length*	Measured Buckling	Calculated Critical Mass (Spherical Geometry)
0.500 inch	2.06	7.1 cm	$13,028 \times 10^{-6} cm^{-2}$	485 lbs. of enriched U

To date sixteen different lattices have been measured with the three rod sizes initially chosen, 0.925-inch, 0.600-inch, and 0.300-inch. In order to evaluate the minimal critical mass for 3 percent enriched uranium rods in light water it will be necessary to conduct critical approach experiments with a fourth and smaller rod size; current plans are to swage the 0.300-inch diameter rods on-site to a diameter of 0.17-inch for these measurements.

Experiments were completed for determining k_{∞} of the 3 percent enriched UO_3 polyethylene moderated systems at H/U atomic ratios in the range of 6-12. Some inconsistencies have arisen in the measurements involving the UO_3-H_2O mixtures; material which was to have been prepared with an H/U atomic ratio of about 10 was found on subsequent chemical analysis to have an actual H/U ratio of about 7; further, the repeatability of the measurements with the UO_3-H_2O mixtures has in some cases exceeded the expected error limits of the k_{∞} measurements; this may be the result of uncertainties in the values of the H/U ratios.

The maximum value of k_{∞} for the case of polyethylene moderation (CH_2) is

The second phase of this study indicated that the use of a constant age of 27 cm^2 for all uranium concentrations was the main reason for the conservatism in the calculated critical parameters for enrichments below 5% U-235. This study indicated that the neutron age should be taken inversely proportional to the square of the effective water density in the homogeneous mixture.

The present phase of this study involves a calculation of the fast effect (previously assumed to be unity) and the recalculation of k_{∞} reflecting these fast effect values. This study will also involve a correction on the extrapolation length to be used for water-reflected systems. The validity for such a correction to the extrapolation length for systems in which a reduced density core is reflected by a full density reflector has already been indicated.

The method used to calculate the fast effect is based on a formulation developed by APED for heterogeneous systems. For homogeneous solutions this formulation is reduced to the following:

$$\epsilon = 1 + \frac{0.372}{2.23 \frac{N_H}{N_{28}} + 1.33}$$

$\frac{N_H}{N_{28}}$ = atomic ratio of hydrogen to U-238.

Using this formulation for fast effect and calculating η, f, and p as before, k_{∞} was calculated as a function of H/U for several enrichments. The maximum k_{∞} for each enrichment is given in Table I.

TABLE I

% U-235	k_{∞} (max.)	H/U (Atomic Ratio)
0.95	0.981	4.90
1.00	0.998	4.95
1.50	1.154	5.96
2.00	1.255	6.56
3.00	1.380	8.24
4.90	1.510	10.45

The experimental value for the minimum enrichment with a maximum k_{∞} of unity is 1.02 ± 0.02% U-235. Interpolation between the values in Table I indicates this enrichment to be about 1.005% U-235. The experimental value of k_{∞} for 2 percent UF_4 at an H/U^{235} atomic ratio of 195 was found to be 1.216 ± 0.013. The theoretical value calculated in this study for these conditions is 1.225.

Miscellaneous Experiments for Nuclear Safety Specifications

Further exponential experiments were conducted with the 1.25 percent enriched I and E type fuel elements (1.336-inch O.D., 0.500-inch I.D.). The fuel rods consisted of six elements, each 7.5 inches in length, positioned in an aluminum tube of 1.402-inch O.D. with a 0.028-inch wall thickness. The fuel tubes

were loaded in a hexagonal lattice configuration. The following bucklings were determined this month.

Separation Between Rods (Inches)	H_2O/U (By Volume)	Buckling (Fuel Cores Dry)
1.85	1.14	4450×10^{-6} cm^{-2}
2.40	2.82	3696×10^{-6} cm^{-2}

The value of k_{∞} for the 2 percent enriched UF_4-paraffin mixture with the H/U^{235} atomic ratio of 195 was previously given as 1.206; the experimental data have now been further analyzed on the basis of a Wigner-Wilkens neutron spectrum, i. e., the effective cross section values which were used were appropriate to this spectrum. The value of k_{∞} is revised slightly as the result of this analysis to 1.216 ± 0.013.

Neutron Age Measurements

The analysis of the second series of experiments performed to determine the neutron age to indium resonance of Na-Be neutrons in water and in kerosene has been continued. Some of the more important parts of the analysis and the derived experimental results to date are given in this report.

A least-squares procedure has been carried out successfully to determine the best normalization for the experimentally-determined photoneutron background flux distributions. No direct normalization is available, because of failure of the ionization chamber which was used to measure the gamma activity of the beryllium-free source. The normalized background so determined has been subtracted from the Na-Be flux distributions. The asymptotic tails of all three 1.45 ev flux curves are consistent with the first-collision approximation within statistics. The normalization used has also been found to provide the best fit to the asymptotic thermal neutron distributions, but here the scatter of individual points around the first-collision distribution is two to three times greater than statistics. This point has not yet been investigated in detail.

The remainder of each of the large-source resonance neutron distributions has been fitted with a smooth curve, chosen so that the third derivative of $\log (r^2\phi)$ is monotonic and reasonably continuous. The portions of these curves between 11 and 17 cm have been used as models for the tails of the distributions obtained with the small sources. In contrast to the conclusion reached in the first series of measurements, the asymptotic behavior is not established until r becomes greater than 17 cm, so some physical assumption is required to bridge the gap. The range of "reasonable" assumptions explored to date introduces an uncertainty in the small-source ages of the order of plus or minus one percent.

Determination of the ages of the resulting curves is currently in progress. Results obtained to date are listed below:

Source-Moderator	Relaxation Length	Position of Peak	Age
First Series			
Large-Water	3.22 cm	----	14.7 cm^2
Small-Water	----	----	----
Large-Kerosene	3.12	----	14.0
Small-Kerosene	----	----	13.2
Second Series			
Large-Water	3.29 cm	6.25 cm	14.60 cm^2
Small-Water	----	6.15	>14.38
Large-Kerosene (bad)	3.41	----	15.01
" " (good)	3.36	6.30	14.73
Small-Kerosene	----	6.25	13.98

NEUTRON CROSS SECTION PROGRAM

Absolute Fission Cross Section for U^{235}

A redetermination of the mass per unit area of the gold foils used in the measurement of the monoenergetic U^{235} fission cross section was started. The area will be redetermined by an optical measurement of eight diameters for each foil. These measurements have been made for seven of the gold foils used. A preliminary examination of these measurements indicates that the areas of these foils range from 0.06 percent to 1.3 percent larger than the constant areas previously assumed.

Slow Neutron Scattering Cross Section of Water

During the month the room temperature water scattering experiments for incident neutrons of 0.141 ev energy were completed, and a similar set of experiments at an energy of 0.184 ev was begun.

At 0.141 ev incident energy, the neutron energy spectra of scattered neutrons were measured at 5°, 10°, 20°, and 30° scattering angles in the vicinity of the elastic peak using the 0.030-inch thick water sample holder. An angular distribution of the elastic peak was taken from 4° scattering angle to 76° using the same sample. Using a thinner (0.012-inch) sample of water, neutron energy spectra were taken at scattering angles of 10° and 60°. For normalization purposes the elastic group from vanadium was observed at 10° scattering angle.

The first axis was then changed so that neutrons of 0.184 ev are now incident on the specimen. At this energy the vanadium spectrum at 10° has been taken and an angular distribution of the elastic group from the thick water specimen is being taken at present.

Analysis of the 0.141 ev and 0.095 ev data reveal that within statistics the magnitude of the zero degree elastic and of the peak of the inelastic components

of the scattered beams are the same at the two energies. It was found that the angular distribution of the elastic portion of the 0.141 ev scattered neutrons fit very well the Debye-Waller function $\exp(-Q^2u^2)$ for a value of $u = 0.20$ A°. This compares with an experimentally determined value of $u = 0.30$ A° at an incident energy of 0.095 ev. This difference is not understood since the parameter u should vary only with temperature. The measurements of B. N. Brockhouse at AECL, Chalk River, gave a value of $u = 0.4$ A° for an incident energy of 0.035 ev.

Comparison of data taken with the 0.030-inch and 0.012-inch water sample holders reveals no appreciable effects which could be ascribed to multiple scattering.

Pu^{240} and Pu^{241} Fission Cross Sections

For the second month no fission cross section data were obtained at the 105-DR crystal spectrometer because the neutron beam was turned off to allow a lower radiation exposure to construction personnel installing the gas cooled irradiation loop on the X-1 level below the spectrometer.

A new parallel plate boron chamber has been constructed and bolted onto the front end of the fission chamber. This arrangement has proved to be more satisfactory than having the boron foil mounted in the fission chamber since the chance of accidental alpha contamination has been eliminated, and it is now possible to operate the boron chamber at a pressure different from the fission chamber. At a filling pressure of 25 psi of A-CO_2 the integral bias curves compare favorably with the old boron chamber.

In an attempt to achieve optimum detection efficiency studies were made on the effect of varying the clipping time, voltage, and pressure of the fission chamber.

Fast Neutron Cross Sections

The new vernier chronotron circuit has been physically completed and a new circuit developed to help reduce errors caused by variation in input pulse height. The system is now being checked out on actual photomultiplier detector input signals.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Correlation of Data on Heavy Water Moderated Cluster Lattices

Using Mummery's method, the PCTR-derived values of k_∞ and f for the various PRP lattices have been analyzed. A summary of the methods of analysis and the results is being prepared for inclusion in the forthcoming Physics Research Quarterly Report. Also included will be comparable data derived from material buckling measurements performed in Canada and Sweden for similar configurations. The data from various sites are in quite good agreement.

Improved Theoretical Methods

The use of the variational form of a linear theory has been studied as a starting point for its numerical approximation. Replacing the Lagrangian integral by a numerical integration formula reduces the Lagrangian to a form which defines a set of approximate finite-difference equations.

The advantages of this procedure are the automatic treatment of variable or discontinuous cross sections without the need for special boundary-crossing formulas and the possibility of systematically improving the accuracy of the approximation by using more elaborate integration formulas. In addition, the finite-difference equations for the direct and adjoint solutions will be consistent; that is, they will be adjoint to each other and will lead to identical eigenvalues, regardless of the truncation errors caused by the numerical approximation.

Low Exposure Pu Lattices

Design of the experimental equipment is complete and fabrication is in progress.

PCTR Experiments

The high exposure Pu lattice experiments await procurement of fuel material. Some analytical work is in progress concerning the form of the resonance multiplication factor of Pu.

Preliminary calculations are being made on highly self-shielded Pu fuel rods; the aim being to obtain long life, constant power output fuel assemblies. Results so far indicate that the specific power as a function of Pu density approaches a constant value for densities greater than 9 g/cm^3 for small diameter fuel rods.

Instrumentation

Fabrication of the warp measurement unit for the profilometer was completed. The lenses and mirrors to be used with this unit have not yet been received from the vendor, but similar elements which were on hand were installed and the unit was tested. The tests confirmed that the unit was capable of measuring warp to ± 0.001 inch. It has been found that a blinker shutter originally included in the design to assist in differentiating between the various images can be eliminated. The warp print-out mechanism was attached to the unit and tested. The system worked perfectly and demonstrated to the customer that the complete warp measuring system including the automatic print-out mechanism was accurate to at least ± 0.001 inch. Fabrication was completed on the diameter measurement unit except for the lens to be used in it. The design drawings are 95% complete.

All drawings for the wide-angle viewer are approved and in the hands of Technical Shops for estimating. Estimating is about 95% complete.

All measurements were completed in the determination of the thermal conductivity of graphite and UO_2 samples at temperatures between 1000°C and 2200°C. A report describing the methods and procedures used is being written and is about 75% complete. This work is being done in assistance to Ceramic Fuels Development Operation.

A semi-portable alpha-beta-gamma air monitor was designed on paper for possible application in PRTR. A memorandum report describing the proposed system will be issued in the near future.

GAS COOLED REACTOR PROGRAM

Experimental determination of the appropriate lattice parameters began during the week of March 16.

Some materials for the fuel temperature coefficient measurement have been received, and Tech Shops has been asked to finish fabricating materials by April 30, 1959.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month. There were five unscheduled shutdowns with two due to faulty bypassing technique and three due to a faulty control rod magnet contact. The channel iron that holds the rod drive mechanism on rod No. 3 had apparently been sprung causing poor contact between the control rod end and the rod magnet.

A three-day maintenance outage was taken to drill a through-hole for flux traverse measurements 3-3/4 inches below the longitudinal center line of the reactor.

The speed of rod No. 5 was doubled by changing the reduction gears in the drive motor. The rate of reactivity addition after the change is half the maximum allowed by the operating standards. Parts have been ordered to modify the other rods. Better reactor control will result as well as some time savings.

Graphite cross section measurements were completed during the month.

The first experiments for the gas-cooled reactor program were started.

Drawings were prepared and work orders issued for the graphite and aluminum tubes for the 1.007 percent enriched uranium, 7-element cluster experiment.

Radiation from the moving face of the reactor contributes to short working time limits allowed for loading and unloading the test cells. The possibilities of a radiation shield are being investigated. Radiation energy measurements have been made by RMO personnel to provide design information for the shield. Analysis of the data has not been completed.

In the TTR room, critical mass experiments were conducted during the first week of the month. Experiments for the Lattice Neutron Temperature Study were conducted during the balance of the month.

There were 7 unscheduled scrams during the month. One was caused by faulty operation of bypass switches. The remaining six occurred during the testing of some new ion chambers which were noisy.

An automatic temperature controller has been built and connected to the power

circuits for the TTR temperature controlled thermal column.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Arrangements between GE and the Division of Biology and Medicine, AEC, for the employment of Dr. Frank Pasquill as a visiting scientist for a period of one year were completed through HOO-AEC. Financial support for Dr. Pasquill's employment was agreed to by DBM, both for his employment at Hanford and for his occasional visits to other AEC sites. Necessary arrangements, within GE, for the employment of Dr. Pasquill neared completion at the end of March.

Acquisition of materials and preparations for the forthcoming stable atmospheres dispersion experiments were accelerated during the month. A contract was executed by HOO-AEC for the erection of towers and poles, and work was begun on this aspect of the experimental equipment. Surveying of the experimental course was completed except for an irregular extension of the southwest end of the 25,600 m arc. 486 pumps and bases were received and the delivery of an equal number of 3 HP gasoline engines to drive these pumps was scheduled for April 7-8. Installation of the portable mast near the generation point was begun. The control panel for the portable mast is to be located inside the 622 Building for the duration of these experiments. Procurement of personnel for these experiments was essentially completed with the employment of two non-exempt personnel and the acceptance of job offers by three University of Washington meteorology students. The latter persons will report on or about June 15.

Analyses of the problem of significance of individual concentration measurements and the development of significance tests for various models and their parameters were continued. Various models which simplify the calculation of the flux of tracer material through sequential vertical cylindrical surfaces were also examined for suitability. In all of this work, much depends upon the shape of the distribution functions involved, information which will not be available until the experiments have been run. On this account, some effort has been made to keep preliminary analyses systems as flexible as possible. The precise calculations necessary to flux and deposition calculations cannot be reasonably anticipated in their entirety until the actual basic data are in hand, however.

DOSIMETRY

In the Body Monitor, tests are continuing of various photomultiplier arrangements for the large NaI crystal. The seven 3" tubes gave excellent resolution--between 9 and 9.5%. It was found that replacing the center tube with a reflector changed the resolution very little. The resulting decrease in background indicated that practically all the K^{40} peak is due to the photomultipliers. Initial tests of a more uniform array of six 3" tubes have given less satisfactory results.

The 256-channel analyzer began giving trouble. It was out of operation about one-half the month. Most of the difficulty was with the live-timer. Two basic faults were corrected in the last week and it is hoped that this will remedy the situation.

Filters were installed on the main building air supply so that the cell air is double filtered. There has been no further indication of contamination in the cell.

A plutonium wound case was measured again and found to have 1.2 ± 0.02 mμc in his finger. A subject exposed to mixed fission product inhalation was examined; no radioactivity was detected.

A new type of charging belt, one filled with metal staples, was installed on the positive ion Van de Graaff in an effort to reduce some of the instabilities

construction, printed circuit types interchangeable in kind from one type of instrument to another. All experimental models of the above-named instruments have been previously thoroughly tested, evaluated, and accepted.

A simplified testing unit for various transistorized printed circuit boards is about completed. The tester will enable maintenance personnel to simply and easily test the various developed transistorized circuits including amplifiers, multivibrators, binaries, and count-rate meters. Such a system will greatly reduce downtime of portable and fixed instrumentation using the plug-in transistorized printed circuit components.

The pinhole camera was tested with the accelerator. Using Eastman Type KK X-ray film, a dose of 500 mr from a point source at the face of the camera will darken the film. Personnel at Purex requested some photographs of a floor which has some radioactive material seeping under it. No satisfactory results from field tests have been obtained yet.

The alpha air fixed-filter counter was fabricated, tested, and delivered to the field.

Two experimental, demonstration-model, nuclear incident alarm units were completed and tested including exposure to a 30,000 r/hr gamma field to insure alarming under extremely high dose-rate conditions. The units have performed reliably for about three weeks of continuous operation. No meter drift or reading change has been apparent even in the most sensitive case, using the booster transistor amplifier in the three weeks.

The available alarm-point operation settable on the units with such stable operation is from one mr/hr to more than 10 r/hr. This is a dynamic range of 10,000 to one. As addenda experimental work, several cadmium sulfide photocells were used with NaI crystals. This type of detector was found to be useful for gamma dose-rate fields exceeding 10 r/hr. The experimental demonstration nuclear incident alarm units use a phototube and a terphenyl-in-polyvinyltoluene crystal as a detector. The complete package unit can be fabricated for about $250 per unit in lots of 10 to 20.

The remaining three telemetering data stations were calibrated and all remote stations were installed. An inspection tour of the data station positions by representatives of Radio Maintenance, AEC, and HLO revealed five stations to be inoperative because of faulty or damaged wind generators. The results of the inspection are to be forwarded to the contractor by the AEC.

The new alpha source which was electrodeposited on platinum for the zinc-sulfide particle counter was received. The source had considerable background due to contaminates on the source itself. The background was almost entirely eliminated by attaching a metal ring to the photomultiplier tube to prevent the tube from seeing the scintillations on the source. The signal to noise ratio was decreased by a factor of two as compared to the old source. This is understandable since it was necessary to place the alpha source farther from the filter so the unit will accommodate two-inch filters instead of one-inch filters. Variation caused by turning the filter were eliminated which indicates that the electrodeposited source is evenly deposited.

The one square cm scintillation external probe for the scintillation dose-rate meter, Model II, has been received from Technical Shops and a preliminary calibration check made. The response appears linear over the ranges tested and at the energy of the Ra source used. There is a beta to gamma response ratio of 4.5.

The investigation of determining the efficiencies of various light pipes continued with emphasis on beta-gamma detection.

A dual beta-gamma probe design has been completed and Technical Shops have started the fabrication.

WASHINGTON DESIGNATED PROGRAM

The magnetic sweep system of the mass spectrometer for this program was completed in its final form and satisfactorily tested. The maximum sweep range is 14 mass units at the mass 238 region.

Efforts toward putting the entire ion-counting ion detection system into reliable operation were temporarily suspended in order to meet the need for providing as soon as possible some analytical service to this program. The alternate ion detection system consisting of the electron multiplier, vibrating-reed electrometer and Brown recorder were put into operation. Studies of the accuracy of isotopic ratio measurements and sample sensitivities were begun.

CUSTOMER WORK

Analog Computing

A six-region xenon poisoning study has been completed for the PRTR and a report is being prepared.

A formal report on the simulation of the PRTR control system is in preparation.

The NPR open coolant loop frequency response is being studied.

A study of water pump behavior for the NPR design has begun.

The simulation of an electromagnetic non-destructive test has been completed and a report, HW-59546, was issued.

Maintenance requirements on the present computer are increasing; in particular, it appears that replacement of a large number of potentiometers throughout the machine will be necessary.

The bids for both the new recorder and computer have been opened. The recorder has been ordered. The computer order had not been placed at month's end.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	93	85.6
24-Hour General	62	85.3
Special	124	85.5

Except for a little more wind than usual, March was a near-normal month and was devoid of any notable extremes.

Instrumentation

The main instrument unit of the sensitive gamma scintillation area monitor for the Regional Monitoring Operation was redesigned from the standpoint of layout for ease of maintenance. The final unit is now being fabricated. The original experimental unit is still working quite satisfactorily and has been used in both aircraft flights and in boats on the river for sensitive gamma area monitoring. The full scale first-range sensitivity corresponds to 0.015 mr/hr from a Ra gamma source.

Acceptance tests were started on 47 new HAPO GM's and eight Victoreen remote-area monitoring systems with a total of 65 channels. Evaluation tests were continued on scintillation alpha air sample counters while tests were completed on a 500-kc scaler stage and on standards for linear amplifiers. A survey of commercial remote-area monitoring systems was finished. Assistance was given in evaluation of a gamma pinhole camera.

Optical

Design drawings are being made and fabrication is about 50% complete on a scanning system which can be used in the six-inch diameter access holes on the rear shield wall of the reactors in conjunction with a TV camera to view the rear face.

The modified slit camera for the 105-C Fuel Inspection Facility was tested and demonstrated. Tests revealed light leaks which are being eliminated by sheet metal shields. The film carriage is being adapted to hold film packs as well as cut film holders. Several fine pictures of cylindrical objects have been obtained.

The routine Optical Shop work included the modification of a slit camera and a Redox crane periscope head; the fabrication of 20 glass bearings, borescope parts, and pyrometer components; the repair of a camera shutter; and the installation of a new coolant system on a Jorgan Grinder.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

1252210

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
E. R. Wagner	3/16-17	American Car & Foundry Washington, D. C.	Look over Gas-Cooled Reactor Physics Experiments.	RE Heineman TJ Oakes	No	300: 326 305-B
D. M. Johnson	3/16-17	Kaiser Engineers Oakland, Calif.	" " "	RE Heineman TJ Oakes	No	300: 326 305-B
J. E. McCloskey	3/16	Electronics Associates, Inc. Los Angeles, Calif.	Consult on Analog Computer.	HH Burley WD Cameron GR Taylor	No	300: 326
O. J. Judd	3/18	Rush Drake Associates Seattle, Wash.	Discuss Analog Computer Techniques.	HH Burley WD Cameron GR Taylor	No	300: 326
R. M. Walker	3/23	G-E Research Lab. Schenectady, N. Y.	Discuss electron spin resonance of irradiated silicon.	JE Faulkner	No	300: 326
Eugene Tochilin	3/26	USNRDL San Francisco, Calif.	Discuss neutron measurements.	J DePangher	No	300:328,329 3706,3717-B 3745,3745-A 3745-B,3760
Dr. M. L. Barad	3/26-27	Air Force Cambridge Research Center Bedford, Mass.	Discuss dispersion.	GR Hilst PF Gast HM Parker	No	200-W:2704-W 622 300:326,3760
Lt.Col. B. Pusin	3/26-27	6th Wea. Sq. Tinker Field, Okla.	Coordination of Air Weather Service Obs. during dispersion experiments.	GR Hilst	No	200-W:622 2704-W

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
Dr. W. H. Clayton Winton Covey, Jr.	3/26-27	Texas A and M College Place, Texas	Coordination of Texas A & M observations during disperaion experiments.	GR Hilst JJ Fuquay	No	200-W:622 2704-W

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. S. Selengut	3/3-5	Western Joint Computer Conference San Francisco,Cal.	Attend Conference.	--	No
	3/6 & 3/9	Univ. of Calif. Berkeley, Calif.	Presented talks.	L. M. Grossman	No
I. T. Myers	3/4	Los Alamos Scientific Laboratory Los Alamos, N.Mex.	Discuss calorimetric measurements on graphite.	Charles Holley	No
		" " "	Discuss neutron dosimetry.	S. J. Bame	No
		" " "	Discuss whole body counting.	Marvin Van Dilla	No
	3/9	Univ. of Texas Austin, Texas	Discuss gamma ray measurements.	H. P. Hanson	No
	3/10	Rice Institute Houston, Texas	Discuss whole body counting.	Marvin Van Dilla	No
B. R. Leonard, Jr.	3/4-5	Rice Institute Houston, Texas	Attend Neutron Cross Section Advisory Committee Meeting.	Prof. T. W. Bonner	Yes
	3/9	General Atomics San Diego, Calif.	Discuss slow neutron scattering.	A. W. McReynolds G. W. Stuart	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. D. Clayton N. Ketzlach	3/9-11	E.I. DuPont de Nemours Savannah River, Ga.	Present papers to Industrial Nuclear Safety Group Meeting	H. K. Clark	Yes
J. E. Faulkner	3/9-11	E.I. DuPont de Nemours Savannah River, Ga.	Attend Industrial Nuclear Safety Group Meeting.	H. K. Clark	Yes
J. J. Fuquay	3/23-24	Armour Research Ill. Inst. of Tech. Chicago, Ill.	Discuss deposition measurement.	J. Rosinski	No
		Argonne Nat'l Lab. Lemont, Ill.	Discuss meteorological measurements.	H. Moses W. C. Swinbank	No
		American Meteorological Society Univ. of Chicago Chicago, Ill.	Participate in instruments clinic as invited discussant.	G. Gill	No

Chemical Research and Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Reactor Components

In studies on the dissolution of uranium dioxide (formed by exposure of uranium wire to hot water) by decontaminating agents under study, Turco 4501 and 4512, alkaline permanganate, and APACE(II) solution (ammonium citrate - EDTA) solubilized very little uranium. Peroxide in carbonate-bicarbonate solution did solubilize the uranium dioxide as did also the APACE(II) solution when it was used following prior treatment of the dioxide with alkaline permanganate (APACE(I) solution). In similar experiments with irradiated uranium dioxide, it was shown that some of these reagents, particularly citrates, will desorb much of the fission product content without dissolving the oxide. Adsorption of fission products from the uranium dioxide leach solutions by scaled and unscaled mild and carbon steel surfaces was studied. In general, carbon steel surfaces adsorbed fission products more strongly than stainless steel. Adsorption was particularly high from peroxide-carbonate solutions (5 to 15 per cent) but was markedly reduced by the addition of ammonium citrate and Dupanol. Large differences in the adsorption of individual fission products were noted.

Coupon decontamination studies were concerned largely with modifications of the APACE process. Varying the acidity of the Step II solution from 4.5 to 9.0 decreased decontamination by a factor of about 10 for carbon steel and 50 for stainless steel. Preliminary tests indicate reagent concentrations in both steps can be reduced appreciably without serious loss in decontamination. Either sodium citrate or sodium oxalate appears to be as effective as ammonium citrate in the Step II solution. Removal of fission product contamination adsorbed onto unscaled surfaces is more difficult than when the contamination is adsorbed on a scaled surface. Among several corrosion inhibitors tried with the APACE Step(II) solution, acridine, thiourea, and 2-mercaptobenzothiazole showed the most promise and will be investigated further.

Flow Characteristics of an Aluminum Packed Bed

Studies have been started to determine the flow characteristics of simulated reactor effluent water through beds packed with various forms of aluminum turnings. This is part of a program directed toward the use of such material to decontaminate reactor coolant water.

The present experimental equipment consists of an eight-inch-diameter by ten-foot long column with taps every three feet for pressure measurement. Differential pressures are measured with a Foxboro 0-200-inch DP cell.

Initial studies of flow through a "standard" packing (2S aluminum turnings ca. 0.005-inch thick by 0.13-inch wide) packed to an average density of 4.37 lb/cu.ft. indicate some bed compression with increased flow rate. This results in a slightly higher rate of increase in pressure drop with flow rate than would be anticipated. Pressure drops at 290 gpm/sq.ft. are about 0.67 psi per ft. of bed.

Automatic Analyzing Monitor

Work on the formal report for this development was in progress during the month. In conference with IPD representatives it was agreed that the instrument should be placed in as near routine operation as is presently possible and that a careful search would be made for optimum locations for permanent installations of this and future instruments.

Uranium Oxidation and Fission Product Volatilization

Coil and crucible configuration for induction melting of uranium was firmed up after testing various designs. A compact arrangement was developed which permits the coil and crucible to be sealed in a metal tube of small diameter. With air as the insulator between crucible and tube wall the temperature of the tube did not exceed 175 C when the crucible temperature was maintained at 1200 C. Designs of induction coil disconnects were developed.

Scheduled experiments on the release of fission products from low level irradiated uranium in an air atmosphere were nearly completed. The effect of temperature, time, and air flow rate on the fission product fraction released was determined. The deposition pattern after release was investigated with and without filters in the line.

Xenon, iodine and tellurium behaved similarly. These elements were released at a rate in proportion to the rate of oxidation of the uranium metal. About 80 per cent of these elements was released when the metal was completely oxidized. Longer heating periods did not drive off the remaining 20 per cent at a 1215 C furnace temperature.

As expected, increased temperature caused an increased fission product release rate for each of the seven isotopes studied. The range of temperatures investigated was 620 - 1440 C. Air flow rate was found to have a minor effect on the total amount released but strongly affected the deposition pattern after release. A much higher fraction remained in the furnace tube at low air flow rates.

Ruthenium behaved peculiarly. At 1215 C it was released at a steady rate until a total of 2 per cent was volatilized up to the time of complete uranium oxidation, or in about 50 minutes. Then a greatly accelerated release occurred until a total of about 46 per cent was released during an additional 70 minutes of heating.

Reactor Effluent

IBM-tabulated chemical analyses of retention basin samples and related operating conditions for the last eight months of 1958 were received; release rates for

As^{76} and P^{32} for each reactor were studied along with the data from the previous three years. Both isotopes continued to show consistent seasonal variation as well as definite increases each year. The data will prove useful in predicting future individual reactor release rates in the event of process or production changes.

Analytical Services

Arsenic-76 is being reported with ± 10 per cent error at the 95 per cent confidence level. Use of a two liter sample and spike solutions helped meet that needed refinement.

SEPARATIONS PROCESSES

Recovery of Neptunium in Purex

Operational difficulties encountered with the dichromate-oxidized 2A recovery flowsheet used in the last plant run prompted experimental studies of alternate methods for effecting extraction of neptunium in the 2A column.

Batch extraction studies with plant 3WB revealed little difficulty in effecting extraction of neptunium by use of reductants. In these tests two successive extractions of 3WB (adjusted to 8 M HNO_3) were made at 50 C. The first extraction simulated the feed point of an extraction column while the second extraction simulated the waste (dilute uranium) end of such a column. Neptunium distribution ratios obtained with various 3WB feed treatments indicate that partial recovery of the neptunium in 3WB could be effected with no treatment other than the evaporation and storage at elevated temperature which 3WB customarily receives. However, nearly complete recovery appears easily possible by addition of ferrous sulfamate and hydrazine to the feed.

Subsequent studies with synthetic 3WB indicated that neptunium could be readily reduced to neptunium(IV) and extracted out of 8 M HNO_3 by addition of either sodium nitrite or ferrous sulfamate and that the concentration of ferric and sulfate normally present in 3WB did not significantly hamper the extraction of the neptunium. These studies also indicated a workable scrub section neptunium(IV) distribution coefficient of about 0.3 with a 2 M HNO_3 scrub.

These studies thus confirmed results obtained in previous anion exchange work, viz., that neptunium(IV) can be readily formed in 8 M HNO_3 and is rather stable at this acidity and nitrate concentration.

Mini runs were made to test the feasibility of recovery of neptunium from 3WB by two approaches. The first attempted to effect recovery of neptunium by extraction of 3WB with 30 per cent TBP to which had been added about 0.001 M nitrous acid. This approach seeks to establish an appropriate aqueous phase nitrous acid concentration profile in order to catalyze oxidation to neptunium(VI) by the nitrate present in the aqueous phase. It proved successful in earlier laboratory studies of neptunium extraction in the HA column and has been used successfully in the plant HA column during the last two run periods. However, the Mini test of this

approach with 3WB resulted in high internal reflux of neptunium with the 1.5 M HNO_3 scrub stream used to effect adequate scrubbing of nitric acid out of the 2AP. This, together with the brief aqueous phase hold-up time in the 2A extraction section at rates projected for the plant run, indicated that only marginal neptunium recovery could be guaranteed in a plant run using this approach.

A Mini run in which 0.05 M ferrous sulfamate and 0.05 M hydrazine were added to both feed (3WB at 8 M HNO_3) and scrub (2 M HNO_3) resulted in satisfactory neptunium recovery (to a waste loss of about 0.2 per cent) but virtually total internal reflux of plutonium. This again confirms results obtained in earlier anion exchange work in which clean separation of neptunium and plutonium could not be obtained with 8 M HNO_3 feeds.

On the basis of earlier anion exchange experience reduction of the feed acidity to 6 M HNO_3 should give improved plutonium separation and should require only a slight increase in solvent flow over that used in the Mini run. Accordingly, the flowsheet planned for the next plant run will employ a 6 M HNO_3, 0.05 M ferrous sulfamate, 0.05 M hydrazine feed and a 1.5 M HNO_3, 0.05 M ferrous sulfamate, 0.05 M hydrazine scrub solution. The uranium-bearing neptunium extract from the 2A column will be processed through the IBX-IBS columns to effect separation of neptunium and uranium (a flowsheet used successfully in previous plant runs). Additional concentration and purification of the neptunium will be effected by a 2A-2B total reflux flowsheet (likewise used successfully in previous plant runs). This flowsheet will therefore retain much of the cost advantage resulting from use of the 2A column rather than the HA column and hopefully will avoid problems of the nature encountered with the dichromate flowsheet.

Specific Alpha Activity of Neptunium-237

A consistent difference of about three per cent between the results of neptunium determinations by alpha counting and by coulometric titration has been resolved by a redetermination of the specific activity of neptunium-237. It was found that the specific activity of neptunium-237 is 1562 ± 7 disintegrations per minute per microgram which corresponds to a half-life of $2.14 \pm 0.01 \times 10^6$ years. The previously accepted half-life was $2.2 \pm 0.1 \times 10^6$ years. The determination was made both by using low geometry absolute alpha counting and 4π liquid scintillation counting with known amounts of neptunium-237. The amounts of neptunium-237 counted were known from the make-up of a solution prepared from purified neptunium metal and rechecked by coulometric titration.

Tritium Processes

Initial testing of the palladium absorption material prepared by scrbing tetrachloropalladate ion on anion exchange resin and decomposing was not successful. This was apparently due to incomplete decomposition of the resin, as tars were evolved in the chromatographic runs. Separation was insignificant.

Analytical Services

Analysis of organic phase neptunium was simplified by hydroxide precipitation of neptunium from alcohol. The organic sample was dissolved in five volumes of ethyl

alcohol and aqueous Np^{239} spike and uranium carrier added. The uranium was precipitated with alcoholic potassium hydroxide. The precipitate was dissolved in nitric acid and treated as a normal aqueous sample. More than 98 per cent of the neptunium was carried.

An eight-foot modified Junior Cave was obtained from Chemical Research and moved into 6-3A the latter part of the month. The cell installation is a temporary expedient to reduce personnel exposures when aliquoting, titrating, and handling dissolver solutions and 1WW waste samples.

A matrix for eleven isotopes measured in crop and vegetation samples was prepared for test programming on Data Processing equipment. The geometry of a filled 9 ounce jar placed on top of 3" x 3" NaI (Tl) crystal was used.

A flame photometric method has been adapted for the determination of aluminum with ± 5 per cent error at the 95 per cent confidence level. Aluminum-cupferron complex was extracted into hexone which was aspirated. The presence of 20 to 100 mg of zinc did not cause interference.

Daily plutonium standards for coulometric titrations showed a precision of ± 0.8 per cent at the 95 per cent confidence level over a two-week period of operation.

WASTE TREATMENT

Solvent Extraction of Fission Products

A series of scouting experiments are being performed to determine the potential of fission product solvent extraction for waste treatment or fission product recovery applications. Two extractants have been used to date: two per cent di-2-ethyl hexyl phosphoric acid (DEHPA) in Amsco and four per cent tall oil in chloroform. Extraction of gross beta activity from synthetic 1WW spiked with plant waste was studied as a function of pH. Extraction reached a maximum of 42 per cent at pH 7.2 with DEHPA and of 63 per cent at pH 10.3 with tall oil. The tall oil is a product of the distillation of wood (by-product of turpentine manufacture) and is primarily a mixture of high molecular weight fatty acids and rosin acids. The purified individual acids are available from this source at reasonable cost.

Fixation of Purex Waste by Spray Calcination

Powders with and without phosphate and prepared by spray calcination of synthetic Purex 1WW solution were heated to ca. 900 C. The phosphate containing product melted to a dense glass but proved very corrosive to iron or nickel crucibles. In plant application, this glass will probably require ceramic crucibles for fusion. The phosphate-free calcined 1WW did not melt under these conditions but sintered to a compact mass of fairly high density. Volume reduction from spray calciner powder to sintered product was six to eight fold, and this material did not appear to be corrosive to iron.

Fixation of Purex Waste by Batch Calcination

Four preliminary scouting runs utilizing unagitated batch calcination techniques have been performed. Solutions simulating the approximate limit of chemical stability of "formaldehyde-killed" and three-fold concentrated Purex 1WW have been used as feed. Two techniques have been briefly tested: (a) dropwise addition of the solution into a hot (1000-1100 C) calcination vessel in which drying and calcination are performed essentially simultaneously, and (b) preconcentration to a thick sludge followed by drying and calcination at temperatures up to 800 C. Although very little quantitative data have been obtained on the resulting calcines, results of these early runs are encouraging. The bulk volume of calcined product varied from about 12 to 37 per cent of the concentrated feed. The lowest volume resulted from operations where nearly complete melting of the calcine was achieved.

Semiworks Fluid Bed Calciner

Site preparation, equipment fabrication, and equipment procurement for the semiworks calciner have been initiated. Preliminary design is completed and final design is about 70 per cent complete.

ANL Fluid Bed Calcination Studies

Scouting calcination studies on synthetic Purex 1WW in a 6-inch fluid-bed waste calciner have continued at ANL. The majority of the runs, to date (of 6-7 hours duration) has employed a feed of simulated Purex 1WW, feed rates of 6 liters/hour, and calcination temperatures of 350 to 500 C.

Operations at calcination temperatures of 350 to 400 C resulted in a product with a tapped bulk density of $\sim$1.2 g/cc. (No other analytical data were available.) The major problem encountered at these temperatures was the formation of +20 mesh-size irregularly-shaped lumps (similar to Grape-Nuts). The +20 mesh fraction although somewhat adversely affecting fluidization characteristics, did not tend to buildup in the bed over the 6-7 hour runs.

Operation at 500 C was markedly improved over that at 350-400 and was characterized by a decrease in the +20 mesh fraction and an increase in the +60 and +80 mesh fractions, with an attendant improvement in fluidization characteristics.

Future work will employ a low-acid feed similar to that resulting from nitrate destruction by formaldehyde and subsequent three-fold concentration (the approximate limit of chemical stability). In addition, the length of runs will be increased to twenty-four hours or longer.

Observation Wells

No significant changes were observed in the extent of ground water contamination from disposal facilities in the chemical processing areas. Wells monitoring the 216-BY crib site continued to show Co^{60} concentrations up to 10^{-4} uc/ml. Reperforation of wells in this area did not change the concentrations of Co^{60} found.

Disposal to the Ground

Studies were continued on the efficiency of various anion exchange resins for removal of Pu from CAW (Recuplex) waste. A new sample of Permutit SK resin was obtained and tested. Both column and equilibrium studies verified the previous poor uptake data for this resin as compared to other resins tested. At room temperature and a flow rate of 3.5 ml/cm^2/min., 5 per cent breakthrough was found at 15, 90, and 225 column volumes for 20-50 mesh Permutit SK, Amberlite IRA-401, and Amberlite IRA-400, respectively. A Dowex 1X4 column at room temperature, 50 - 100 mesh, and flow rate of 6 ml/cm^2/min. gave a 5 per cent breakthrough at 245 column volumes. Column elution studies showed 95 per cent removal of Pu at 2.2, 4.1, 16, and 15 column volumes for Permutit SK, Dowex 1X4, Amberlite IRA-401 and Amberlite IRA-400, respectively. All results reported to date are for about 25 C. Column uptake and elution studies were started at 60 C.

Current engineering and laboratory data applicable to the recovery of plutonium from Recuplex process waste by anion exchange were presented to engineers in the Research & Engineering Operation, CPD. Sufficient data are available to begin the detail design of the proposed prototype resin column. Calculations indicate that the available fluid head will be ample for a gravity-feed system if the solids in the waste do not seriously plug the bed. Tests will be conducted to evaluate the effect solids may have on the pressure drop across a resin bed; backwash characteristics will also be investigated.

Special Geological Studies

Well drilling by the Artesian Well and Pump Company (Project AT(45-1)-1255) and the Midland Drilling Company (Project AT(45-1)-1406) on current contracts was completed. Installation of well screen, development and a pumping test on well 699-31-53 remain to be done by Artesian Well and Pump Company. More than 500 pounds of bentonite were used in drilling the well, below the water table. Attempts will be made to remove the bentonite using standard development procedures and special detergents in order to recreate the pre-existing aquifer conditions. Inasmuch as the well was drilled to determine these conditions, assurance will be lacking that the goal was attained.

TRANSURANIC ELEMENT AND FISSION PRODUCT

Multicurie Cell Rare Earth Recovery Investigations

Analytical results on the cerium recovery run made last month and preliminary results and observations on runs performed this month indicate very poor flowsheet performance. Cerium recovery was very low and a voluminous (50 per cent centrifuged volume) ferric sulfate precipitate greatly increased the bulk of rare earth sulfate product. This interfered with subsequent dissolution of the cake, and only partial dissolution was obtained in water or dilute nitric acid (the ferric sulfate, however, appeared to be preferentially solubilized by oxalic acid). Supporting studies show that the reasons for these difficulties are the decrease in 1WW volume per ton of feed processed and the increase in total process iron since the cerium recovery process was developed (HW-54500). These changes have

resulted in a five fold increase in total iron concentration, leading to the observed ferric sulfate precipitation. Tracer level experiments suggest that the difficulty can be alleviated or prevented by: (1) diluting the 1WW feed, (2) neutralizing to a lower pH (0.5 vice 2), or (3) centrifuging at an elevated temperature to take advantage of the retrograde solubility of the rare earth sulfates.

In other multicurie cell experiments with a new sample of plant waste, the zirconium-niobium bearing precipitate in as-received 1WW was found to consist of two phases, one easily and the other difficultly removable by centrifugation. Zirconium-niobium appears to be distributed more or less non-preferentially between the two phases. The heavy solids settled readily on standing and centrifuged to a volume of about 2.5 per cent. The light solids did not settle and were not removed by centrifugation for five minutes to 1,200 G, but were removed by 15 minutes centrifugation to a centrifuged volume of five per cent.

Promethium Recovery and Purification

A promethium recovery process is being studied and includes the following steps: (1) isolation of a crude rare earth mixture from Purex 1WW, (2) removal of cerium from the rare earth mixture, and (3) separation of promethium from the other rare earths.

Study of the first step, largely from the standpoint of cerium recovery, has been under way for some time, and the results of current studies with plant waste are reported elsewhere. Preliminary experiments with samarium as a stand-in for promethium (which has no natural isotopes) gave 93 per cent samarium sulfate precipitation. Separation of cerium from the other rare earths by oxidation with permanganate and precipitation as the iodate has been repeatedly demonstrated and works well. However, other cerium-rare earth separations are being investigated in order to minimize the corrosion and ruthenium volatilization problems which might result from plant application. Following removal of the highly radioactive cerium, the promethium will be separated from the other rare earths and purified by a variation of the Ames cation exchange resin - EDTA method. Principal uncertainty is in the extent of radiation induced resin damage in the third step, and innovations will be aimed at increasing through-put rates and decreasing hold-up times to minimize this factor. Promethium product purities well in excess of 99 per cent should be attainable.

Xenon Isotope Separations

The Atomic Energy Commission has requested that a study be made of the recovery and separation of Xenon isotopes from dissolver off-gas streams. In support of the isotopic separation portion of this study, the scope design of a pilot unit providing separation by thermal diffusion is currently under way. On the basis of theoretical calculations, two columns of the single stage, concentric tube-type have been scoped. Their dimensions are:

Design	Length (meters)	Innertube O.D., cm	Outertube O.D., cm	Gap cm
1	6.0	3.41	4.68	0.635
2	6.0	11.46	12.74	0.635

Design 2 is included to determine whether increasing the column size can be used as a means for increasing production capacity and consequently making single stage apparatus practical for plant use in spite of some theoretical indications to the contrary. The operating temperature of the hot surface of the inner tube is calculated to be 879 C. The optimum pressure appears to be 0.4 atmospheres absolute.

Fission Product Isolation and Packaging Prototype

Three major pieces of equipment remain to be completed in the fabrication of the Cesium Isolation and Packaging Prototype. The hydrolyzer is expected to be completed about the first of April; while the capper and the hopper and crystallization assembly are expected to be completed by the end of April. The rest of the equipment is in location at the 321-A Building and is undergoing calibration and preliminary testing.

Studies are being made to explore the possible use of the prototype for various fission products. The initial study presenting the modifications required for packaging strontium and cerium is documented in HW-59767, "Alternate Uses for Cesium Isolation and Packaging Prototype Equipment." Briefly the report indicates that an estimated $120,000 and a 16-month modification period would be required to permit packaging more than 500 megacuries a year of strontium fluoride. The prototype could be used with essentially no modifications for packaging more than 1000 megacuries a year of cerium oxide.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Self-Balancing X-Ray Absorption Instrument

The development of a prototype model of a self-balancing X-ray absorption instrument (X-ray photometer) is almost complete. The instrument has been designed principally for in-line analysis applications where it may advantageously replace gamma absorptiometers in some locations because of the much higher photon intensity of the X-ray source. The main disadvantages as compared with radioactive sources are the added bulk and the added maintenance of the X-ray head.

The present instrument prototype uses an air-cooled, medical-type X-ray head, a split beam, and dual ion chamber detectors. Two basic systems have been tested; an AC type and a DC type. Although slightly more reliable and more sensitive, the AC system must be mounted at the detector, whereas the DC system can be remotely located, permitting easier maintenance of the electronics in a "Separations Plant" installation. A transistorized AC system as well as an all electronic AC system was tested. The range of the instrument can be adjusted from a 0 to 30 g/l to a 0 to 100 g/l uranium range. In all ranges, the precision was better than 1.3 per cent standard deviation.

EQUIPMENT AND MATERIALS

Bearing Test Program

A journal made of commercially pure titanium was tested for compatibility with a boron carbide bearing. On two trials, the combination seized quickly while operated at about 3000 rpm when submerged in water and radially loaded with about 10 psi. Titanium transferred onto the boron carbide demonstrating the incompatibility of this combination when operated under the described conditions.

Combination Pump-Agitator

Initial experiments on a combination pump-agitator have demonstrated the basic workability of the concept. To provide the combination pump-agitator, holes were drilled in the casing of the bottom stage of a Johnston deepwell turbine pump. A small fraction of the liquid passing through the bottom stage is discharged through the casing holes to agitate the tank contents. Initial agitation studies have demonstrated that a horizontal cylindrical 30,000 gallon tank (approx. 10-feet in diameter, 40-feet long) can be homogenized in approximately an hour. Such a pump-agitator combination could find widespread separations plant use since two tank operations can be performed using the same electrical supply system (motor and jumpers).

Completion of Conical Slinger Seal Studies

The Johnston deepwell turbine pump used for testing of the conical slinger seal (splined-coned assembly) has been dismantled after 2700 hours and inspected for wear. Neither the slinger cone nor the graphite face was noticeably worn. No evidence of seal leakage could be found. The unit is being reassembled and will be stored in 300-W. No further testing is contemplated. A seal of this type has been recommended for installation on the L-cell (plutonium solution) pumps in Purex.

Archimedes Screw Metering Pump

The Archimedes Screw metering pump, described in the January report, has been transferred to CPD for use in the 224-U Building. Although originally designed for use as a reliable low-flow metering pump, it will be used in 224-U as a proportional liquid sampler. It will be adapted for taking a carefully measured liquid sample continuously from the building condensates for subsequent laboratory analysis.

Plastic Casting Studies

Assistance has been given the Engineering Operation of Fuels Preparation Department in the development of an improved ultrasonic device for detecting imperfections in the bonding layer of I and E slugs. Our assistance has been primarily in the development of plastic casting methods for certain of the detection probe parts which were subject to frequent failure. Field experience with a probe employing

a new type cast epoxy crystal holder has shown a marked improvement in bond-layer-imperfection detection sensitivity, presumably resulting from the better acoustical properties of the epoxy resin crystal holder.

Plastic casting techniques have been developed for making replacement parts for portable radiation detection instruments. Instrument shop personnel have been trained in these techniques.

Corrosion of Ti-6Al-4V Alloy in HNO_3

A titanium alloy, Ti-6Al-4V, is under consideration as a material of construction for the entire loop of the Redox product concentrator. Literature data indicate corrosion rates for this alloy in boiling 65 per cent nitric acid of about 0.3 mil per month. These rates were confirmed. However, in boiling 5 M nitric acid, corrosion rates of from three to five mils per month for specimens as received, welded, and coupled to tantalum were obtained. These rates are higher than those observed for 304-L stainless steel under the same conditions. Corrosion rates observed for A-55 titanium under the same conditions were less than 0.01 mil per month.

Corrosion by Dibasic Aluminum Nitrate

Aluminum (6061-T6) and 304-L stainless steel were examined as possible construction materials for containing dibasic aluminum nitrate (diban) as proposed for use in the Redox process. Corrosion rates for the aluminum material increased from about 1.5 to 600 mils per month in 4.17 M diban as the temperature was increased from 25 to 106 C. Aluminum does not appear suitable for this service. Under the same conditions, corrosion rates for 304-L stainless steel were less than 0.1 mil per month.

PROCESS CONTROL DEVELOPMENT

Assistance to Chemical Processing Department

The dual jet sample jumper for the Redox F-I (IAFS) sampler has been installed. The system provides adequate sample flow but the sample appears to be diluted somewhat, with steam from the bleed to the jets. A pressure switch is being installed on the sampler line (in the sample gallery) to stop the flow of steam and motivating gas to the jets in the event the sample line should become pressurized due to plugging in the discharge line of the first stage jet.

UO_3 Plant Calciner Automation

Four Fischer-Porter Magnetic Flowmeters have been installed in the feed streams to the K calciner. Since this installation, K calciner has been started up three times and shutdown twice with greater control than has been recently obtained. Powder temperatures have been maintained at 520 F within plus/or minus 1 F during steady state conditions, as compared with temperature fluctuations of plus/or minus 25 F which had occurred when the "sticking" rotameters were used. The inherent noise signal present in the Fischer-Porter system has been effectively damped out by the long length of pneumatic line connecting the secondary instrument and the feed recorder controller.

IC Column Studies

Three methods of analyzing the column contents to show the distribution of uranium between the two phases and the ratio of the two phases to each other throughout the column are being investigated. One is a photometric device that analyzes the phases trapped between the plates of the cartridge after the pulser and feed pumps are shut off. Another is a small hold-up uranium photometer that withdraws a continuous sample directly from the columns. (The closely spaced, aqueous wetted viewing windows exclude the organic phases of the mixed phase samples from being viewed.) The third is a phase selective photometer of very small dimensions designed to be inserted directly into an operating column at a number of points through sealed ports. Each of these have distinct advantages and disadvantages and each will be investigated further.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End Studies

Shear NaK Studies. Studies are currently being made to develop safe methods for handling the small sodium and NaK reservoirs present in some of the fuels to be handled in the non-production fuel reprocessing program. In recent studies tubes containing sodium have been sheared underwater with inert gas blanketing the gas space above the shear blade. Although capsules containing up to 100 grams have been sheared in a single blade stroke without incident, the results are not considered representative of plant conditions. In these experiments the thin wall tubing collapsed and minimized the area of sodium-water contact. Consequently the reaction was not so violent as it would have been under actual plant shearing conditions when greater than 50 per cent of the tube area would remain open.

To determine the violence of the NaK-water reaction when NaK is free to react completely with water, small bottles containing up to 8 grams of NaK were fractured by the shear. Although the hydrogen generation rate was considerably greater than in the sodium experiments discussed above (sufficient to force water, gas and some NaK particles from the shear feed port), it was found that the inert-gas blanket was effective in preventing burning and explosions in the shear gas space.

From these experiments it is concluded that sodium and/or NaK can be safely reacted under water employing inert gas blanketing as long as it is reacted a little bit (say up to 5 or 6 grams) at a time. Consequently in the future, studies are to be made to develop sawing and shearing techniques which will permit meeting NaK a little bit at a time. Such techniques are compatible with the NaK-containing fuel elements Hanford is to process.

Shear Blade Performance. The equivalent of one ton of fissile material in typical non-production fuels geometry has been chopped with an alloy steel shear blade, without significant attrition of the blade. The blade, currently being life-tested, has made several thousand cuts totalling approximately 5000 sq.in (cross section area) of material cut.

Sawing Studies. Sawing studies have been made during the month using a dry friction blade for cutting Zircaloy tubing. In addition to the basic sawing studies, an off-gas filtration system including a rotoclone and a filter assembly was installed to permit studying of the particulate generated during the friction cutting operations. Although quantitative information is not currently available from these tests, the following pertinent observations were made:

1. Some burning of small chips and fines occurred in the saw hood during the friction cutting operation. Burning did not propogate along the Zircaloy tube proper.

2. All particulate generated was not oxidized or burned. Up to 10 per cent of the material collected in the rotoclone hopper was metallic zirconium.

3. Approximately 45 square inches of Zircaloy tubing (approximately 3/16-inch thick cut) were cut during the test. This represents roughly the cutting required in trimming the "hardware" from one ton of power reactor fuel uranium. Although approximately 85 per cent of the Zircaloy powder was trapped in the rotoclone, sufficient 3 to 10 micron particles passed through the cyclone to plug the filter assembly.

On the basis of these studies additional methods are to be explored for handling saw particulates. Liquid spray scrubbers and underwater sawing are to be studied. In addition, "cold sawing" is to be investigated as an alternate to friction sawing. During April, cold sawing feasibility tests will be performed at the Motch and Merryweather Company in Cleveland, Ohio.

Feed Preparation

Dissolution of Uranium-Molybdenum Alloy. Early in the month it was observed that the presence of ferric nitrate in the dissolvent during dissolution of uranium-molybdenum alloys permits dissolution, without solids formation, to higher terminal uranium concentration and lower terminal acidity than has been possible with either nitric acid alone or with nitric acid - aluminum nitrate - hydrogen fluoride combinations. This observation has been exploited as a means of preparing solvent extraction feeds from uranium-molybdenum alloys without the use of fluoride containing solutions. With one molar ferric nitrate present, U - 3 w/o molybdenum alloy could be dissolved to terminal uranium and free nitric acid contents of one and 0.2 M, respectively, without appreciable solids formation. Similar results were obtained with U - 9 w/o molybdenum alloy. The free acid of such solutions, when cooled, can be reduced to less than zero with dibasic aluminum nitrate or caustic. Precipitation of ferric hydroxide appears to limit the extent of neutralization possible. The pH of the neutralized solutions is still less than zero. Plutonium is readily oxidized to Pu(VI) in these solutions by dichromate. A series of solutions prepared by dissolution of uranium-molybdenum alloys and containing varying uranyl nitrate, ferric nitrate, and free nitric acid has been set aside for observation of stability during long term storage at 25 and 50 C.

It was further observed that the presence of ferric nitrate increases the dissolution rate of uranium-molybdenum alloys, uranium metal, and uranium dioxide by nitric acid. The most pronounced increase in dissolution rate occurs at low acid where the dissolution in nitric acid alone becomes very slow. This property may be useful to shorten time cycles in batch dissolution to no heel.

Behavior of Explosive Uranium-Zirconium Residues in Zirflex. Experience of other workers has demonstrated that annealing heat treatments of uranium-zirconium alloys which produce the delta phase (formerly designated the epsilon phase) lead to explosion hazards in nitric acid dissolution of such alloys. Attempted dissolution of alloys containing the delta phase results in isolation of the delta phase as a powder residue. This residue has been demonstrated to be pyrophoric and capable of explosively violent oxidation reactions when subjected to a sharp impact or an electrical spark.

Since a uranium-zirconium alloy will exist in the diffusion layer of uranium metal fuel elements metallurgically bonded to Zircaloy jackets (a fuel under consideration for the NPR) some concern was felt for hazards which might arise from formation of the delta phase in this diffusion layer.

Since the Zirflex process will be used to declad these fuels, experimental studies were initiated to determine if the Zirflex decladding process would dissolve or desensitize delta phase uranium-zirconium alloys. Results to date, while preliminary, are encouraging.

The technique which has been used for preparation of explosive residues is that described by Schulz, Scott, and Voiland, viz., heat treatment of uranium-zirconium alloys to form the delta phase followed by partial anodic dissolution of the sample in cold dilute nitric acid. The anodic dissolution results in fairly rapid dissolution of the bulk alloy. Powder residues are formed, however, which on drying and sparking with a Tesla coil oxidize in a thoroughly authoritative manner (i.e., "explode"). The results of the tests conducted thus far are not entirely clear-cut in that residues formed in this way do not dissolve entirely in the Zirflex decladding media (aqueous ammonium fluoride or ammonium fluoride - ammonium nitrate mixtures). However, the more reactive constituents do dissolve rapidly in Zirflex decladding media. This has been verified both by sparking tests and by comparison of X-ray diffraction patterns before and after treatment with the Zirflex reagents.

In all cases the residues remaining after Zirflex treatment are quite inert in the sparking test. Similarly, comparison of X-ray patterns shows in all cases rapid disappearance of the most prominent lines apparently associated with the reactive portion of the residues.

Quite recent results suggest that the Zirflex-insoluble residues observed in these tests may be formed in the anodic dissolution procedure used to prepare the reactive powders (e.g., zirconium oxide). A bulk uranium-zirconium alloy subjected to a heat treatment known to produce delta phase did not produce powder residues when exposed directly to the Zirflex decladding medium, although corrosion of the alloy did occur. Thus there is considerable basis for optimism that the conventional Zirflex decladding operation will result in complete dissolution of the zirconium

present in the diffusion layer on metallurgically bonded uranium fuel, thereby eliminating the possibility of isolation of powder residues in subsequent nitric acid core dissolution.

It should be recognized, however, that the Zirflex process planned for the NPR fuel elements will not be capable of dissolving the zirconium out of bulk high-uranium, low-zirconium alloys. The only known safe dissolution approach for such alloys entails inclusion of sufficient fluoride (in excess of 4 moles fluoride per mole zirconium) in the nitric acid dissolving medium to assure that the zirconium in the alloy is dissolved as rapidly as the uranium.

Dissolution of Uranium-Zirconium Alloys. Exploratory experiments were done attempting to define the effect of aluminum nitrate and hydrogen-fluoride on the formation of explosion sensitive surfaces during the dissolution of uranium-low zirconium alloys. The studies were done using a U-5 weight per cent zirconium alloy. In the absence of aluminum, a fluoride to dissolved zirconium mole ratio of about four prevented sensitive surfaces. With aluminum nitrate present, the F/Zr mole ratio required to prevent sensitive surfaces is greater than four. With 0.5 and one molar aluminum nitrate present, sensitive surfaces were obtained at F/Zr mole ratios of eight and ten, respectively.

Sensitive surfaces formed by anodic dissolution of U - 5 weight per cent zirconium in one molar nitric acid were completely de-sensitized in less than 30 seconds exposure to boiling 3 M NH_4F-0.5 M NH_4NO_3, Zirflex reagent.

Sodium Dissolution. Measurements of the instantaneous pressures developed in the reaction of submerged metallic sodium with cold 13 M HNO_3 were made using an unbonded strain gage and recording oscilloscope. Reactions were carried out in an 8-inch pipe (open at the top) employing submergences of 3-8 feet

The reactions were characterized by an audible report and a decided movement of the 8-inch pipe, but little spray or violent gas evolution was noted at the top of the container. Interpretation of the oscillograms is now under way.

Darex. Analyses of the information obtained during chloride removal from Darex dissolver effluents have indicated the following trends:

1. During typical chloride removal conditions, the concentration of total chloride in the vapor phase exceeds that in the liquid if the acid concentration in the liquid is greater than the chloride concentration in the liquid.

2. The ratio of the vapor to liquid chloride concentrations is apparently inversely proportional to the chloride concentration in the liquid.

3. The presence of stainless steel hinders chloride removal.

4. Under "total" reflux conditions, the chloride removal rate varied markedly with boil up rate - suggesting the possibility of a rate limiting reaction in the vapor phase.

Niflex. Niflex (HNO_3 - HF) dissolution studies of 304 stainless steel have continued. Experiments designed to discover why the bottom portion of the stainless steel charges did not dissolve (see February report) were unsuccessful. Charging ammonium bifluoride (F/SS ratio of 5) at the top or bottom of the boiling solution, changing the contact area between the stainless steel and Hastelloy-F, or charging all the stainless steel near the top or bottom of the dissolver, did not significantly change the dissolution pattern. Incomplete dissolution still occurred along the Hastelloy-F contact area and near the bottom end of the stainless steel charge.

Increasing the F/SS mole ratio from 5 to 5.5 or 6 with 2 M HNO_3 and 2 M fluoride increased dissolution of the stainless steel charge to approximately 99.9 per cent in a four-hour period. Dissolution of the areas in contact with Hastelloy F was generally obtained.

Stainless steel clad sintered uranium dioxide pellets (1/2-inch in diameter) were declad in 2 M nitric acid and 1 M ammonium bifluoride solution with a nominal F/SS mole charge ratio of 7. After a four-hour decladding period, aluminum nitrate and nitric acid were added to make the solution 2.3 M HNO_3, 0.66 M ANN, 1.33 M fluoride and 0.2 M stainless steel. Dissolution of the UO_2 was essentially complete in eight hours after the additions. At the end of the run one per cent of the stainless steel was undissolved. The undissolved uranium still encased in stainless steel was 0.4 per cent of the total uranium charged.

Materials of Construction. The corrosion of 304-L stainless steel and Hastelloy F in nitric acid - ferric nitrate systems (as proposed for dissolution of uranium-molybdenum alloys) was studied. Corrosion rates in boiling solutions increased as the concentration of either ferric nitrate or nitric acid was increased. At nitric acid concentrations of five molar or less and ferric nitrate concentrations up to 0.6 M, corrosion rates were less than two and 0.3 mil per month for 304-L and Hastelloy F, respectively. Rates for higher ferric nitrate concentrations will be obtained.

A coupon of Hastelloy F welded with Nionel showed general attack at a rate of about two mils per month during exposure in the 321 Building Darex dissolver.

Boron^{10} Monitor. Development tests to determine optimum geometry, cell thickness, materials of construction, moderator size, and source intensity, are about 80 per cent complete. Cylindrical lucite cells ranging from 3-inch to 6-inch in diameter were tested to determine optimum cell size. The maximum sensitivity to boron concentration in the 1 gm/liter range occurs with a 4-inch diameter cell. Thin-wall stainless steel tubing and reactor grade zirconium pipe are being evaluated for use in the plant prototype.

The thermal neutron density as measured in these tests is about 15 per cent greater with paraffin moderator than with water. The maximum counting sensitivity is observed with the neutron source located in the moderator as near to the measuring cell as possible. The data obtained thus far indicate that a source intensity of about 10^5 neutrons/sec. will be adequate, and will produce a dose rate of approximately 4 mREM per hour outside the moderator.

Solvent Extraction

Feed solutions prepared by dissolution of uranium-molybdenum alloys with nitric acid-ferric nitrate as solvent resemble Darex feed solutions in their Redox solvent extraction behavior. Dispersion-disengaging behavior under Redox conditions appears normal. Batch contact studies showed little if any extraction of molybdenum or iron into hexone. Limited fission product distribution data show similarity to that obtained with Darex feeds.

Redox Processing of NPF Fuels

Two Redox-type HA-HC Column solvent extraction runs processing simulated Darex feeds were performed at Oak Ridge National Laboratory. The first run tested the effect on HA Column flooding rate of 100 ppm "Mistron" de-emulsification agent in high-silicon-content feed (0.015 M Si). The use of "Mistron" (insoluble magnesium silicate in fine powder form) increased the flooding rate by a factor of 2.7 compared to the same test performed without the additive. The increased flooding rate is about 40 per cent greater than that of the standard Redox flowsheet tested earlier. Visual observation indicated that the majority of the "Mistron" was carried up the column by the organic stream to the upper organic-aqueous interface. The organic product stream remained clear and the column packing remained essentially clean. Long-term effects will not be determined during the remainder of the tests.

The second run tested the effect of an intermediate concentration of silicon (0.004 M Si) in a Darex feed solution on HA Column flooding rate. This run flooded at a rate approximately two-fold higher than a similar run with 0.015 M Si and at approximately the same rate as a standard Redox run.

A maximum of three more tests remain to be performed. These tests will probably be completed in April.

REACTOR DEVELOPMENT - 4000 PROGRAM

Plutonium Recycle Program

Reduction of Plutonium Oxide

Work has continued on both the direct reduction of PuO_2 and the *in situ* conversion of it to chloride (in a chloride melt) followed by reduction with zinc-magnesium.

Efforts to dissolve plutonium dioxide in molten sodium chloride-potassium chloride-magnesium chloride at 650 to 750 C by chlorination with phosgene have been unsuccessful, resulting for example in only a 17 per cent dissolution after four hours at 650 C. A very significant discovery was made, however, from experiments with uranium dioxide aimed at a better understanding of the chlorination process. Uranium dioxide was found to dissolve very readily in 1:1, NaCl-KCl under the influence of phosgene to give a red solution which turned yellow on cooling. Spectrophotometric measurements disclosed no UCl_4, hence the material is believed to be UO_2Cl_2. Upon reacting with zinc-magnesium or (more slowly) with zinc alone, reaction occurred and a precipitate of a dark red material formed a third phase.

This material was identified as UO_2 by X-ray diffraction. Thus, by chlorination followed by reduction, UO_2 can be cycled through a salt phase and be recovered as UO_2. The separation implications are obvious and apply not only to uranium-plutonium systems, but to uranium-thorium systems as well.

Potassium-Aluminum Chloride System

The effect of uranium concentration on the uranium distribution in the KCl-$AlCl_3$-Al system was examined for both the KCl and $AlCl_3$ excess regions. With excess potassium chloride, the distribution coefficient appears linear to a metal content of about 17 w/o uranium and, expressed as the ratio of the uranium mole fraction in the metal divided by that in the salt, was 0.77. In the aluminum-chloride rich region, however, the uranium concentration in the metal phase "plateaus" at a metal content of about 14 w/o uranium (0.02 mole fraction) and remains quite constant over the interval in which the salt phase uranium content ranges from 0.005 to 0.020 mole fraction. The distribution coefficient thus varies inversely with the uranium salt content in this range.

Analytical

Because of some uncertainties in the analyses of constituent elements of the potassium chloride-aluminum chloride system and in anticipation of the solubility studies, X-ray spectrographic methods were devised for analysis of uranium, potassium and chloride. The method of internal standards was used throughout; strontium serving as the standard for uranium; calcium for potassium, and rhodium for chlorine. In the concentration ranges of interest, potassium and uranium can be determined to an accuracy of about 0.1 to 0.2 g/l, which is adequate. Aluminum in chloride solutions cannot be analyzed by the X-ray spectrographic method because of chloride interference.

Non-Aqueous Systems

A study program has been undertaken to explore the chemistry of some inorganic systems which may have application to the processing of nuclear fuels. Preliminary experiments have been done in the liquid NO_2 system.

Sealed tubes containing dry dinitrogen tetroxide and reactor grade UO_2 were held at temperatures ranging to 105 C. About 50 per cent conversion was found in three runs where reaction times ranged from 56 to 85 hours and N_2O_4/UO_2 mole ratios ranged from 6 to 9.5. Because of failure of a number of reaction vessels under pressure, a manifold-pressure vessel system will be installed which will permit studies at still higher pressures.

Plutonium Recycle Test Reactor Fuel Reprocessing

A preliminary test of the mechanical feasibility of charging full size PRTR fuel elements was successfully concluded in the Redox Plant. The test indicated that the full size elements can be handled and charged into existing dissolvers but that a folding bail would be required.

The effects on reprocessing costs and production schedules of using such techniques are currently being evaluated.

Shielding Material

Samples and data on locations of serpentine deposits on the Pacific Coast were procured. Tests indicate that Washington serpentine may be completely satisfactory for reactor high-density concrete in place of Canadian and Arizona serpentine previously known to be available and acceptable. Both initial cost and shipping costs for the estimated 1000 tons needed are expected to be significantly lower for local material.

Waste Disposal

Radiant Heat Spray Calcination

Nine runs were made in the eight-inch by ten-foot demonstration unit during the month. These were aimed at determination of operating conditions which would result in a powder with maximum density, free flowing characteristics, and a minimum of dust. The use of phosphate addition consistently gave higher density (0.82 vs. 0.42 gms/cc), less column hold-up, and less dust than was achieved with straight formaldehyde killed, synthetic 1WW. Addition of sugar (in addition to phosphate) gave a product of somewhat higher density (1.05 gms/cc) and also resulted in markedly lowered power requirement. Thus, the required heat input was reduced 52 per cent using steam atomization (nitrate serving as oxidant) and 90 per cent with added air or oxygen. That higher particle temperatures were attained was also evidenced by the fused, glassy appearance of the product particles. Caution must be exercised, however, with sugar addition to avoid pre-reaction in the feed tank. One minor, but potentially grave, incident resulted from this reaction. Thus, on standing overnight after sugar addition, a high acid feed underwent reaction and ruptured the plastic feed lines.

Several equipment modifications were made which resulted in improved performance. These included use of an Argonne type, pulsed, filter blow-back scheme. This works very well and results in easier product removal and more efficient off-gas filtration. An air driven vibrator was mounted on the top of the column and has proven effective in reducing the amount of solids hold-up on the walls. A down draft condenser was installed on the acid recovery equipment for smoother operation and easier collection of condensates than with the original direct-contact condenser. With these changes and increased operating experience, performance of the unit has steadily improved and is generally very satisfactory. However, shattering of the particles is still a problem and tends to result in a powder which is not free flowing.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

Numerous thin, discontinuous beds of silt, sand, clay and gravel of the Ellensburg (?) formation between basalt flows beneath the east side of the Hanford project indicate the probable course of the small, low-gradient, early Columbia River. These beds also permit correlation of flows between wells and show the basalts to be interfingering from sources to the east and to the west. The zone of interfingering and maximum number of interbeds centers about ten miles east of the present deepest part of the Pasco Basin and trends slightly west of north apparently across the present anticlinal ridges. The data indicate that sanitary or process water can be procured from the basalt series most easily along this zone where a maximum number of interflow contacts occur.

The first draft was completed of a contour map of the Ringold Formation in the vicinity of the chemical processing areas. This map shows "islands" of Ringold rising above the water table and erosional troughs in the Ringold filled with fluviatile sands and gravels. These irregularities explain the peculiar shape of the 200 East ground water mound. The small tongues of water moving west from the mound do so in these troughs.

Also constructed was an improved and more detailed map showing contours on the basalt.

A new drilling fluid additive called X-5 was tested in the laboratory. This synthetic mudding agent is claimed to give the same benefits as bentonite, but unlike bentonite, to break down after several days leaving the aquifer in its original condition. Tests showed that breakdown is not fast or at all complete. Hence, although X-5 performs better than bentonite, it still influences soil permeability to an unacceptable degree.

Correlation of 44 soil samples from two wells indicated that a close approximation of the natural soil moisture content can be achieved by determining the centrifuge moisture-equivalent. The ratio of moisture content to centrifuge moisture-equivalent is near unity from 2 per cent to 14 per cent moisture but decreases rapidly below 2 per cent. The specific retention values averaged 2.1 per cent and 3.4 per cent in several samples from two wells while the natural moisture content averaged 1.7 per cent and 3.5 per cent, respectively. These results indicate that the centrifuge moisture equivalent test can be applied with considerable confidence in determining the specific retention values for Hanford soils.

Soil Chemistry and Geochemistry

Studies of the soil chemistry of cerium indicate that a large part of the increased removal of Ce from solution by soil with increasing pH is due to cerium hydroxide precipitation. On the Ce uptake vs. pH curve, a dip in uptake was noted at about pH 9. Present observations indicate that this is due, at least in part, to peptization of the cerium hydroxide precipitate, causing it to remain in solution rather than settling out with soil. Larger amounts of cerium in the soil-water system provide a strong buffer against increase of pH beyond 5.5 by removal of hydroxyl ions to precipiate cerium hydroxide.

Comparisons were made of Cs retention by clinoptilolite and some common cation exchange resins. In a system containing 1 M $NaNO_3$ and 0.01 M Cs^+, the capacity of clinoptilolite was ten times that of the resins. This ratio of sodium to cesium concentration would be exceeded in all present waste streams.

Reactions of fluoride-containing solutions with calcite and apatite were investigated for Sr removal. These reactions were found to be effective over a wider pH range than the calcite-phosphate reaction. An invention report was submitted on the basis of this and other improvements. Al^{+3} and Fe^{+3} are known to interfere with the reaction when present in large amounts. It was found that the optimum concentration of NaF is about 0.05 M and that Sr retention decreases on both sides of this concentration. Rare earths, Pu, and U are also removed from solution by this reaction.

Ground Waste Investigations

Preparations were made for a field test of methods being developed for prediction of crib capacities. A 2-foot by 2-foot model crib will be used at a location where ground water is only about 12 feet from the ground surface. Sr^{85} (65 d half-life) will be used to spike the synthetic waste. A 1500 gallon tank truck will be used for water supply.

Calculation of Hiester-Vermuelen parameters for soil columns of various lengths showed that the "S" parameter, which can be thought of as equivalent to the number of theoretical plates in a column, increases with increasing column length. The height per S value and the specific reaction rate "constant" both decrease with increasing column length. Since these factors have been shown to remain constant with column length for resin columns, it appears that soil column operations cannot be interpreted on the same basis as for cation exchange resin columns.

Field Apparatus Development

The closed circuit TV system assembled for in-well examinations was used in cooperation with CPD to examine internal dissolver components in a radiation field of several r per hour. Good clarity and definition of the viewing area were obtained. Rotatable mirror and remote focusing attachments were designed and ordered.

A locally designed crystal-controlled chronometer and amplifier were tested in trial seismic measurements of depth to ground water in the vicinity of Gable Butte. Some difficulty was experienced when using the hammer impact method for generating the sound wave whose travel time from impact point to geophone was to be measured with the chronometer. The non-reproducibility of the data was traced to random triggering of the scaler from electrical "noise" generated subsequent to the initiating impact. Much better performance was found using small charges as sound-wave initiators.

An electrical conductivity soil-moisture measuring unit was developed which is almost independent of soil packing. The unit consists of a wire screen electrode placed between two 1/16-inch plexiglass sheets. The plexiglass sheets are encased in another electrode made by fastening a wire screen on the outside of each sheet. The plexiglass is perforated to allow soil to contact both electrodes. The whole unit is only about 2 x 2 x 1/4-inch and can be easily buried in soil.

Micromeritics

An efficient filter was assembled for possible use in Radiometallurgy cut-off cells for removing uranium debris from cut-off operations waste. Composed of hard felt discs with flow from the periphery to the center, the filter will remove virtually all particles one μ and larger from these streams. Pressure drop is only 1-inch of Hg at a flow of 0.5 gpm.

Improved sensitivity achieved through use of a strain gage sedimentation balance permitted greater accuracy in sizing the particles from an autoclave rupture of a uranium fuel element. Fifty per cent of the particles were shown to be less than 35 microns diameter.

Radioisotopes in Reactor Cooling Water.

The build-up of radioisotopes in reactor effluent water following chemical cleaning of the tube and slug surfaces was followed for 1-1/2 months. The concentrations of most of the radioisotopes were reduced by factors of 5 to 100 by cleaning and were still low by factors of 2 to 5 after two weeks. P^{32} and As^{76} were still low by a factor of 2 after six weeks. This indicates that frequent purging could bring about a reduction in reactor effluent water radioisotope concentrations. Disposal of the purge material and increased corrosion would become more important problems than at present.

Paper electrophoresis studies of reactor effluent water radioisotopes show that Cr^{51} moves in three separate zones indicating that it may be present in three different ionic forms.

Facilities were completed and tests have been underway since March 17 to determine the effect of temperature, flow rate and column length on the ability of aluminum turnings to remove radioisotopes from reactor effluent water. One column of stainless steel turnings is also being operated to determine the efficiency of this material.

Successful standardization of Fe^{55}, a K-capture radioisotope which emits only X-rays, was accomplished through an X-ray counter which was calibrated by X-ray - gamma ray coincidence counting measurements on Mn^{54} whose 5.4 kev X-ray is nearly the same energy as the 5.9 kev Fe^{55} X-ray. Techniques are now available for all types of emitters needed in current reactor effluent water studies.

Chemical Protection Agent

A second biological trial of the radiation protective ability of erioglaucine was completed this month. A significant increase in the survival of rats following acute whole body irradiation was achieved, similar to that observed previously with mice. Six out of ten rats, intraperitoneally injected with the dye ten minutes prior to absorbing 900 r of 250 KVP X-radiation, were alive 30 days afterward. Only one of ten similarly irradiated, but unprotected animals survived this time interval.

L. P. Bupp

Manager,
Chemical Research & Development

LP Bupp:bp 1252235

[redacted]

ORGANIZATION AND PERSONNEL

G. Jansen, Jr., was hired and assigned to the Chemical Development Operation as an Engineer I.

D. J. Brown, Junior Engineer, Chemical Effluents Technology, was granted a three-month leave of absence to return to College.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
R. T. Huntoon H. G. Marsh	3/4/	Savannah River Laboratory Aiken, South Carolina	Discuss neptunium chemistry.	EE Voiland	Yes
D. Karraker D. A. Orth J. Ergle	3/3-5/	Savannah River Lab. Aiken, South Carolina	Discuss Purex process chemistry and neptunium chemistry.	MT Walling GE Benedict RL Moore WH Reas	Yes
F. P. Baranowski	3/5/	Washington Office of the Division of Production AEC - Washington, D.C.	Non-Production Fuels Program	LP Bupp OF Hill	Yes
W. L. Gonnason	3/9/	Modern Home Builders Inc. Everett, Washington	Geophysical surveys at Hanford; serpentine needs.	RE Brown JR Raymond	No
S. Muessig J. A. Calkins F. C. Armstrong A. E. Weissenborn	3/12/	US Geological Survey Geologic Branch Spokane, Washington	Geologic studies.	RE Brown DJ Brown JR Raymond WH Bierschenk	No
R. Else	3/17-20/	Packard Instrument Co. San Francisco, Calif.	Install equipment	JD Ludwick	No
L. F. Grill	3/19-20/	Rocky Flats Plant Dow Chemical Company Boulder, Colorado	Discuss analytical methods for plutonium and other materials.	RJ Brouns EW Christopherson DL Reid HJ Anderson GJ Alkire	Yes

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
T. H. Thomas R. H. Graham	3/19/	Lockheed Aircraft Corp. San Francisco, Calif.	NPR and other reactor seismic vulnerability studies.	RE Brown	No
E. W. Hook R. E. Lowe R. A. Williamson J. Garrick	3/19/	Holmes & Narver, Engrs. and Constructors Los Angeles, Calif.	NPR and other reactor seismic vulnerability studies.	RE Brown	No
E. Anderson	3/23/	Division of Reactor Development - AEC Washington, D.C.	Non-Production Fuels and PRP Research & Development, pyrochemical processing and Zirflex.	LP Bupp OF Hill WH Reas EE Voiland MT Walling JL Swanson	Yes
D. J. Pflaum	3/26/	Division of Licensing and Regulation - AEC Washington, D.C.	Radioactive waste disposal to the ground.	DW Pearce	No
William L.S. Wu, M.D.	3/26-27/	Convair San Diego, California	Discuss chemical protective agents; methods of waste disposal at Hanford.	JM Nielsen JL Nelson	No
F. Lindell	3/31/	Penberthy Instrument Co. Seattle, Washington	Discuss window design.	KH Hammill RL Moore	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
M. H. Aldrich	3/2-6/	Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy Pittsburgh, Pa.	Attend conference.	---	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. J. Wheelwright	3/1/	Ames Laboratory Ames, Iowa	Discuss rare earth separations and ion exchange.	FH Spedding	Yes
	3/2-3/	Oak Ridge National Lab. Oak Ridge, Tenn.	Discuss rare earth separations and ion exchange.	E. Lamb	Yes
L. C. Schwendiman	3/3-4/	American Standards Assoc. Washington, D.C.	Participate as committee member in ASA Meetings.	CR Russell MM Braidech	No
	3/4-5/	Oak Ridge National Lab. Oak Ridge, Tenn.	Discuss uranium melt-down experiments, waste disposal technology, observe small particle techniques.	GW Parker R Morton JC Bresee T Wilmarth EE Beauchamp	No
J. L. Daniel	3/4-5/	Conference on Analytical Chemistry & Spectroscopy Pittsburgh, Pa.	Attend Conference	---	No
	3/9-10/	Research Laboratory Schenectady, New York	Technical consultation on high temperature research.	J Burke	No
	3/11/	Lamp Division (G.E.) Cleveland, Ohio	Discuss mercury isotope separation.	WD Trautman	No
W. R. DeHollander	3/5-6/	University of Washington Seattle, Washington	PhD Recruiting	---	No
J. M. Nielsen	3/16/	Division of Biology & Medicine - AEC Washington, D.C.	Attend meeting on Measurements	JG Terrill, Jr. F Western G Dunning	No
H. F. Tew	3/19/	Kiwanis Club Dayton, Washington	Presented Talk.	---	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. C. Amos	3/15-18/	AICHE Meeting Atlantic City, N.J.	Presented Paper	---	No
	3/19/	Oak Ridge National Lab. Oak Ridge, Tenn.	Discussions on Fission Product Recovery and Non-Production Fuels Reprocessing.	E Lamb C Watson	Yes
N. P. Wilburn	3/16-18/	AIChE Meeting Atlantic City, N.J.	Attend Meeting.	---	No
	3/19-20/	Case Institute of Tech. Cleveland, Ohio	Discuss Computer control problems.	TJ Walsh	No
R. F. Maness	3/30-31/	Battelle Memorial Inst. Columbus, Ohio	Discussion on improvement of existing materials for power reactor fuel dissolver construction.	AM Hall FW Fink	Yes
W. H. Reas	3/10/	Washington State Univ. Pullman, Washington	Attend University Relations Council Meeting.	---	No
W. H. Reas L. P. Bupp	3/17/	Division of Research -AEC Washington, D.C.	Discuss Division of Research sponsored programs and other R&D activities.	D Miller	Yes
	3/18-20/	Argonne National Lab. Lemont, Illinois	Discuss R&D activities directed toward the chemical processing of power reactor fuels.	S Lawroski	Yes
L. P. Bupp	3/16/	Engineering Services New York, New York	Engineering personnel register.	FB Nuelle	No
	3/2-3/	University of California Radiation Laboratory Berkeley, California	Technical conference on Trans-Plutonium Elements.	I Pearlman	Yes

UNCLASSIFIED

UNCLASSIFIED

C-26

HW-59717

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

Dr. Bergene Kawin, of the Metabolism Operation, resigned to accept a position outside the Company.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

The concentrations of I^{131} in thyroid glands of jack rabbits were about one-quarter of those one year ago. Values follow:

Location	μc/g wet thyroid		Trend Factor
	Average	Maximum	
Prosser Barricade	9×10^{-4}	2×10^{-3}	- 3
4 Miles SW of Redox	4×10^{-4}	1×10^{-3}	- 5

Columbia River Contamination

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

Sample Type	Location	μc/g wet wt.		Trend Factor
		Average	Maximum	
Minnows (entire)	Hanford	1×10^{-3}	1×10^{-3}	- 2

A virulent strain of C. columnaris killed salmon fingerlings within 10 hours when fish were exposed to a suspension of the bacteria. A similar exposure of fish to a relatively non-virulent strain produced killing in 20 hours. The virulent strain injected I.P. into fish produced typical lesions to scales, fins, and flesh only after one to two weeks. Organisms were easily cultured from the kidney as well as surface areas of I.P. injected fish. But they could not be cultured from surface areas of fish unless they were exposed to a suspension of organisms. Naturally infected fish show lesions more typical of the I.P. injection than of the external contamination.

Fallout Contamination

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

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

Effect of Reactor Effluent on Aquatic Organisms

Normal monitoring of effluent from the 100-KE reactor was resumed following repair of the effluent pump which had been out of service since last December. Evaluation of results is difficult because of the upset experimental conditions, but an adverse response of the young salmon to an effluent concentration of 2-1/2 per cent continues to be evident.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Strontium

A preliminary test to evaluate the radiation effects of Sr^{90}-Y^{90} fed to rainbow trout was started. Few results have been obtained as yet, but it appears that the force-feeding techniques employed cause excess stress and should be avoided if possible in future experiments of this type.

Basic information on blood pressures and heart rates in unanesthetized, free-swimming trout was obtained with the use of the new Sanborn Poly-Viso recorder. These measurements indicate that the true values are higher than generally reported in the literature. The perfusion technique for measuring the rate of transport of Sr^{90} and other ions across the gill membranes is being altered in accordance with this new information.

Daily feeding of Sr^{90} was initiated on 9-month-old miniature swine at levels of 5 and 1 µc/day with six animals at each level.

Preliminary to a comparative study of Sr^{90} and Ca^{45} metabolism in individual tissues and organs of swine, a satisfactory surgical approach was developed. It includes simultaneous sampling from the renal artery and vein, the portal vein, the femoral vein, the ureter, and the bile duct at various time intervals following dosing.

Iodine

No noteworthy changes were observed in the Q/D in the sheep or swine except for a moderate drop due to beginning of lactation.

Sixteen ewes fed a 3 mc dose of radioiodine following weaning in 1957 gave birth to 25 normal lambs.

A number of excess newborn lambs are being given a single oral dose of I^{131} ten days before sacrifice in order to obtain data on uptake and half-life in the thyroid gland of the very young animal.

Cesium

Varying calcium concentration in nutrient culture from 2 to 24 meq/l depressed uptake of Cs^{137} into bean plants by as much as 20%.

Plutonium

Additional data were obtained on the therapeutic effectiveness of orally administered DTPA. An oral dose level of 12 mM/kg reduced femur deposition by a factor of 10 and liver deposition by a factor of 30. This is approximately equivalent to that of 1.5 mM/kg injected IP, the latter being somewhat less effective in preventing bone deposition and somewhat more effective in preventing liver deposition. Measurements of total plutonium excreted were 80% with the 1.5 mM/kg IP dose, 80% with 12 mM/kg oral dose and 9% in untreated controls. The DTPA employed in these experiments was a specially purified grade and was administered as a calcium tri-sodium salt. The 12 mM/kg oral dose was marginally lethal. Of seven animals employed in the test, six survived.

Radioactive Particles

Histologic examination of tissues from mice killed 500 days after inhalation of $Pu^{239}O_2$ is in progress. Initial observations include lymphosarcoma in intestinal mesentery. Neoplastic growths have not been seen in lung tissue, although autoradiograms showed presence of Pu^{239} particles.

$Plutonium^{239}$ assay of tissues and excreta from 12 dogs killed up to two weeks after inhalation of $Pu^{239}O_2$ are nearly completed. Two weeks after exposure about 45 per cent of the total Pu^{239} deposited was excreted in feces and 0.05 per cent in urine. At that time approximately 55 per cent of the deposited Pu^{239} was in lung and less than 0.5 per cent in other tissues. Exposure of other dogs to $Pu^{239}O_2$ have been completed for studying the effects of aerosol concentration on deposition and translocation.

Gastrointestinal Radiation Injury

The radioisotope feeding phase of the experiment designed to study long-term effects of chronic beta irradiation of the intestine was completed. Fifty rats were fed an average of 410 μc/day Y^{90} for a period of 56 days. Eight of these animals died or were sacrificed in terminal stage between the 20th and 54th day. Absorption and deposition in the animals of Sr^{90} (impurity in the Y^{90}) amounted to less than 2 μc in the animals succumbing to the treatment and should not interfere with the evaluation of subsequent long-term effects. An additional 50 rats consumed an average of 91 μc Y^{90}/day for the 56-day feeding period. None of the animals in the lower level group and none of the 50 control animals died during the radioisotope feeding. The high level group lost 25% of their initial body weight during the feeding period which they recovered within 2 weeks after radioisotope feeding stopped. The lower level group showed a 3% loss in weight early in the feeding period, since which time their growth has paralleled that of the controls.

Radiation Protection Agents

Two animals, weighing approximately 50 and 100 pounds and measuring 28 and 36 cm in body width at the midline were exposed to the Maxitron at 100, 120, and 145 cm distance to the midline to determine tissue-dose distribution. Radiation factors were 250 KVP, 30 ma with filtration of 2.5 mm Cu and 1 mm Al. Victoreen thimble chambers were placed both externally and internally in various locations in the animal. The readings at the distance signified are shown below:

Roentgens/Minute

Body weight 49 lbs - Body width 28 cm				Body wt. 99 lbs - Body width 36 cm		
Position	100 cm	120 cm	145 cm	100 cm	120 cm	145 cm
Under scapula	14.5	10.5	2.4	2.9	2.3	1.7
Mid-abdominal	8.0	10.5	4.8	16.0	9.0	6.5
Anterior -external	18.0	5.5	5.0	9.0	5.0	5.2
Posterior -external	--	4.0	6.0	4.5	4.2	3.2
Oppos. side -external	4.0	1.1	2.4	2.0	3.4	1.2

In a preliminary study on testing certain agents for their therapeutic value following skin irradiation (20,000 rads, 1.5 mev Beta) from a Van de Graaf accelerator, twelve irradiated sites on three young pigs were treated with either Salcolan spray (Rich Co. - furnished by Division of Biology and Medicine), Desitin ointment (Desitin Chemical Co.), tissue extract, or physiological saline solution. Some irradiated areas were covered while others were left uncovered.

After almost two months of treatment, Desitin ointment seems to give the best results. The success of this material may be partially explained by its sticky consistency and good adherence to the skin.* Covered dry and moist areas appear to show more advanced healing than uncovered areas.

(Salcolan spray** contains salol, cod liver oil, lanolin, caroway oil and olive oil, while Desitin contains Norwegian cod liver oil, zinc oxide and petrolatum.)

* Principal reason is its high content of NORWEGIAN cod liver oil.

** Made in Texas.

Microbiological Studies

Maximum protection from X-rays was afforded to petit yeast cells by a $3.5 \times 10^{-}$ g cytochrome C/ml of culture. Protection was observed only when the cytochrome C was in the medium during irradiation. A similar concentration of albumin gave no protection indicating that the effect is not a non-specific one due to the protein concentration.

Yeast cells exposed to 240 Kr of X-rays showed evidence under the electron microscope of a changed membrane structure. Since this observation has not yet been independently repeated, it is possible that artifacts due to fixation may have caused the apparent difference.

Ecology

Amounts of two fallout radioelements in evergreen needles that were sampled from different environmental habitats last summer follow:

Station	Inches average annual rainfall	μc/g dry wt. $Zr\text{-}Nb^{95}$	Cs^{137}
Quinault	140	1×10^{-4}	5×10^{-6}
Packwood Glacier	100	5×10^{-5}	3×10^{-6}
Bear Prairie	50	9×10^{-5}	5×10^{-6}
Rock Lake	15	6×10^{-5}	2×10^{-6}

Mapping of the gross plant communities of the Hanford Reservation was completed. Eight plots were established for long-term studies to determine if any detectable changes are occurring in the plant communities of the Hanford Reservation.

Manager
BIOLOGY OPERATION

HA Kornberg:es

C. OFF-SITE VISITS AND HAPO VISITORS

Name	Dates of Visits	Company or Organization Represented/Visited	Reason for Visit	Personnel Contacted	Access to Rest'd. Data	Areas & Bldgs.
VISITS TO HANFORD WORKS						
Dr. Kirschner and J. Riegel	3/10	WSC, Pullman, Wash.	Seminar and tour	RT O'Brien & Biology personnel	No	100-F, Biology
10 Officials from Bank of Commerce	3/10	Seattle	Tour	Bustad, Foster	No	100-F, 146, 141
Maj. J. L. Terry	3/10-12	USAF, Kirkland AFB, NM	Discuss inhalation experiments	Bair	No	100-F, Biology
Dr. Leroy Augenstine	3/10-11	AEC, Wash. D.C.	Review program	Kornberg & staff	No	100-F, Biology
Garry S. Lewis	3/12	Sanborn Co., Seattle	Consultation	Foster	No	100-F, 146
Dr. Wright Langham	3/13	Los Alamos, NM	Seminar & tour	Kornberg & staff	No	100-F, Biology
39 Kennewich High School Students	3/17	Kennewick	Tour	Davis, Bustad	No	100-F, 146-141
Bloodworth & Burlingame	3/18	GE, New York	Tour	Bustad, Foster	No	100- F,146-141
Dr. Art Wielander	3/19	U. of Wash., Seattle	Discuss summer institute program	Kornberg, et al	No	100-F, Biology
Mr. Pflaum	3/24	AEC, Wash. D.C.	Tour	Thompson, Bustad	No	100-F, Biology
T. Adams and Chas. Eagan	3/23-24	U. of Wash., Seattle	Perform physiol. experiment on sheep	Bustad	No	100-f, Biology
Dr. Wu	3/24	Convair, San Diego	Discuss research	Thompson, Bustad Warner, Hungate	No	100-F, Biology
Drs. Donaldson and Seymour	3/23-24	U. of Wash., Seattle	Discuss radio-ecology program	Foster, Davis, Kornberg	No	100-F, Biology
VISITS TO OTHER INSTALLATIONS						
R. T. O'Brien	3/2-3	WSC, Pullman	Present seminar	Ray, Kirschner	No	
M. F. Sullivan	3/4-6	U. of Ore. Med. School U.of Wash. Med. School	Present seminar, discuss research	Van Bruggen Carlson	No	
R. F. Foster	3/4-6	Wash. D.C.	NAS Committee Mtg.	Members	No	
D.G. Watson	3/23-27	USPHS, Portland; Pac. Fish. Biol. Mtg.,	Attend meetings	Eldridge Gearhart	No	
J. J. Davis	3/23-24	USPHS, Portland	Attend meetings	Eldridge	No	
R. L. Uhler & J. D.Stewart	3/27	WSC, Pullman	Discuss research	Moodie, Gardner	No	
W. J. Clarke	3/9-14	U. of Calif., Berkeley U of C Vet. School, Davis	Give paper Consult	AIChE Andersen	No	

UNCLASSIFIED

HW-59717

1252245

D. Lectures

a. Papers presented at meetings

W. J. Clarke, 3/11/59, "Peacetime Accomplishments of Atomic Energy and How They Affect Agriculture," American Institute of Chemical Engineers (student shapter at U. of Calif.), Berkeley, California.

b. Off-site Seminars

R. T. O'Brien, 3/3/59, Pullman, Washington (WSC), "Radiation Effects on Cell Permeability".

M. F. Sullivan, 3/5/59, U. of Oregon Medical School, Portland, Oregon, "Gastrointestinal Radiation Injury".

D. E. Warner, 3/16/59, Burbank Schools' sciences classes, "Biology Research at Hanford."

c. Biology Seminars

V. H. Smith - 3/11/59 - "The use of NMR and EPR resonance in biological resear

Dr. Wright Langham, Los Alamos Scientific Laboratory, "Cesium-137 Biospheric Contamination from Weapons Tests", March 13, 1959.

Dr. Webster S. S. Jee, Radiobiology Laboratory, University of Utah, Salt Lake City, March 31, 1959, "Plutonium in Bone".

J. F. Cline, "Various Avenues of Uptake of Zinc-65 by Plants," March 11, 1959.

J. R. McKenney, 3/25/59, "Metabolism of Sr^{90} in Sheep and Swine".

E. Publications

a. HW Publications

None

b. Open Literature

Schiffman, R.H. and P.O. Fromm, "Chromium-Induced Changes in the Blood of Rainbow Trout, Salmo gairdnerii," Sew. & Ind. Wastes, 31(2): 205-211, February 1959. (Work performed prior to employment at Hanford.)

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

March, 1959

ORGANIZATION AND PERSONNEL

There were no changes in personnel during the month.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

A progress report covering the past year's activities on the input-output response simulation studies was submitted to the General Manager, HAPO, early in the month. Later in the month, a meeting was held with the General Manager at which the future scope of the study and plans for its completion by the end of the year were outlined. It was emphasized again that meeting the outlined schedule depends heavily on the availability of computational programs and assistance.

The specific application of the general method developed for use in this area to an investigation of an operational problem in the Redox plant has been discussed with CPD personnel and a tentative model developed.

Mathematical improvement of the multivariate computational program has continued.

Business Descriptions

A rough draft report describing various theories which can be used for business descriptions has been completed. Further work on the actual description of business in these terms is continuing.

OPERATIONS ANALYSIS STUDIES

Z Plant Information Study

The Z plant test program was formalized and approved by the task force on March 10. Questions pertaining to the use of the IBM equipment were resolved with the IBM engineers and a production test is being prepared for CPD approval.

FPD Process Control and Experimentation

An interim report was issued on the study concerned with locating the optimum combination of preheat and submerge times in the canning cycle. Further investigation of the optimum region was recommended and will be undertaken in

a pilot plant study. At this time the effects of changing silicon content and temperature in the canning bath will also be evaluated. It is planned that one production line will use the recommended cycle for a period of time in April to further evaluate its effects.

Data from a pilot plant experiment designed to evaluate the effects of using a spire with thicker walls in the canning of I and E fuel elements were analyzed. Based on the results of this pilot plant study, an extended run on a production canning line will be made within the next few weeks.

An experiment was designed to determine whether vacuum annealing of fuel elements after canning would relieve lock-in stresses in the fuel elements and hence permit rejection of those fuel elements which would be inclined to warp in the reactor. At the same time, it was desired to determine necessary time and temperature combinations to relieve such stress. A 5/9 replicate of a 3^2 experiment was designed which would permit evaluation of both linear main effects and the linear x linear interaction, in addition to determining whether or not curvature in one or both of the main effects existed. Should significant curvature exist, it was planned to complete the experiment with the additional four anneal treatments in order to determine what was contributing to the curvature. This could not be determined using the 5/9 replicate. The experiment is currently being conducted.

Increasing the core size of a fuel element reduces the size of the core-can annulus and theoretically gives rise to smaller minimum residual can wall thicknesses. Counter balancing this is the beneficial effect of increased reactivity in the reactors. In order to determine just how seriously increasing the core size reduces the can wall thickness, an experiment was designed and conducted using a range of values for the core-can annulus. An analysis is being made of the data to evaluate the effects of this on fuel element quality as measured by can wall thickness and total bond count.

In determining the degree of non-wetting associated with a given combination of treatments, empty cans have been used, the assumption being that the degree of non-wetting encountered in this way is the same as that encountered in the canned fuel element. It was recommended that this assumption be checked, and an experiment was designed to that end.

Further work was done in connection with evaluating the optical comparator method for determining residual can wall thickness. Based on accumulated results from several studies, it appears that the optical comparator method, while it may be a good measuring tool in its own right, does not measure the same thing as the commonly used caustic penetration method.

Fuel Element Failures

The study concerned with relating rupture indices to corrosion indices is continuing.

Work in connection with determining the rupture rate curve which would

the curves arising from the empirically determined rupture model used to describe side rupture rates. Based on the results of this study, a recommendation is being prepared to the effect that corrosion limits for reactor operation be removed until the side failure rate is appreciably reduced.

Graphs useful in the interpretation of rupture data were prepared. The data are numbers of ruptures occurring in each of two types of fuel element irradiated under comparable conditions. These can be used to determine when to terminate a test which is sequential in nature. The average number of ruptures needed to detect given differences in rupture rates can also be determined.

Production Tests

Dimensional distortion data from Production Test IP-56-A-86-MT are being analyzed in order to further evaluate low hydrogen dingot I and E fuel elements. A comparison is being made with ingot fuel elements also charged in this test.

Further work has been done in evaluating the precision of the C-Basin Profilometer. This is concerned with average warp, warp angles (angle between rib marks and convex side of the fuel element), and hot spot angles (angle between rib marks and hot spot). Meaningful angle figures are very useful in determining the relationship between warp and hot spots which can have far reaching effects in determining how much effort should be expended in reducing and controlling warp.

Reactor Calculations

Preliminary work is being done in connection with the over-all problem of determining the accuracy and precision of certain reactor data. The problem of immediate concern is to evaluate the uncertainty associated with the calculated daily total reactor power level. Among the error sources that obviously need investigation are errors in the flow-meters, errors in the thermocouples, possible channeling of the outlet water, or a significant temperature drop before reaching the thermocouple. An associated problem is concerned with allocating the reactor power to the individual process tubes. Data have already been collected in this connection, and are presently being analyzed.

CPD Control

The examination of available data to determine the reliability of material control of the amounts of plutonium received, remaining, and removed was continued. It is planned to use the recently developed techniques associated with the causal relationship model in order to obtain a better understanding of the complex interrelationships involved.

Data from January and February were used to estimate the process and analytical variances. Shifts in the estimates of the process average and process variance were discovered, and were subsequently traced to changes in the impurity content of the feed material.

[redacted]

Radiation Protection Precision and Accuracy Study

Statistical analysis was performed on a Records and Evaluation Operation experiment to determine the magnitude of calibration, film, and observer errors associated with the calibration and development of radium gamma calibration film. Results of the analysis led to the design of three more experiments which will further evaluate calibration error. These experiments should aid in determining (1) the iso-tropic nature of HAPO's radium gamma source when rotated on its axis; (2) the effects of exposure time, exposure distances, and failure of the inverse square law; (3) the error associated with a standard value of the radium gamma source.

Rough drafts of a manual to describe the film dosimetry process and an interim report describing progress to date on the precision and accuracy study were completed.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Metallurgy

Further discussions were held concerning the statistical analysis of uranium hardness data from a recent test to examine physical properties as a function of irradiation time.

In support of NPR design physical properties testing program, assistance was requested in analyzing x-ray diffraction patterns of annealed Zircaloy-2 samples. Composite distribution techniques based on moment analysis are being used to resolve multi-peak diffraction patterns into their component parts, particularly to estimate the height and half-width of each peak.

2000 Program - Reactor

An analysis was completed of the heat transfer properties of a reactor fuel column which lies non-concentric within its coolant tube. This is the first of a series of investigations in this particular geometry which have been suggested for study.

2000 Program - Separations

A mathematical investigation was completed of the shielding properties of a proposed spherical cask.

Work was continued on the development of an appropriate computational routine to obtain the solutions of a set of simultaneous algebraic equations which describe a complex chemical reaction.

4000 Program - PRP

Investigations continued on the heat transfer properties of fuel elements under the non-linear but realistic assumption that thermal conductivity is temperature dependent.

4000 Program - Swelling Studies

Statistical analysis was initiated of void data read from 20 enlargements of radiographic cross-sections of an irradiated uranium cylinder. The primary objective of the analysis is to determine the precision of estimation of bubble radii distribution and total void volume from radiographic data. Since the sections were taken at differing radial-distances from the center of the uranium cylinder, additional information will be provided concerning the effect of temperature on void volume and bubble radii distribution.

6000 Program - Biology and Medicine

Work was initiated on the estimation of parameters which occur in the modified power function implied by a recently constructed mathematical model for the uptake and retention of radioactive isotopes of groups of experimental animals.

Consultation was held concerning the fitting of linear combinations of exponential functions to data obtained from the aquatic community which has been administered a fixed acute dosage of radiocesium. An iterative least squares computation procedure was suggested as a candidate for the estimation of parameters occurring in the sum of exponentials model.

A statistical analysis of data on mouse lung tumor incidents following administration of various substances was performed and an unclassified letter summarizing the results sent to interested persons.

6000 Program - Atmospheric Physics

Work continued on a formal report jointly authored with Atmospheric Physics personnel discussing the derivation and utilization of statistical techniques for analyzing data from the pending Air Force - AEC diffusion and deposition study.

General

Further consultation was held with Chemical Effluents Technology Operation concerning a mathematical description of the breakthrough ratio prediction curve. A formula obtained from the solution of a quasi-linear second order partial differential equation was presented, and it was agreed to attempt a fit of the mathematical formula to some data obtained from observations on laboratory soil columns.

Work continued jointly with Data Processing Operation on the checking of a 709 IBM routine for quantitative resolution of counting results obtained from multisource short half-life radioactive material in the presence of appreciable background.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Employee Relations index data for all FPD components for the six successive quarters beginning with the fall of 1957 have been analyzed in order to determine the correlation between ERI figures and attitude survey results, and primarily to determine when a shift of a given number of ERI points may be called significant. This amounts to setting up control charts for different group sizes. The relationships between ERI's and certain measures of production efficiency were also investigated.

Test reactor reactivity values for three sizes of I and E fuel elements having different amounts of enrichment were analyzed to determine how well enrichment can be predicted from a reactivity value.

Mathematical investigations continued in connection with the program of studying eddy-current and ultrasonic methods of non-destructive fuel element testing.

Irradiation Processing Department

Preliminary discussions were held with interested parties in connection with the process tube leak problem at F reactor. A statistical approach to this problem has been formally proposed. Further action will be taken during April.

Data arising from job knowledge tests given to reactor operators were analyzed as requested. It was suggested that true-false questions and multiple choice questions, although easy to correct, are not very adequate in determining whether or not a candidate has minimum required job knowledge. Correlations between test results and types of training given the individuals were also investigated.

Chemical Processing Department

A review was made of the potential ground air concentrations of particulate fission products and plutonium emitted to the atmosphere from the 200 Area stacks. Results were given in a private communication to personnel of Facilities Engineering Operation who requested the study. It is anticipated that further work will be done in this general problem area.

Construction Engineering Operation

Meetings were held with personnel of the Construction Engineering Operation concerning the application of statistical and probabilistic techniques in a systems reliability study being performed on the K reactors. A system block diagram has been drawn up and current efforts are directed toward writing a precise description of the logic of the system as an intermediate step to the derivation of a reliability formula.

C. A. Bennett By J B K

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
George Y. Jordy	3-23-59	AEC- Office of Oper. Anal. & Forecasting Washington, D.C.	Consultation on linear programming	CA Bennett RY Dean RL Basmann	No
W. J. Devine	"	AEC-Div. of Prod. Washington, D. C.	"	"	"
John Vallance	"	AEC-HOO Richland, Wash.	"	"	"
W. H. Bloodworth	3-31 and 4-1-59	GE-Mgmt. Consult. Services - New York	Review of oper. research programs	CA Bennett et al.	Yes
J. F. Burlingame	4-1-59	"	"	"	No

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. L. Nicholson	3-6-59	Univ. of Washington Seattle, Washington	School for Graduate Study	CB Allendorfer	No
R. Y. Dean	"	"	"	"	"
C. A. Bennett	3-10-59	Wash. State Univ. Pullman, Wash.	University Relations Council	Prof. C. Stevens	"
C. A. Bennett	3-16-59	Univ. of Mich. Ann Arbor, Mich.	Recruiting Ph.D.'s	George Hay	
	3-17-59	AEC-Div. of Research Washington, D.C.	Consultation on Wash. Des. Project	DR Miller	Yes
	3-18-59	AEC-Div. of Nuclear Mat'ls Mgmt. Wash.,DC	Discussion of nuclear materials mgmt. paper	GD Adkins	Yes
R. L. Basmann	3-27-59	Wash. State Univ. Pullman, Wash.	Seminar	H McAllister	No
W. L. Nicholson	3-30 to 4-3-59	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Wash. Desig. Program	AC Cameron	Yes

PROGRAMMING OPERATION
MARCH 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

The report on an in-reactor, semi-continuous, minimum inventory process for "olive" production was issued. (HW-59682, "Advantages of Palmolive Alternate," by E. A. Coppinger and E. T. Merrill, 3/17/59.) Four alternates were studied and compared. The advantages of the proposed alternate relate to improvements in product purity, increased production rate, and more rapid attainment of a certain production rate.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

Schedule and Inventory for PRTR Fuels

A detailed study of a schedule for charging, discharging, and chemical processing of PRTR fuel was completed. The accompanying table summarizes this information which may be used for procurement of the necessary materials and in planning for the chemical processing operations in anticipation of the first four years of PRTR operation. Although the table is considered acceptable for planning purposes, it is not regarded as absolutely representative of situations which may exist even one to two years from the present. There are many factors which could change and thus influence the development of such a chart.

Cycle Analysis

The report, HW-59758, "A Calculation of the Reactivity Worth of Plutonium and Uranium-235 as Enrichment in Thermal Reactors", was completed and distributed. This report compares the attainable exposures of uranium-238 enriched with varying percentages of uranium-235 or plutonium in three sizes of reactors. The report shows that under certain practical conditions plutonium-239 has a greater reactivity worth than uranium-235 in thermal reactors of high neutron utilization efficiency. Also, plutonium containing appreciable amounts of the higher isotopes may exhibit a greater reactivity worth than either plutonium-239 or uranium-235 in high efficiency thermal reactors.

The MELEAGER A and B fuel-cycle analysis codes were compiled and run during the month, with considerable progress achieved in debugging. Preparation of cross-section and related input information was essentially completed.

A paper entitled "Selected Economic Aspects of Plutonium Fuel Utilization in D_2O Moderated Reactors" was presented at an AEC sponsored unclassified symposium on March 3 and 4. The paper is being issued as a topical report.

PRTR SCHEDULE FOR CHARGE, DISCHARGE, AND PROCESSING OF FUELS

FY & Qtr.		Reactor Charge: No. of Pieces[e] Spike[f] L[i]	H[i]	U[g]	MX[h]	Kg Pu in Spike	MX	Reactor Discharge: No. of Pieces L	H	U	MX	Kg Pu in Spike	U	MX	Chemical Process[d]: No. of Pieces L	H	U	MX	Kg Pu in Spike	U & MX	Recovered Pu,H,Kg
1960	1																					
	2																					
	3	24	0	60	0	6.5	0															
	4																					
1961	1[a]	0	0	0	0	0	0															
	2[b]	11	0	0	0	3.0	0	0	0	7	0		0.2									
	3[c]	10	0	0	0	2.7	0	10	0	4	0	1.9	0.2									
	4	0	15	0	0	5.1	0	15	0	0	0	2.6			0	0	11	0		0.4		
1962	1	0	15	0	0	5.1	0	15	0	0	0	2.3			15				2.7		2.6	
	2	0	13	0	0	4.4	0	5	6	2	0	2.2	0.3		15				2.5		2.4	
	3	0	5	0	28	1.7	6.4	0	14	19	0	3.2	3.0		15				2.4		2.3	
	4	0	0	0	23	0	5.2	0	14	9	0	3.2	1.4			18			4.1		3.9	
1963	1				21		4.8	0	14	7	0	3.1	1.1			18	25		4.1	3.9	7.6	
	2				7		1.6	0	0	7	0		1.1			12			2.7		2.6	
	3				9		2.0			5	4		0.8	1.0								
	4				14		3.2			0	14			3.4			24			3.8	3.6	
1964	1				14		3.2				14			3.4				21		5.1	4.8	
	2				14		3.2				14			3.4								
	3				14		3.2				14			3.4				21		5.1	4.9	
	4				14		3.2				14			3.4				21		5.1	4.8	
TOTALS		45	48	60	158	28.5	36.0	45	48	60	74	18.5	8.1	18.0	45	48	60	63	18.5	23.4	39.5	
		311				64.5		227				44.6			216				41.9		39.5	

Please see following page for footnotes.

Footnotes

a: Start 10-1-60, first day of fiscal 61 second quarter = reactor day 0

b: Charge 11, discharge 7 - balance by temporary displacement of 4 test pieces.

c: Charge 10, discharge 14 - test pieces now back. First 10 in batch 1 are not.

d: Identification and dates for processing batches. Date given is day on which dissolver may be charged with "cooled" pieces. Recovery and refabrication estimated at 60 days from dissolver charging.

Type	No.	Date
Natural U	11	April 20, 1961
Low Spike	15	July 7, 1961
Low Spike	15	October 5, 1961
Low Spike	15	January 3, 1962
High Spike	18	May 26, 1962
Natural U	25	July 4, 1962
High Spike	18	September 20, 1962
High Spike	12	December 7, 1962
Natural U	24	May 12, 1963
Moxtyl	21	September 25, 1963
Moxtyl	21	February 9, 1964
Moxtyl	21	June 26, 1964
Moxtyl	at	136.5 day intervals

e: Pieces means fuel assemblies or fuel elements.

f: Spike - Pu-Al alloy fuel.

g: U = Natural UO_2

h: MX = Moxtyl = "mixed crystal" fuel - mixed uranium and plutonium oxides.

Final summary of an IBM-650 computer analysis of two aspects of plutonium fuel utilization was nearly completed. Some data points must still be re-run using the 650 simulator on the IBM-709 followed by an IBM-702 run. This is necessary because HAPO no longer has the IBM-650. These runs have been delayed by difficulties associated with the organization of data through the simulator codes.

C. 6000 PROGRAM

Radiological Consultation

Consultations were held on the possible use of iodine-131 as a tracer in meteorological experiments designed to study the deposition properties of vapors as compared to particles. Investigations of shorter-lived isotopes were started to minimize the quantities released from the controlled area and the time period between experiments due to contamination of the course. Discussions on the permissible release rates from the separations areas stacks and the potential problems were held.

Calculations of the radiation doses expected from a ground level release following a single tube incident in PRTR were performed and the previous write-up on elevated release from the same type of incident revised to include both types of release.

A paper "Radiation Protection - Standards and Laws" was prepared for presentation to the American Industrial Medical Association meeting in April.

A trip to the Vallecitos Atomic Laboratory and to San Jose to obtain information on the Vallecitos Boiling Water Reactor was made on behalf of the Small Boiling Water Reactor Subcouncil of the GE Reactor Safeguards Council. Notes from this trip were prepared and submitted to the other members of the Subcouncil.

D. OTHER ACTIVITIES

At the request of the AEC, alternate proposals for conduct of the 1959 - Summer Institute on Nuclear Energy program at HLO were prepared. These alternates involved offsite trips and an expanded lecture program to include offsite speakers. Either of these alternates resulted in substantial deletions of time usually devoted to the problem assignments. The study of these alternates was presented at a meeting of the ASEE Nuclear Committee in Washington, D.C. on March 8. The alternate involving presentation by offsite speakers was unanimously favored over the one involving offsite trips because of the lesser effect on time utilized on problem assignments.

At the same meeting ten candidates for the 1959 - SINE program at HLO were accepted. Nine of these have chemical engineering backgrounds; one has a chemistry background. Eight either hold or formerly held "Q" clearances. Eight have Ph.D. degrees.

Arrangements were completed to permit B. Mastel and J. DePangher to speak before the Washington State University Chemistry and Physics Departments, respectively. Professor Harold Dodgen was invited to talk before the HLO Seminar group. He will talk on the WSU research reactor and the program of research associated with it.

Arrangements were completed and Dr. A. Hadley Cantril addressed the HLO Science Colloquium on March 5. Approximately 150 people attended. The talk was exceptionally well received.

A rough draft report describing HLO's research and development activities for the next five fiscal years (HW-59633-RD) was prepared and issued for comment as part of the HAPO Five Year Program document.

Estimates of manpower and money requirements for the next five years for HAPO research and development programs were supplied to the local AEC. The information is to be used as background information for the JCAE Hearings soon to be held on AEC Laboratories.

Chas. A. Robinson for L.H. McEwen

Manager, Programming

LH McEwen:dl

VISITS TO OTHER INSTALLATIONS: (CONTINUED)

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. A. Eschbach J. R. Triplett	3/5/59	Argonne National Laboratory Lemont, Illinois	To discuss plutonium in thermal and fast reactors.	L. Koch, L. Link, H. Monson, F. Foote, and D. Okrent	Yes
J. W. Healy	3/24-26	General Electric Company Vallecitos Atomic Lab. San Jose, California	To review information on Vallecitos Boiling Water Reactor for GE Reactor Safeguards Council.	L. Kornblith G. Sege K. Cohen	No
C. A. Rohrmann	3/8-9	AEC - Washington, D.C.	To make arrangements for revised SINE and to participate in the Selections Committee work of ASEE for SINE.	G.W. Courtney, Jr.	No
	3/9/59	Johns Hopkins University Baltimore, Md.	Spoke before graduate and undergraduate chemical engineers on "Process Engineering Problems in Hanford Separations Plants."	Prof. H. E. Hoelscher	No

VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
Dr. W.L.S. Wu	3/23-27	Convair San Diego, Calif.	To review radiation protection and radiological sciences programs.	J.W. Healy R.L. Junkins	Yes	300 - 3746 & 328
Dr. A.H. Cantril	3/5/59	The Institute for International Social Research Princeton, N.J.	HLO Colloquium speaker.	M. Lewis	No	300
Dr. R.D. Bennett	3/16-17	GE Vallecitos Atomic Laboratory	R & D discussions with Laboratories Managers.	M. Lewis	Yes	200-W, 231-Z 100-K 300

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. H. McEwen	3/5/59	University of Washington Seattle, Washington	To discuss cooperative research program.	Prof. L.D. Carlson	No
L. H. McEwen	3/10/59	Washington State University, Pullman, Wash.	To discuss cooperative research program.	Prof. C.M. Stevens	No
E. A. Eschbach J. R. Triplett	3/2/59	Nuclear Power Development Dept., Detroit Edison Co. Detroit, Michigan	To discuss plutonium utilization in fast spectrums.	R. Standord	No
	3/3-4	AEC - Washington, D.C.	To attend Symposium on D_2O Moderated Reactors presenting information on Pu fuel cycles.	J.F. Kaufmann	No

RADIATION PROTECTION OPERATION MONTHLY REPORT - MARCH 1959

A. ORGANIZATION AND PERSONNEL

Plans to realign the functions within the Radiation Protection Operation were announced. The main changes included establishment of a Radiological Evaluation Working Group headed by R. L. Junkins and inclusion of the Regional Monitoring function in the Radiation Monitoring Operation. The changes were effective April 1, 1959.

On March 2, 1959, Joan M. Weston transferred into Radiation Monitoring and Luese W. Powers transferred to P&IR&D. R. K. Jones transferred into Exposure Evaluation and Records on March 9 to replace R. H. Beauchamp who transferred to R&FR&D on March 16. Also on March 16, L. J. Defferding transferred to R&FR&D and A. F. Patrick transferred to CPD. Edna D. Britch was reactivated from illness leave on March 23. Lillian J. Whitney transferred into Radiation Monitoring on March 23, 1959.

Five employees were transferred within RPO to increase job knowledge and provide additional experience. The RPO force remains at a total of 132.

B. ACTIVITIES

An explosion occurred on March 31, 1959 in a lathe hood located in Room 179-B of the plutonium metallurgy facilities in 234-5 Building. Two Hanford Laboratories' employees were machining a piece of plutonium metal in the hood at the time of the explosion. A piece of the broken hood front struck one of the employees above the left eye causing a laceration about 3/4" long. Both men and four other employees working in other parts of the room left the room immediately. High-level plutonium surface contamination occurred on the face and shoulders of the two men working at the hood at the time of the explosion. The injured man received a shower promptly after the incident to remove loose surface contamination. After the shower, contamination levels in excess of 40,000 d/m plutonium were found on the head and shoulders of the injured employee. This same level of contamination was measured in the vicinity of first degree burns on the left side of the neck of the employee who received the laceration.

Skin decontamination down to levels on the order of 1,000 d/m was successful within a few hours after the incident. Minor excision of contaminated tissue was performed at the 200-W First Aid Station as a precautionary measure.

Diethylenetriaminepentaacetic acid (DTPA) treatment was administered about three hours after exposure. The injured employee was taken to the Kadlec Hospital for further minor decontamination and treatment. Measurement of possible contamination in the wound area was made the following day in the Shielded Personnel Monitoring Station. Approximately 2,000 d/m plutonium was detected in the vicinity of the wound area and approximately 4,000 d/m was measured in the vicinity of the neck burns. Preliminary analysis of the first urine sample obtained about three and one-half hours after the incident indicated that plutonium deposition in excess of the permissible limit was very unlikely. Skin decontamination of all employees associated with the incident was successful. Gross amounts of plutonium contamination were deposited on most of the exposed surfaces in the laboratory room which was sealed off pending orderly decontamination.

Excluding the above incident, no additional cases of plutonium deposition were confirmed during the month. This maintains the total number of deposition cases which have occurred at Hanford at 228. There are 162 employees currently employed who have a measurable deposition of plutonium.

Analyses of the film badges and work assignments of three IPD employees indicated that these employees had received radiation exposure slightly in excess of 0.3 r in seven days. A particle discovered on the shoe of one IPD employee resulted in an estimated localized dose to the skin of about 6 rads including 0.6 r.

A fire involving peanut oil occurred in a hood in Room 179-B of the plutonium metallurgy facilities in the 234-5 Building. The fire was extinguished with sand. No spread of contamination to the room or personnel resulted. A continuous alpha air monitor was installed in Room 179-B of the 234-5 Building to provide monitoring and alarm for plutonium air contamination.

Modification of the positive ion Van de Graaff accelerator was completed. Radiation measurements during operation testing indicated that the abnormal condition which resulted in an exposure above permissible limits in February had been corrected.

Incidental to a background aerial survey flight to Spokane, a flight was made over several working uranium mines in the area in order to compare the capabilities of the 5" x 5" plastic scintillator with commercially available uranium prospecting equipment. Preliminary evaluation indicated that the larger mines were easily detectable from the air.

Testing of the reduced area electrodeposition procedure for plutonium bioassay was continued during the month. Prototype reading of the total area indicated an average yield of around 75% for six spike samples. Some difficulty was encountered in cross-contamination of the test blank samples. Operational testing of this procedure is continuing. The eventual application lies in on-plant bioassay sampling.

A "criticality drill" was held to test the effectiveness of the RPO emergency procedure for high-level film dose evaluation. The unknown doses were evaluated in slightly less than two hours; however, overestimations up to 60% were made at some dose levels. Investigation was started into the possible effect of film fading as the cause of the overestimation.

The appropriation request for procurement of an automatic film processing system was approved. Requisition of component parts was initiated.

Standard gamma pencils and stray radiation chambers were used to measure the gonad dose associated with various X-ray procedures at Kadlec Hospital. Emphasis for this survey was placed on the gonad dose which is received during the 4" x 5" and

14" x 17" chest X-ray examinations. The lead aperture which is now used with the X-ray measurements has resulted in a significant reductions in the dose to both male and female gonads and also to the head of the subject. A masonite and a water phantom were used in all of the measurements. The application of the pulse pencil reader technique to these measurements has been a significant advance in evaluating with a high degree of accuracy these very small doses. These measurements may be the most accurate measurements of this type yet to be performed. Appropriate chambers permit measurements of dose as low as one microroentgen by application of the pulse pencil reader principle.

Advice was provided on drafting of a chapter for radioactive shipping requirements for the SS Accountability Manual.

Committee work was completed for the AEC Committee on Transportation of Highly Radioactive Materials.

Information on the number of personnel engaged in radiation protection work at HAPO was prepared for AEC-HOO for forwarding to the Division of Production, Washington, D. C.

C. EMPLOYEE RELATIONS

Announcement was made that A. R. Keene had been invited to present a paper entitled "Confinement Techniques and Handling of Plutonium in Research Laboratories" at the OEEC Symposium on Health Physics at Riso, Denmark, on May 25-28, 1959.

There were two medical treatment injuries for a frequency of 0.91. No security violations occurred during the month.

Three suggestions were received for evaluation. Six suggestion evaluations were completed and none were adopted. Two suggestions are pending in RPO for evaluation. No awards were made.

A lecture on "Radiation Hazards" was presented to the R&D Flight of the 9401st Air Reserve Squadron at Washington State College, Pullman, Washington, by B. G. Lindberg.

D. SIGNIFICANT REPORTS

HW-59859 "Monthly Report - March 1959, Radiation Monitoring Operation" by A. J. Stevens.

HW-59307 "Resistance of Elastomer Gloves to Nitric Acid" by T. C. Mehas.

HW-59399 "Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities through December 1958" by K. F. Baldridge.

Con. Undoc. "Inventory of Radioactive Liquid Wastes to Active Disposal Sites - January 1959" by K. F. Baldridge.

HW-59918 "Regional Monitoring Activities, March 1959" by B. V. Andersen.

HW-59880 "Waste Disposal Monitoring Activities Summary, March 1959, by K. F. Baldridge.

Report of Invention - "An Improved Fluorescent Lamp" by A. R. Keene.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings
Dr. W. Langham	3-13-59	Los Alamos Scientific Laboraty Los Alamos, N. M.	To be counted in Shielded Personnel Monitoring Station	G. D. Brown	No	747 & 747-A 700 Area
Mr. C. Beck	3-16-59	Washington Office AEC, Washington 25, D. C.	Discuss radiation protection techniques	A. R. Keene H. J. Paas	No	3746:300
Dr. W.L.S. Wu Capt. J. R. Poppen	3-23-59 thru 3-27-59	Convair, San Diego California	Review radiation protection practices at and near HAPO and tour HAPO facilities	A. R. Keene and Staff	No	3705, 3706 329, 3745, 3746:300 747:700
E. Tochilin	3-26-59	Navy Radiological Defense Lab., San Francisco, Calif.	Discuss pencil reader	F. L. Rising W. V. Baumgartner	No	3706,329 300
Prof. Barnes	3-17-59	Univ. of Idaho, Moscow, Idaho	Viewed and discussed film badge processing machine	C. M. Unruh L. F. Kocher	No	3706:300

VISITS TO OTHER INSTALLATIONS

J. W. Vanderbeek	3- 8-59 thru 3-22-59	Joint Committee on Atomic Energy, Washington, D. C.	To observe at the hearings on Employee Radiation Hazards and Workmen's Compensation	C. A. Hamilton	No
A. R. Keene	3-13-59	Seattle, Washington	Attend speech by Dr. Libby	None	No
B. V. Andersen	3-16-59 thru 3-21-59	Sandia Air Base, Alburquerque, N.M.	Attend Armed Forces Special Weapons Symposium	Col. Hanson	Yes

VISITS TO OTHER INSTALLATIONS (Continued)

E. C. Watson	3-8-59 thru 3-18-59	Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee	Attend the Fellowship Advisors meeting Attend conference on emergency dosimetry	Attendees	No
		Massachusetts Institute of Technology, Cambridge, Mass.	Discuss correlation of neutron exposures and blood-sodium	Dr. C. J. Maletskos	No
		National Bureau of Standards	Radiation calibration problems discussion	T. P. Loftus	Yes
K. R. Heid	3-27-59	Westinghouse Repair Shop, Portland, Ore.	Monitoring service	Mr. Nebler	No
B. G. Lindberg	3-24-59	State College of Washington, Pullman Washington	Discuss radiation hazards	Lt. Col. A. G. Taflinger	No
B. G. Lindberg	3-31-59	Yakima Valley Junior College, Yakima, Wash.	Discuss "Civil Protection Against Radiation in Fallout"	Wm. Killinger	No

REGIONAL MONITORING - RESULTS (February 23, 1959 - March 22, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	1.4	% MPC_{GI}	--
Separations Areas	Total Beta	2.2×10^{-6}	µc/cc	-2
Pasco	Isotopic	0.6	% MPC_{GI}	--
Kennewick	Isotopic	0.3	% MPC_{GI}	--
Richland	Total Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
Columbia River Water				
Above 100-B Area	Total Beta	4.0×10^{-8}	µc/cc	--
100-F Area	Isotopic	6.8	% MPC_{GI}	--
Hanford Ferry	Total Beta	7.7×10^{-5}	µc/cc	--
Pasco	Isotopic	1.6	% MPC_{GI}	--
McNary Dam	Total Beta	3.0×10^{-6}	µc/cc	+4
Vancouver, Washington	Total Beta	7.3×10^{-7}	µc/cc	--
Waste Water				
Outlying Test Wells	Total Beta	2.7×10^{-6} (Max)	µc/cc	--
Reactor Effluent Retention Basins to River	Total Beta	29,000	curies/day	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	0.8	mrad/day	--
Environs	Gamma	0.5	mrad/day	--
I-131 Separations Areas	I-131	2.2×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	3.1	curies/week	--
Active Particles - Project	--	18	ptle/100 m^3	--
Active Particles - Environs	--	31	ptle/100 m^3	--
Vegetation				
Separations	I-131	1.9×10^{-6}	µc/gm	-3
Residential	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	5.6×10^{-4}	µc/gm	--

* The % MPC_{GI} is the percent of the maximum permissible limit for continuous occupational exposure to the gastrointestinal tract calculated from drinking water limits.

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

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
March	1	1
1959 to Date	4**	3

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
March	30,860	56	0	1
1959 to Date	96,706	150	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(ow)	mr(s)
March	10,092	759	49	19	43	6.04	15.07
1959 to Date	30,822	2,604	302	41	181	4.04	19.02

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
March	1,189	6	0	0	2
1959 to Date	3,509	17	1	0	10
Fast Neutron					
March	149	0	1	0	2
1959 to Date	224	0	2	0	11

Bioassay

	March	1959 to Date
Plutonium: Samples Assayed	713	2,351
Results above 2.2×10^{-8} μc/sample	37	85
Fission Products: Samples Assayed	663	2,271
Results above 3.1×10^{-5} μc FP/sample	2	12
Uranium: Samples Assayed	265	877
Confirmed Plutonium Deposition Cases	0	4*

*This brings the total number of plutonium deposition cases which have occurred at Hanford to 228.

** Includes two incidents occurring in January and one in February which were not included in last months' total.

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	32	3.6	46	5.1	2.1	41
Hanford Laboratories	23	4.0	22	6.5	2.4	13
Chemical Processing	31	5.9	57	30	3.5	60
Chemical Processing*	8.6	8.6	1	0	0	0
Special Incidents	1.1	1.1	1	0	0	0
Random	2.2	0.6	24	0	0	0

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

Thyroid Checks	March	1959 to Date
Checks Taken	0	0
Checks Above Detection Limit	0	0

Hand Checks		
Checks Taken-Alpha	26,848	84,548
-Beta-Gamma	18,781	56,120

Skin Contamination		
Plutonium	23	54
Fission Products	11	116
Uranium	9	35

CALIBRATIONS

Portable Instruments	Number of Units Calibrated March	1959 to Date
CP Meter	903	2,789
Juno	269	879
GM	1,283	3,983
Other	201	614
Total	2,656	8,265

Personnel Meters		
Badge Film	932	2,764
Pencils	2,231	3,545
Other	384	1,258
Total	3,547	7,567
Miscellaneous Special Services	406	1,033
Total Number of Calibrations	6,609	16,865

AR Keene
Manager
Radiation Protection

AR Keene:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - MARCH, 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 3.83, which is considered about average experience.

The absenteeism rate was 4.28 per cent, which is about average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 14,317 hours. The total shop work backlog is 21,151 hours of which 50% is required in the current month, with the remainder distributed over a three month period. Overtime worked during the month was 6.4% (1160 hours) of the total available hours.

Distribution of time was as follows:	Man Hours	% of Total
Fuels Preparation Department	1466	10.2
Irradiation Processing Department	1154	8.0
Chemical Processing Department	577	4.1
Hanford Laboratories Operation	10717	74.8
Construction Engineering Operation	39	.3
Miscellaneous	364	2.6

The number of requests from customers for emergency service increased from the previous month, necessitating an overtime ratio of 6.4%. Other project shops were utilized to capacity in providing assistance to the Technical Shops.

The acquisition of additional craft personnel is proceeding on schedule. One instrument specialist and one instrument technician trainee were added to the roll. A journeyman welder was tested and found to meet our requirements. He is currently awaiting the necessary security clearance before starting work. Applications from journeyman machinists were reviewed and fifteen were selected as potential HAPO employees. The top seven of this group are in the process of obtaining security clearance and will be called in as soon as possible.

The Rockford Planer, which was placed on order March 2, was received on March 27 and placed in operating condition.

The Technical Shops manager visited Offutt Air Base in Omaha, Nebr., and the Bendix Co. Plant at Kansas City, Mo., to inspect surplus machine tools owned by the Federal Government. Two turret lathes were found to be acceptable and were obtained for use by the Fuels Preparation Department. A precision lathe and a boring and turning machine were tentatively obtained for the Technical Shops pending release by the Air Force. Work is continuing on the program to replace the loaned graphite equipment which must be returned to the 2101 Bldg. in the fall of 1959.

RADIOGRAPHIC TESTING OPERATION

Activity for Radiographic Testing Operation was slightly above normal due to increased activity on the tubular product program. A total of 9,555 tests were made, of which 1,217 were radiographic (including X-ray and gamma ray) and 8,338 were supplementary tests. Out of a total of 954 man hours, 528 (55.3%) were used in connection with radiographic tests, and 427 (44.7%) were used on supplementary tests. The supplementary test work included dimensional measurements (micrometric and plug gage), eddy current, leak detection, penetrant, and ultrasonic thickness measurements.

The number of pieces handled this month was slightly under that of the previous month, totalling some 2,577 items. However, again continuing the trend of last month, the feet of material examined was considerable, amounting to 29,200 feet. This large increase is indicative of continued automation of some tests on tubular products. Work was done for 16 different organizational components, representing most of the operating departments and service organizations. A total of 19 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 16 different occasions for advice and information regarding general testing theory for other than the jobs tabulated in Part II - Testing Statistics.

Approval was received during the month for relocation of Radiographic Testing Operation field facilities from the 200-E Area to an unused shop building at White Bluffs. The building will be identified as Building C-26-WB Testing Laboratory and will provide space for the tubular products program and Radiographic Testing Operation activity.

Also, in the new facility category, equipment has been moved into the basement of the 325 Building to assist in the Ceramic Fuels Development Program. The items involved include x-ray equipment, eddy current testing facilities, fluorescent penetrant testing equipment, and a mass spectrometer for leak detection. The fuel development work being done will be facilitated by having the test equipment integrated with fabrication work.

The heavy equipment has been removed and the building completely cleaned of accumulated debris, at White Bluffs. Cutting the trench in the floor slab for the conduit and drain piping has begun. Fabrication of the pickling troughs is about 50 per cent complete and work has started on the jib crane, tank supports, exhaust hoods, ductwork, etc. An acid storage tank, ANN storage tank and make-up vessel that have been found on plant as available, as well as the available deionized water storage tank, have been delivered to the White Bluffs shop for the necessary modifications.

Testing Statistics

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
CPD	94	109-1/2	96	Purex silver reactor, 2" sch 40 and 10" sch 10, SS pipe; Redox dissolver plate and pipe welds 2", sch 80.
CEO	1296	1693	201	2-1/2", 8", 10" nozzles; 8" and 10" SS flanges. PRTR containment vessel weld seams.
HLO	8141	27387	2255	Pig x-ray; PRTR ceramic fuel rod closures and cladding; gamma heating slug; swelling capsules; 1/8" O.D. x 22' long SS sheath; Zr clad solid U core fuel rod; 1.3, 1.65, 5% Pu-Al fuel rods; 6%, 10%, 16%, U-Al CO-extruded rods; .680" I.D. x .035" x 7' long zr tubes; .505" I.D. x .030" wall x 10' long zr tubes; KER, ribless zr. process tubes. PRTR mark 116 heated mock-up: 18% (NP oxide) Al-NP fuel rod.
IPD	24	13-1/8	25	Pig tail adapter fittings; 1" and 2.24" O.D. joints, #27, VS.
TOTALS	9555	29203	2577	

FACILITIES ENGINEERING OPERATION

Projects

There were 18 authorized projects at month's end with total authorized funds of $7,726,400. The total estimated cost of these projects is $7,870,400. One project was completed during the month. Two new projects are awaiting AEC approval. Project Proposals for ten new projects are in preparation.

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

Engineering Service

Title	Status
Reroofing of 146-FR and 222-U Buildings	Work complete except for gravel course.
Removable Grating - 3745-B Building	Material expected 4-15-59.
Traveling Crane Improvements 314 Building	Work complete.

Title	Status
Noise Attenuation 3760 Building	Equipment room will receive additional noise attenuation treatment.
Provide Additional Hoods, Room 7-2A, 325 Building.	Work complete.
Decontamination of the Interior of 314 Building.	Work is essentially complete.
Renovate Room 30-C - 326 Building	New equipment is being received for installation.
Improve Lighting - Rooms 11-1A & B - 325 Building	Work is progressing. Fixtures on hand.
306 Building Water Filter	No action pending negotiation with vendor.
Design & Install Fire Alarm System 314 Building	Design work being analyzed for cost savings.
Air Balance - 108-F Building	Engineering work in progress.
Auxiliary L.P. Propane Gas Supply - 325 Building	Work essentially complete.
Building Modifications - 146-FR Building	Space is occupied. Work essentially complete.
Lighting Study, Bindery Room, 3760 Building	Installation work delayed because of lack of materials.
Gamma Irradiation Facility - 3730 Building	Roof opening complete. Concrete removal complete.
Locker Room Modifications - 321 Building	Work in progress and nearing completion.
Heating & Ventilating Study - 306 Building	Study work completed. Recommendations are being analyzed prior to physical performance.
Unfired Pressure Vessel Survey	Unfired Pressure Vessels in the 300 Area are being physically checked and maximum allowable stress is being calculated. Safety relief valves have been ordered for several vessels and some piping changes have been made for code conformation. Third party inspection was made on 7 vessels this month.

Title	Status
Erection of Towers for Atmospheric Physics	The contract was let to Patton-Hill of Pasco for the contract price of $11,600. Work started on 3-18-59 and is approximately 15% complete.
Study - Layout of Biology	Work is being performed for preparation of Biology Facilities Layout to meet requirements for next 10 years including design cost estimate, and right order of magnitude construction cost estimate.
326 Building Retention Waste Sump Modifications	Removal of existing retention tanks and use of sump as collecting basin is being considered. Sump pumps with greater capacity will reduce maintenance and the possibility of basement flooding.
Uranium Scrap Burner - 306 Building	Initial study work has been started. Equipment has been determined. Preliminary design has been reviewed with customer. Construction cost estimate indicates this work will be of Informal Request magnitude.

Design and Drafting

Title	Status
Equilibrium Chamber	A device to measure thermal conductivity of dense ceramics. Detail work essentially complete.
Creep Capsule	In-reactor creep measurement of zirconium. A capsule to monitor stress, elongation, and temperature while being irradiated. 20% complete.
Wide Angle Viewer - PRTR Examination Cell	Work complete.
Wet Storage Basin Manipulators and Cleaner - 325-A Building	Work in progress at 50% complete.

Other design and drafting work in progress includes the following:

Automation of feed mechanism of Kux Hydraulic Press - 325 Building.
Mechanism for Rupture of Irradiated Fuel - 3x3 loop ETR.
Redesign of portion of in-reactor loop - 3x3 loop ETR.
Tools for handling discharged fuel elements - ETR.
Modifications to 14 ton Shipping Cask.
Modifications to Vacuum Welding Box - 306 Building.

Maintenance and Building Engineering - Landlord Functions

Costs - February - $ 116,249
January - 112,907

FYTD Total: $794,986 - 63.9% of Budget. The predicted expenditure forecast cost over the same period was estimated to be $815,600 or 65.5% of Budget.

Analysis for Month of February: Unusual maintenance fell off because certain work which was expected to take place was being rescoped. Building maintenance on the other hand exceeded prediction by $5000; this is partially attributable to some jobs being considered of a not "unusual" nature. Steam was within $500 of that anticipated. At month's end, this account was $20,600 (1.6%) under expended. But billings for power operators amounting to $7,000 were not received yet against this account. Unusual activity is expected to increase.

Miscellaneous

Engineering investigation of the Livonia-type roof on 325 is still in the fact-gathering stage. A meeting was held March 16 to obtain the laboratory staff's point of view.

Engineering investigation of the heating and ventilating problem in 329 Building is in an analytical phase. Detailed questionnaires for room are being evaluated.

The lunchroom relocation study for 3760 Building has been implemented by a work order to Construction Operation.

The potential radon problem has been carefully reviewed in a series of meetings chairmanned by the Maintenance and Building Engineering Specialist. Specific recommendations were made at the meeting held March 17, 1959. Interested physics, health, and radiological personnel were in attendance.

A preliminary study to improve the appearance of the 300 Area grounds and the vicinity of the 747 Building has been undertaken by CEO.

AEC approval was obtained through a formal request for performance of contingency maintenance of the 327 Crane. The work will render the crane more maneuverable and responsive, with attendant efficiency and safety.

AEC approval was requested for contingency maintenance to the 325 building ventilating and exhaust fans. This work can provide the necessary air for the High Level Radiochemistry Facility and for the Basement Improvements of the Heavy Equipment laboratories, as well as for other required hood and cave additions.

TECHNICAL INFORMATION OPERATION

As a result of a suggestion by a Hanford secretary, a list of standard abbreviations and compound words was distributed to the Plant through the Department communications specialists. The list suggested that, since often alternate forms of an abbreviation are acceptable, it is desirable to select one of these alternatives and to use it consistently. The list should be useful to Hanford secretaries, stenographers, and report writers.

A summary of the AEC's book publishing program was distributed to the field. It described the purpose of the program, listed books which the AEC would like to see written, and the methods by which this is accomplished. The intent of the summary is to encourage HAPO participation in the program, since a number of the books which the Commission would like to see written relate directly to HAPO activities and desirably should be written by Hanford authors.

A number of unclassified HAPO fuel element subcontracts were upgraded to Confidential by HOO. The criteria on which this action was based are very general and restrictive. Unless these criteria change, all research and development work carried out with or for production reactor fuel elements must be born classified. A review of the effects such a ruling will have on the NPR fuel element development schedule is currently being made by appropriate HAPO personnel. A request has been sent to HOO for review and declassification of development work involving external modifications of the fuel elements for the existing production reactors.

About 1,400 Geneva Papers, mostly foreign, were received. These papers went directly to file without any additional record-keeping since we have been notified that all Geneva Papers would be indexed in a special edition of Nuclear Science Abstracts.

The results of the 1958 inventory of Research and Development reports and Atomic Weapon Data reports were reported to GE Security. HAPO's holdings are 10,130 copies of which 105 copies are Weapon Data reports and the remaining 10,025 copies are Research and Development reports. Twenty-nine copies were reported as unaccounted for, of which twenty-seven were carry-overs from previous annual inventories. None of the unaccounted for reports are Weapon Data.

Work Volume Statistics	February	March
Document Distribution and Files		
Documents routed and discharged (copies)	19,219	15,913
Documents issued (copies)	10,354	9,197
Documents sent offsite (copies)	3,893	3,904
Document reserves filled (copies)	987	820
Documents picked up and delivered	25,790	23,015

Document Accountability	February	March
Holders of classified documents whose files were inventoried	310	447
Documents inventoried in Files (copies)	28,705	9,220
Documents destroyed or retired (copies)	5,274	3,891
Documents revised (copies)	2,835	1,735
Documents pulled and documents filed (copies)	12,815	17,623
Documents reclassified	561	328
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	202,961	202,995
Reference and Publication		
Books cataloged (new titles)	2	191
Books added to the collection (volumes)	227	512
Ready reference questions answered by professional staff	185	186
Literature searches by professional staff	107	123
Reports abstracted (titles)	214	204
Formal reports prepared (titles)	12	5
Offsite requests for HAPO reports (copies)	208	217
Reports released to CAP (titles)	20	56
Library Acquisitions and Circulation		
Books ordered (volumes)	415	333
Periodicals ordered	122	225
Books circulated (volumes)	1,601	1,835
Periodicals circulated (issues)	2,549	3,225
Inter-Library loans	66	61
Films borrowed or rented	31	24
Industrial film showings	44	72
Bound periodicals added to the collection	28	29

Library collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Totals
No. of books	25,869	8,181	1,398	1,938	37,386
No. of bound periodicals	11,588	1	1,431	96	13,116
	37,457	8,182	2,829	2,034	50,502

Classification and Declassification	February	March
Documents, including drawings and photographs reviewed for downgrading or declassification	128	93
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	24	33
Documents submitted to Declassification Branch, Oak Ridge	21	9

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

BUDGET CLASSIFICATION: General Plant Projects - FY 1958 - AEC-2-23-58-L

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN	CONST.			
			AMOUNT	SCHED.	SCHED.	DESIGN	DESIGN	DESIGN
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CGH-804	Ceramic Fuels Press Enclosure - 325 Building		$41,000	100	100	6-19-58	- - -	8-1-58*
		$34,000	6-2-58	100	100	10-1-58	1-15-59	1-15-59*
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

All work on this project has been completed except cleanup of some tar which splashed on the 325 Building during the press enclosure roofing work. Completion of the cleanup is expected by April 1, 1959.

* Actual dates.

CGH-809	Electrical Modifications - 328 Building		$40,000	100	100	7-30-58	- - -	11-30-58*
		$30,000	6-30-58	100	100	1-9-59	3-1-59	2-27-59**
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The Physical Completion Notice dated March 9, 1959 has been issued. All exceptions were completed by March 9, 1959. This project will not again be reported.

* Actual date.
** The project was considered physically complete with exceptions on February 27, 1959.

CAH-827	Automatic Columbia River Monitoring Station		$27,000	0	0	4-15-59	- - -	6-15-59*
		$27,000	3-17-59	0	0	7-15-59	12-31-59	12-31-59
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS:

Directive No. AEC-151, dated March 17, 1959 authorized total project funds to AEC-HOO for design and construction of this project. Work Authority No. CAH-827(1) authorized $15,250 to the General Electric Company for design, procurement, and installation of the monitoring equipment. Carson and Moe were selected by the Commission to design the structure and main river water pump as well as the supply and return piping.

* GE Portion only

1252278

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CAH-828	Central Storage Facility - 300 Area	$37,400	$37,400 2-18-59	N.S. 0	0 0	3-30-59 6-18-59	- - - 12-31-59	5-20-59 12-31-59
		USING COMPONENT: Property Accounting				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The Commission has negotiated Contract No. AT(45-1)-1447 with Carson, Kesterson and Moe, Architect-Engineers for Title I & II services on this project. Title I work started March 30, 1959.

CGH-829	Building 325 Basement Improvements	$70,000	$70,000 2-13-59	83 93	N.S. 10	2-13-59 3-2-59	- - - 9-30-59	5-13-59 9-30-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Work on the partition started March 18, 1959. Design is complete on the ramp and basement access and a bid package is being prepared. Specifications for the sprinkler system are out for comments.

CAH-837	Animal Pens, Isolation and Examination Facilities	$80,000	$80,000 3-17-59	N.S. 0	0 0	N. S. N. S.	- - - 4-1-60	6-1-59 1-1-60
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

Directive AEC-152, dated March 17, 1959 has been received. The General Electric Company was verbally notified that the AEC Work Authority had been issued on March 30, 1959. The Commission has been negotiating with an Architect-Engineer for the design work.

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED COMP. DATE: DESIGN / CONST.
IR-242	Modify 303-J Building to Provide an Interim Test Facility for Fuel Elements	$19,000	$19,000 / 2-17-59	100 / 100	75 / 70	2-17-59 / 2-23-59	- - - / 4-28-59	2-20-59* / 4-28-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. E. Ralph

REMARKS:

Construction Forces have completed 98% of their phase of this job. Plant Forces portion of the work is behind schedule. Overtime effort is being used.

* Actual Date.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED COMP. DATE: DESIGN / CONST.
IR-243	Relocation of 200-E Testing Equipment	$18,000	$18,000 / 3-11-59	70 / 70	25 / 25	3-12-59 / 3-16-59	- - - / 4-22-59	4-10-59 / 4-22-59

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: H. Radow

REMARKS:

Work on the C-25 Building has begun. The existing heavy machinery has been removed and the building cleaned. Orders for the heating plant and sanitary equipment have been placed.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED. / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED. / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	DIRECTIVE COMP. DATE: DESIGN / CONST.	ESTIMATED COMP. DATE: DESIGN / CONST.
IR-	Alterations to the Positve Ion Accelerator Facility - 3745-B Building	$19,000	None / None	0 / 0	0 / 0	.5* / .5*	- - - / - - -	.5 * / 6 *

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: R. C. Ingersoll

REMARKS:

Approval signatures have all been obtained and the Informal Request is being printed.

1252280

* Months after authorization.

AM-7300-018 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION: New Construction - FY 1960

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None / None	0 / 0	0 / 0	- - - / - - -	- - - / - - -	- - - / - - -

USING COMPONENT: Physics & Instruments R & D

FED ENGINEER: R. W. Dascenzo

REMARKS:

A preliminary project proposal requesting funds in the amount of $30,000 for preliminary design has been approved by the General Manager, HAPO and the HOO-AEC. It has been forwarded to AEC-Washington for final approval.

Improvements to Production and
Supporting Installations - 58-b-4

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory - Stage I	$1,000,000	$1,000,000 / 3-23-59	100 / 100	0 / 0	5-22-58 / 6-1-59	- - - / 6-30-60	2-24-59 / 5-1-60

USING COMPONENT: Physics & Instruments R & D

FED ENGINEER: D. S. Jackson

REMARKS: Directive HW-455, Modification 2, dated March 23, 1959 has been received. General Electric Company is authorized to incur costs in the amount of $1,000,000 for construction of Stage I of this project. Tracings, specifications and ATP's have been transmitted to the Commission for preparation of the Construction Bid Package. Seven stainless steel process vessels, formerly to have been procured directly by the General Electric Company, are now to be provided by the contractor. It is estimated that the invitation to bid will be issued about April 8, 1959 and bids will be opened about May 6, 1959. Procurement of engineered equipment by the General Electric Company has been initiated.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CA-744	Metallurgical Development Facility - 306 Building Addition	$2,623,000	$2,685,000 / 11-5-58	96 / 97	0 / 0	6-30-58 / 3-20-59	- - - / 9-1-60	9-1-59 / 9-1-60

USING COMPONENT: Reactor & Fuels R & D

FED ENGINEER: J. T. Lloyd

REMARKS:

A contract for the building and services has been awarded to Jensen-Rasmussen Company of Sunnyside, Washington. The contract price is $934,850; the notice to proceed is being prepared. Design for the chemical processing facility has been initiated and the design schedule is being prepared. Requisitions for equipment have been prepared and submitted for procurement except for six items of inspection equipment; these will be completed within the next two weeks.

BUDGET CLASSIFICATION: Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH: March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CA-749	High Level Radiochemistry Facility	$960,000	$960,000 / 10-31-58	100 / 100	59* / 52	6-15-58 / 8-14-58	- - - / 6-30-59	11-21-58 / 8-30-59

USING COMPONENT: Chemical Research & Development

FEO ENGINEER: R. W. Dascenzo

REMARKS: During the reporting period the following construction work was performed: 1) Concrete finished for Amercoating in liquid storage vault and main floor wainscoating. 2) Ventilation exhaust ductwork through cell structure ground floor slab is being installed, also the supply ductwork is being constructed. 3) The outside ventilating supply duct has been insulated. 4) Installation is progressing on pipework for the liquid transfer hood and stainless steel tubing imbedded in concrete shielding. 5) The 2" auxiliary SS pipe cell exhaust is complete. 6) Electrical work for ground floor distribution and SS conduit for cell structure are being constructed. 7) The re-steel and forms for the cell structure ground floor slab was placed and the floor slab and grout under the cells poured. 8) All three cell SS liners have been installed, aligned, and welded to supports. 9) Electrical work for panels A, B and C, and the fixtures in the basement and exterior doors have been completed. 10) The AEC transferred 429' 2" of ½" 304 SS tubing to the Bohna Company for the design change requiring 12 additional waste

USING COMPONENT

FEO ENGINEER

REMARKS: (CA-749 Continued) - lines from the cells. The following equipment has been delivered to the job site; Jamesburg valves, all reinforced steel, chain and sprockets for vertical doors, health monitoring chambers, electric motors for doors, chilled steel shot, overhead truck door, and part of the ventilation ductwork. Two General Electric Company procurement orders were placed this month. Fourteen Central Research Company, Model 8 Manipulators were promised for delivery by May 25, 1959. FEO approved bids from General Mills Company for a manipulator crane on February 19, 1959, but AEC Procurement did not place the order until March 20, 1959 because of inspection, delivery and payment contract clause difficulties with General Mills. A delivery date of six months (or September 20, 1959) was promised by General Mills, however on 3/23/59 they stopped work due to a strike. A previous order placed with Kollmorgan Optical for an optical periscope promised delivery

USING COMPONENT

FEO ENGINEER

REMARKS: (CA-749 Continued) - before June 30, 1959.

1252282

*Contractor's Schedule.

AM-7300-819 (5-58)

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$350,000	$325,000 6-25-58	100 100	25 29	6-23-58 10-9-58	- - - 2-1-60	12-31-58* 2-1-60
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: A. W. Hervin		

REMARKS:

A revised project proposal, requesting additional funds in the amount of $25,000, is being submitted to the Commission. The primary cause for the overrun was the waste line leaks. The low bidder for the lump sum work was Jensen-Rasmussen Company who bid $104,900; the Fair Cost Estimate was $93,700. The CPFF Construction Contractor made the last major concrete pour on March 3, 1959. Work is progressing on backfill, underslab piping and ductwork. The water door between the two basins is being worked on at the White Bluffs shop.

* Actual date.

CGH-819	Increased Laboratory Waste Facilities - 300 Area	$300,000	$30,000 11-24-58	0 1	0 0	3-23-59 11-1-59	- - - - - -	9-1-59 9-1-60
		USING COMPONENT: Chemical Research & Development				FED ENGINEER: A. W. Hervin		

REMARKS:

Design work started March 23, 1959.

Equipment Not Included in Construction Projects - Program Class 2900

CG-661	Additional Heat Generation Facility - 189-D Building	$475,000	$664,000 9-18-57	100 100	54 55	12-6-56 12-3-58	- - - 8-31-59	10-15-58* 8-31-59
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: A. W. Hervin		

REMARKS:

The mechanical work by the contractor was started on March 13, 1959. The thirty-day work period for the mechanical and electrical work in the 189-D Building started on March 23, 1959. A dimensional error was found in the DC bus work supplied by the General Electric Company and arrangements are being made by the vendor for correction.

Note: L.S. work is about 60% complete versus scheduled 61%.

* Actual date.

AM-7580-BIS (5-58)

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,200,000 / 5-12-57	100 / 100	67*** / 67	9-17-56 / 4-7-58	- - - / 12-15-58	9-2-58* / 10-10-59**
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

The General Electric Company has been verbally notified that revision 3 to the project proposal has been approved and that the directive is being prepared. Approval of the Hazards Survey Group for the 6 x 9 Loop has not yet been received. However, in any case insertion will not be possible before late April or early May because of the ANP Loop.

* Actual date.
** Forecast completion date for benefical use of loops (does not include underwater examination equipment).
*** Based on AEC funds expended versus funds available.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
CG-682	High Level Cut-Off and Examination Cell - 327 Building	$415,275*	$430,000 / 8-20-57	100 / 100	100 / 100	7-18-56 / 3-27-58	- - - / 10-1-58	6-28-57* / 9-30-58*
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: A. W. Hervin		

REMARKS:

Status of Exceptions: Cutting tests are being run on the saw to determine if the new water baffling will prevent the excess splashing of the saw wheel. The sample storage racks were completed. The micrometer for the length measurer has been received and the holder is being designed. The cell exterior portion of the hood lifting mechanism is being worked on in the shop. Two manipulators have been installed in the cell and the third manipulator is nearing completion. Most of the machine work on the fourth manipulator is complete and the gears for the wrist action have been received.

* Actual.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
CA-695	Radio Telemetering Network	$109,078	$109,078 / 9-23-58	100 / 100	100 / 100	2-22-57 / 7-25-57	4-15-57 / 2-1-59	5-27-57* / 2-27-59* *
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:

A preliminary inspection was made on March 20, 1959 and a punch list was given to the contractor for action. CEO will issue a work order for cleanup and adjustment of the wind generators.
The AEC has not officially extended the project completion date.

* Actual Date. 1252284
** Project was complete with minor exceptions.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN	CONST.			
			AMOUNT	SCHED.	SCHED.	DESIGN	DESIGN	DESIGN
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building		$276,000	9	0	1-5-59	- - -	- - -
		$276,000	12-8-58	9	0	N.S.	12-31-60	12-31-60
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: H. Radow		

REMARKS:

Design is progressing. The contract with the offsite vendor for capsule development on R & D has not been resolved; until then, procurement of instrumentation to be loaned to him will not be begun.

CGH-801	X-Ray Diffraction Cell - 327 Building		$10,000	N.S.	0	6-10-58	- - -	7-1-59
		$170,000	6-7-58	40	0	N.S.	- - -	3-1-60
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: R. W. Dascenzo		

REMARKS:

To date the revised project proposal for the remainder of design and total construction funds submitted to the AEC-HOO on November 19, 1958 has not been approved.

CGH-805	High Temperature Tensile Testing Cell - 327 Building		$150,000	40*	0	8-26-58	- - -	6-15-59
		$150,000	2-25-59	45	0	N.S.	3-31-60	3-31-60
		USING COMPONENT: Reactor & Fuels R & D				FED ENGINEER: R. W. Dascenzo		

REMARKS:

Design is progressing as per temporary schedule. Two preliminary specifications and purchase requisitions have been prepared.

* Based on schedule submitted to the AEC.

AM-7300-MR (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59717 H
MONTH March, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building	$700,000	* / *	0 / 0	0 / 0	4-59 /	- - - / - - -	2-60 / 10-60

USING COMPONENT: Reactor & Fuels R & D
FED ENGINEER: H. Radow

REMARKS:
*Verbal notification of AEC-Washington approval of the project proposal has been received; the directive is in preparation.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-838	Fission Product Volatilization Studies Test Facility - 292-T Building	$75,000	$75,000 / 3-26-59	0 / 0	0 / 0	3-30-59 / 6-30-59	- - - / 11-30-59	7-10-59 / 11-30-59

USING COMPONENT: Chemical Research & Development
FED ENGINEER: O. M. Lyso

REMARKS:
Directive HW-484, dated March 26, authorizing total project funds has been received. Design work has been started.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	$100,000	$100,000 / 2-27-59*	40 / 40	5 / 10	3-2-59 / 3-19-59	- - - / - - -	5-15-59 / 7-1-59**

USING COMPONENT: Laboratory Auxiliaries
FED ENGINEER: H. Radow

REMARKS:
Fabrication of the pickling troughs is nearing completion. Design of the exhaust and scrubbing system, autoclave, deionized water system, acid and ANN storage tanks, drainage and supply piping, and conveying equipment is nearing completion. Procurement specifications for some of the major items of equipment have been submitted.

* Letter from J. M. Fryar to J. L. Boyd, dated February 27, 1959.
** Beneficial use is required by May 18, 1959

AM-7300-869 (5-58)

1252221

UNCLASSIFIED

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
R. J. Painter &	3-17-59	ASTM-Exec.Secretary Phila., Pa.	Consultation ASTM Committee - PRTR construction site.	R. B. Socky	No	PRTR - 300
Prof. Woods	"	Purdue Univ. Lafayette, Ind.				
H. Hubbard	3-10-59	G.E. X-Ray San Francisco, Calif.	X-ray Service	R. B. Socky	No	325,325,328 300
J. M. McCollough &	3-10-59	Buckner-Weatherby Co. Seattle, Wn.	Conduct seminar on elec. discharge machine	F. A. Leach	No	328,325 300
D. L. Curtis	"	Japax America Corp. Seattle, Wash.	" "	F. A. Leach	No	"
W. D. Buckley	3-11-59	Perry Institute Yakima, Wn.	Discuss heat treating	J. H. Kelly	No	328, 300
J. R. Mohondro	3-11-59	Hallidie Machinery Co. Spokane, Wn.	To inspect a Heald grinder	J. H. Kelly	No	328, 300
Dave Tuel	3-18-59	Wyandotte Chemical Co. Seattle, Wash.	To demonstrate oil absorbing material	L. J. Lucas	No	328, 300
34 Clarkston HS Students	3-13-59	Clarkston High Sch. Clarkston, Wash.	Learnmore about Tech. Information	C. G. Stevenson	No	3760, 300
Teachers of Richland Schools	3-21-59	Richland Public Sch. Richland, Wash.	" " " "	C. G. Stevenson	No	3760, 300
Northwest Nazarene College Students	3-26-59	Northwest Nazarene Coll. Nampa, Ida.	" "	C. G. Stevenson	No	3760, 300

1252287

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. J. Lucas	3-8 to 3-11-59	Offutt Air Base Omaha, Nebr.	To inspect excess machine tools	A.M. Baye,Sr.	No
		Bendix Plant Kansas City, Mo.	"	F. M. Tyvoll	No
O. M. Lyso	3-17-59	R. E. Chase Co. Seattle, Wash.	Attend Air Filter Display	W. Larson	No
R. B. Socky	3-25-59	Boeing Airplane Co. Wheelabrator Co. Seattle, Wash.	PRTR tubes progress.	Bob Booth	No
R. B. Socky	3-31-59	Wheelabrator Co. Seattle, Wash.	Design information on Vapor Plant Equip.	Mr. Carie	No

EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

GENERAL

At month's end, the staff of the Hanford Laboratories Operation totalled 1225 employees, including 576 exempt and 649 nonexempt employees. There were 489 exempt employees possessing technical degrees, including 278 B.S., 108 M.S. and 103 Ph.D.

TRAINING

Seven sessions of the first program of the Information and Orientation Series were presented with approximately 85% of Laboratories nonexempt employees attending. Plans were completed for presentation of Program II.

UNION RELATIONS

One grievance was received during the month. A Radiation Monitor Journeyman grieved concerning his transfer to another component. The Step I answer was not satisfactory but the grievance is now considered settled at Step I due to expiration of time limit.

There have been a total of six formal grievances processed in HLO since January 1 with three being answered satisfactorily at Step I and one pending arbitration hearing.

COMMUNICATIONS

Two sessions of the annual HLO Department Information Meeting were held in the Village Theater during the month. Approximately 300 employees were in attendance.

Tours were conducted for 10 National Bank of Commerce officials, 30 Clarkston High School students, 40 Kennewick High School students, and 60 Richland school teachers.

EMPLOYEE COMPENSATION

The necessary approvals were obtained to implement organizational changes in Radiation Protection and Employee Relations, both to be effective April 1.

At the March meeting of the HLO Suggestion Board, four suggestions were approved for awards totaling $810, leaving a balance of $2,075 in the HLO suggestion fund for the calendar year.

Applications for General Electric scholarships for two HLO employees were approved locally and have been forwarded to the Company for consideration.

Hanford Laboratories' participation in the Employee Benefit Plans is as follows:

Year 1959	Insurance	Pension Plan	Savings Stock Bonus	Savings Plan	Savings & Security
Jan.	99.8	98.9	40.0	8.2	94.5
Feb.	99.8	98.9	37.9	7.9	94.0
Mar.	99.8	99.0	37.3	7.4	93.7

HEALTH & SAFETY

Laboratories personnel worked a total of 206,000 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 5,878,868 man-hours have been completed with no disabling injuries.

The medical treatment frequency for March was 1.60 as compared with 1.67 during February.

There were three security violations during the month of March, bringing the total to 13 for year to date.

A vapor explosion in a glove-box lathe hood at Plutonium Metallurgy caused minor injury to one employee and some contamination to co-workers. Physical damage, exclusive of decontamination costs, was estimated at $200.

PROFESSIONAL PERSONNEL PLACEMENT

Twenty-one Ph.D. candidates visited Richland during the month of March and offers have been extended to six candidates. Four rejections were received including two from physicists who plan to accept post doctoral or academic positions. Physics continues to be a field of major concern.

Eight BS/MS candidates accepted Hanford offers during the month.

Follow-up visits to Northwest universities indicate that our salary offers probably are slightly low compared to current market and that plant visits by these candidates will be expected to become a serious problem next year.

Hiring for the Summer Program is now complete with 11 professors, 12 graduate students, 10 juniors, and 5 high school teachers having accepted summer offers.

EMPLOYMENT

Twenty-five requisitions for nonexempt employees were filled during the month, leaving 40 open. There are 17 candidates in process and two transfers pending, leaving 21 candidates to be procured to fill the existing openings.

Manager,
Employee Relations

T.G. Marshall:tr

VISITS TO OTHER INSTALLATIONS

Name	Date of Visit	Company Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data
L.J. Kirby	3/2/59	General Electric Co. Eng'g Services	ATP placement meeting and associated discussions	J.R.M. Alger	None
L.J. Kirby	3/3/59	General Electric Co. Eng'g Services	Review papers on all solid state physicists	J.K. Wolfe	None
L. J. Kirby	3/3/59	General Electric Co. Eng'g Services	Review direct placement activities	D.E. Irwin	None
H. A. Paulsen	3/25	General Electric Co. Relations Services	Compensation discussions	R.Z. Bouton	None
H. A. Paulsen	3/27	General Electric Co. Research Lab.	Compensation discussions	Lowell Steele	None

TABLE II. NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	Feb.	Mch.
Requisitions		
At end of month	50	39
Cancelled	1	4
Received during month*	27	19
Filled during month	15	26
Candidates Considered		
Total applications	35	35

Nonexempt Transfer Requests	Feb.	Mch.
Transfer Requests		
Active cases at end of mo.	74	73
Cancelled	2	3
New	6	5
Transfers effected	1	3

* Includes 5 off of "hold" basis

TABLE III. UNION RELATIONS

Grievances Processed - January 1, 1959 to date

Total Processed	6
Step I	
Answered satisfactorily*	3
Step II	
Pending Step II answer	1
Answered	
Satisfactorily**	1
Pending time limit	0
Applied for arbitration	1
Pending arbitrator's decision	1

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

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

C - Technical Graduate and Technician Training Program
Month ending March 31, 1959

	TG Program	TT Program
Number Personnel on assignment	25	10
(HAPO Tech Grad Program.....24)		
(West. District E.P..... 1)		
Distribution of assignments by Depts.		
HLO	10	3
CEO	0	0
R&UO	0	0
FPD	3	0
IPD	11	7
CPD	1	0
Distribution of assignments by functions		
R&D or Engineering	20	10
Other	5	0

TABLE IV. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers*: Extended	Accepted	Open	On the Roll
Ph.D.	558	175	60	44	29	7	8	8
Exp. BS/MS	352	65	48	2	65	40	12	36
Prog. BS/MS	343	--	--	--	187	43	92	11

*Offer totals include offers open on 9/1/58

Ph.D.	3
Exp. BS/MS	3
Program BS/MS	3

B - Technical Recruiting Activity - HLO - September 1, 1958 to Date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers**: Extended	Accepted	Open	On the Roll
Ph.D.	558	175	60	44	19	4	5	5
Exp. BS/MS	293	47	31	2	29	18	5	17
Prog. BS/MS	(Off Program Placement)				15	15	-	-

**Offer totals include offers open on 9/1/58

Exp. BS/MS	2
Ph.D.	2

In addition to the above activity, 19 exempt employees have transferred into HLO from other HAPO departments to date.

FINANCIAL OPERATION MONTHLY REPORT
MARCH 1959

There were no changes in personnel during the month.

Activities

GENERAL ACCOUNTING OPERATION

2000 Program funds for Equipment Not Included in Construction Projects have been reallocated within Hanford Laboratories to provide additional funds for sections where the previous allocation has proven to be insufficient. The adjusted allocation is as follows:

	Expenditure Ceiling	Commitment Ceiling
Reactor & Fuels R&D	$1 260 000	$1 398 000
Chemical R&D	250 000	60 000
Physics & Instrument R&D	150 000	90 000
Laboratory Auxiliaries	180 000	20 000
Radiation Protection	120 000	42 000
Total Allocation	$1 960 000	$1 610 000

Classification activity included transfers of $229,390 from the Work In Progress accounts in addition to the review of 778 purchase requisitions and 666 work orders for capital-expense determination.

Considerable time was spent on investigation and detail adjustments of equipment records for Washington Designated Programs, the responsibility for which was transferred to this office in March.

Travel, living and entertainment expense reports processed during March totaled 186. This represents the highest volume processed for any month in HLO except June 1958 when the closing of the ledger was delayed to complete fiscal year reports.

Review of continuity of service over-accruals during 1958 are about complete. Appropriate credits will be passed to Cost in April business.

The Inventories Budget for FY 1961 and Revision of FY 1960 was consolidated and submitted to Contract Accounting by the due date. Inventories for which Hanford Laboratories are responsible will not vary significantly from the present levels except for Zirconium, Heavy Water, and Spare Parts, due primarily to the Plutonium Recycle Program. A summary of our submission by type and FY ending balances are as follows:

	7-1-59	6-30-60	6-30-61
Platinum	$113 512	$ 116 410	$ 118 986
Gold	9 625	10 502	11 515
Silver	152	167	181
Palladium	3 597	4 003	4 351
Beryllium	8 507	8 632	8 764

	7-1-59	6-30-60	6-30-61
Radium	62 934	62 934	62 934
Gallium	135	185	135
Iridium	131	131	131
Rhodium	57	57	57
Niobium	72	72	72
Heavy Water	37 893	493 216	493 216
Zirconium	498 000	481 000	392 000
Spare Parts	31 000	141 000	241 000
Standby - Spare Parts	40 615	40 615	40 615
Total HLO Inventories	$806 230	$1 358 924	$1 373 957

Project AEC-167 (PRP) will provide $200,000 in spare parts which will be purchased as construction spares and transferred to the operating spares inventory about 7-1-60. The inventory level is expected to turn over every two years or at the rate of $100,000 per year beginning in FY 1961. Heavy Water initial requirements for project AEC-167 include 85,000 lbs. valued at $1,275,000 which will be purchased and transferred to CWIP in FY 1960. Thirty-thousand pounds (valued at $450,000) sufficient to replace all of the material in any one of the loops will be carried in inventory. After the Test Reactor is in operation, consumption will be at the rate of 1,000 lbs. per month, 500 lbs. loss and 500 lbs. reclaimable.

Arrangements were completed for the regular quarterly inventory of special materials as of March 31, 1959 to be conducted by custodial personnel. Property Accounting will not witness the count but will reconcile the results to Property Accounting records. A report of results will be issued in April upon completion of reconciliation.

In accordance with AEC instructions that non-fund costs of Heavy Water billed from off-site must be booked to inventory but separate identity maintained for reporting purposes, two new General Ledger accounts were established. These costs represent depreciation on facilities used to produce Heavy Water at other AEC Operation Offices. Account 1272 - Special Reactor Materials - Non-Fund - will be debited for depreciation shown on billings for Heavy Water and as the material is removed from inventory, the applicable depreciation will be credited to this account with the offsetting debit to account 3518 - NP Depreciation From Off-Site - which in turn will be closed to the AEC at fiscal year end. We will receive from the AEC $26,475 in the month of April representing depreciation on current holdings of Heavy Water.

A physical inventory of equipment purchased for use in the Whitney Program was conducted in compliance with AEC directive 1123-035, Borrowed Equipment. Considerable time and effort was required to make complete records and place these items on IBM. Information was obtained from records of field personnel as well as a screening of work orders, purchase orders and receiving reports filed in HLO Financial Operation. A complete listing of Whitney equipment will be carried on IBM and reported as a memo to Plant and Equipment in Service. Fifty tags were placed on equipment during the inventory. These tags, for the most part, were placed on component parts of systems which had been previously tagged, or RDX equipment. Three hundred twenty-four pieces of equipment were inventoried

with a value of $574,395. Five items ($451) were found to be missing. After a thorough search, a request to write these items off from record was sent to the University of California Radiation Laboratory. Approval was received in a letter to R. L. Warburton, dated March 25, 1959 from L. A. Fitzgerald.

In accordance with the AEC Manual, Section 1104-11, the Commission has requested we add to record equipment acquired under Washington Designated Contracts in completed plant accounts. Equipment purchased in previous fiscal years was recorded in completed plant by the use of the non-fund adjustment account (3561) and equipment purchased in the current fiscal year will be transferred to completed plant through EWIP. Previous years acquisition are 82 items with a value of $92,781. Current year acquisitions transferred to completed plant are 7 items at a value of $7,453 for a total transfer to completed plant from Washington Designated Programs of $100,234.

Work was resumed in March in connection with our program of insuring the correctness of Property Accounting fixed assets. A concentrated effort is being made to complete the inventory and up-dating of our records of fixed assets.

Preparations were completed and a procedure distributed for the physical inventory of uninstalled cataloged equipment in the custody of Chemical Research and Development Operation. The inventory will begin April 6, 1959 with an anticipated completion date of April 27, 1959 for field work. This is the final inventory of uninstalled cataloged equipment for fiscal year 1959.

Reconciliation of the physical inventory of uninstalled cataloged equipment in the custody of Reactor and Fuels Research and Development Operation is complete. A listing of unlocated equipment was furnished to the Section Manager for his review and for use in locating equipment. All of the equipment was located except for 12 items valued at $2,278. Upon receipt of a Missing Plant and Equipment Report, a report of results will be issued.

COST ACCOUNTING OPERATION

Preparation of the Budget for FY 1961 and Revision of Budget for FY 1960 is complete. Submission of data to Contract Accounting has been made with the exception of the "Proposals for Research and Development" which are presently being typed in final form.

Following is a summary of HLO operating program requirements for FY 1960 and FY 1961 as compared to the current budget for FY 1959.

(Amounts in Thousands)	FY 1959	FY 1960	FY 1961
HLO Research & Development	$ 7 836	$ 9 378	$10 464
Off-Site Research & Development			
Special Requests	715	1 000	1 000
Project Whitney	669	660	660
Washington Designated Programs	419	441	467
Equipment & Construction Work in Progress	85	140	158
Miscellaneous-AEC, Inventories, etc.	15	10	10
Standby-Hot Semi-Works	45	36	36
Sub-Total	9 784	11 665	12 795

(Amounts in Thousands)	FY 1959	FY 1960	FY 1961
Charges to Other HAPO Components			
Research and Development	$ 5 255	$ 5 189	$ 5 155
Process Technology	681	737	778
Other	1 902	1 954	1 968
Sub-Total	7 838	7 880	7 901
Service Assessments	2 873	2 693	2 817
Total HLO Requirements	$20 495	$22 238	$23 513

The following budget adjustments were made in March to the FY 1959 Midyear Budget Review and reflected on March cost reports.

1. A reduction of budget funds from $480,000 to $200,000 in the Plutonium Metallurgy Operation for the fabrication of the U-233 Fuel Plates to reflect the current authorization rather than the estimate made last Fall.

2. An adjustment to reflect the fabrication of transplutonic fuel elements as a part of the HAPO 2000 Program rather than an off-site special request as originally budget. Funding for this fabrication job, estimated at $210,000 operating costs and $40,000 capital equipment, will be provided from the existing approved funds.

3. An increase of $22,000 in the Plutonium Metallurgy Operation for 234-5 Weapons Research and Development sponsored by the Chemical Processing Department.

PERSONNEL ACCOUNTING OPERATION

On March 20, 1959, 1,019 envelopes containing Company Proxy Statements, a card entitled "Vote Instructions to Trustees", a business reply envelope, and a cover letter of explanation from Mr. Cordiner and the trustees, were delivered to participants of the Savings and Security Program along with an equal number of envelopes containing the 1958 Annual Report.

Average stock price for the month of February was $77.743. During the month of February, employees' collection for Savings and Security Program amounted to $37,291.33. Company proportionate payment amounted to $19,246.78 and the cost of incentive shares amounted to $6,704.06.

1958 Annual Reports were delivered on March 27, 1959 to Stock Bonus Plant participants who have not as yet become share owners through participation in prior years, or who did not receive a copy of the Annual Report as participants in the Savings and Security Program.

In anticipation of the transfer of responsibilities, a manual was prepared and transmitted to Personnel Accounting, Contract and Accounting Operation, explaining in detail the preparation of all reports and statistics prepared for HLO management, AEC, etc.

PROCEDURES

The initial IBM tabulation of off-site commitments for material and/or services has been received. The necessary details have all been established and the procedure has been turned over to HLO Cost Accounting for routine operation. The tabulation shows open requisitions, purchase orders and contracts for each research program within an operation.

Some liaison work was performed with Data Processing during the month to obtain a satisfactory summary tabulation of active work orders written by HLO personnel.

Discussions were held with other HAPO procedures specialists for the purpose of designing one form to be used for adding employees to the roll and for changing the status or information pertinent to an employee. This one form would replace several separate forms which are now used.

MEASUREMENTS

Contacts were made with four different Company laboratories to exchange information and to study approaches used elsewhere. In addition, a meeting on the subject of laboratory measurements was attended. A breakdown of Technical Shop costs into these associated with the different types of shops is nearly complete.

AUDITING

The final draft of the Work Order Audit report has been completed and referred to those concerned for review. Field work has started on the Audit of General Accounts and Cash Controls.

W. Sale

Manager - Finance

W. Sale/bk

Payroll Statistics

Number of HLO Employee Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 210	575	635
Additions and Transfers In	27	7	20
Removals and Transfers Out	(11)	(6)	(5)
Employees on Payroll at End of Month	1 226	576	650

Overtime Payments During Month	March	February
Exempt	$ 4 088	$ 5 172
Salaried	13 288	10 069
Total	$17 376	$15 241

Gross Payroll Paid During Month		
Exempt	$468 436	$445 638
Salaried	289 814	284 685
Total	$758 250	$730 323

Participation in Employee Benefit Plans at Month End	March Participation		February Participation	
	Number	Percent	Number	Percent
Pension Plan	1 165	99.0	1 157	98.9
Insurance Plan				
Personal Coverage	1 245	99.8	1 231	99.8
Dependent Coverage	834	-	827	-
U.S. Savings Bonds				
Stock Bonus Plan	75	37.3	75	37.9
Savings Plan	91	7.4	95	7.9
Savings & Security Plan	1 024	93.7	1 012	94.0
Good Neighbor Fund	841	68.6	824	68.1

Insurance Claims	March		February	
	Number	Amount	Number	Amount
Employee Benefits				
Life Insurance	0	$ 0	0	0
Weekly Sickness & Accident	12	1 163	15	1 678
Comprehensive Medical	64	5 057	55	5 187
Dependent Benefits				
Comprehensive Medical	174	14 580	113	7 457
Total	250	$20 800	183	$14 322

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
Z. E. Carey	3-16 - 20	GE Schenectady	Acquire Measurements Information.	C.A. Gillespie F.W. Maguire H.T. Thompson A.P. Coleman A.M. Sagendorf	None.

INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
W. S. Kelly	Movable Outlet on Air Supply Ducts Using Metal Zippers
L. L. Ames	The Removal of the "Bone-Seeking" Groups of Radioisotopes from Solution by a Calcite-fluoride or Apatite-fluoride Reaction
R. H. Moore	A Pyrochemical Process Applicable to a Thorium Breeder Reactor Fuel Cycle (HW-59800)
A. R. Keene	An Improved Fluorescent Lamp

[redacted]

[redacted]

[redacted]

[redacted]

1252303