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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

FEBRUARY, 1959

MARCH 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION

RICHLAND, WASHINGTON

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HANFORD LABORATORIES OPERATION

MONTHLY ACTIVITIES REPORT

FEBRUARY, 1959

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Compiled by
Operation Managers

March 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

[redacted]

PRELIMINARY REPORT

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

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TABLE I. FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE February 28, 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	91	214	123	92	215	1*	1	1	2*
Reactor & Fuels Research & Development	187	126	313	182	119	301	5	8	0	1
Physics & Instrument Research & Development	67	27	94	67	26	93	0	1	0	0
Biology Operation	37	44	81	37	44	81	0	0	0	0
Operation Res. & Syn.	14	3	17	14	3	17	0	0	0	0
Radiation Protection	34	99	133	34	100	134	0	0	0	1
Laboratory Auxiliaries	44	181	225	44	184	228	1	4	1	7
Financial	16	33	49	16	33	49	0	0	0	0
Employee Relations	38	25	63	38	26	64	5	0	5	1
Programming	14	4	18	14	4	18	0	0	0	0
General	1	2	3	1	2	3	0	0	0	0
Totals	575	635	1210	570	633	1203	12*	14	7	12*
Totals excluding Internal Transfers	575	635	1210	570	633	1203	8	12	4	9

* 1 nonexempt to exempt

Composite Separation Rate	1.5702
Separation Rate (based on Separations leaving G. E.)	.5785
Controllable Separations Rate	.2479

BUDGETS AND COSTS

Costs for February were $1,662,000, an increase of $53,000 over the month of January. Fiscal year-to-date costs are 59% of the operating budget of $20,730,000. Adjustments were made to the budget during the month to reflect the AEC ceiling of $6,500,000 on 4000 Program work and also to include the new funds authorized for the fabrication of transplutonic elements.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Possible PRTR loss of coolant incidents are being studied under a Hanford contract by Battelle Memorial Institute.

The status of PRTR construction is as follows: Phase I construction is 79% complete versus 89% scheduled, Phase II construction is 74% complete versus 80% scheduled, and Phase II-A construction is 42% complete versus 39% scheduled. The PFPP building construction is 77% complete, with 86% scheduled. George Grant Company was awarded the Phase III PFPP construction contract.

Experimental runs with the PRTR Mark II-b fuel element showed flow and temperature distributions which were very close to design. One run which deliberately included localized bulk boiling did not cause hydraulic instability.

At the request of the Division of Reactor Development the gas-cooled loop facility to be installed in the PRTR will be scoped for maximum gas temperatures up to 1500 F, vice 1100 F.

Swaged UO_2 fuel capsules have attained an exposure of 5600 MWD/T in the MTR. A swaged 9-rod fuel assembly thirty inches in length has reached 1600 MWD/T in the VBWR. Irradiation of a swaged rod 1.44 inch in diameter to approximately 500 MWD/T was successfully completed in the MTR.

Solutions were found to problems of swage feeding and end closures for the experimental fabrication of PRTR fuel elements. The quality of the elements has been markedly increased by improved etching techniques and cladding materials.

The experimental casting of plutonium-aluminum billets has been initiated employing new cryolite process and remelting equipment. Billets have been successfully cast with 0.5, 1.8, and 5.0 weight per cent plutonium, with variations no greater than ± 4 per cent of the nominal compositions.

The 280-ton extrusion press has been activated for extrusion of Pu-Al alloys. Aluminum and aluminum alloys have been successfully die-cast into 6-ft long, 1/2-inch diameter tubes by the Kux Machine Company operating under a Hanford development contract. Tubing materials employed have included Zircaloy, stainless steel, and aluminum.

The first 25 completed Zircaloy-2 process tubes for the PRTR are expected to be ready for final inspection at Tube Reducing Corporation during March.

Macrocracks and microcracks have been detected in all of the rods from the four coextruded Zircaloy-clad 4-rod cluster fuel elements recently discharged from KER loops. Several microcracks were observed in the bonding layer of one of the rods.

A pronounced improvement in smoothness of the uranium-Zircaloy interface was observed in rods formed by coextrusion of fine grained alpha-rolled cores rather than beta heat treated cores.

A simple, fast method for attaching high quality end caps to coextruded rods has been developed. A resistance weld between the end cap and the face of the fuel rod is followed by a fusion weld using the electron beam welding process.

The relative quality of closures of Zircaloy-clad fuel rods is being evaluated (by a destructive test method) by applying a high internal hydraulic pressure between the end cap and the uranium.

Controlled laboratory tests have shown that Zircaloy-2 with an etched ZrO_2 surface film can be hydrided with oxygen-free hydrogen gas at high temperatures but not below about 350 C.

The controlled high-temperature (up to 1050 C) graphite irradiation experiment was removed from the L-42 position in the MTR after a successful four-cycle exposure, and L-42 was recharged with new graphite samples (both TSGBF and CSF types) to be exposed until the end of April. The rod pick-up mechanism to adapt the MTR L-48 shim rod for similar graphite testing has been fabricated and has successfully passed "drop tests" at the MTR.

Heat transfer experiments indicate that the Panellit system of a C Reactor will continue to furnish protection when the reactor is operated with a ruptured rear hydraulic header.

A new experimental polyurethane plastic from B. F. Goodrich Chemical Company (Estane VC) is among the best plastic materials tested to date in terms of resistance to gamma irradiation at room temperature.

2. Chemical Research and Development

A preliminary experiment wherein PuO_2 was added to an NaCl KCl-$MgCl_2$/Mg-Zn system at 1000 C resulted in 54 per cent of the plutonium being reduced. This yield, although not high, is quite encouraging and offers promise of a simple process for direct reduction of plutonium oxide.

The simultaneous recovery of neptunium and plutonium by anion exchange of nitrite treated Purex 1WW was demonstrated on a one liter scale in the 222-S Multicurie cell. Using filtered plant waste, recovery of both neptunium and plutonium exceeded 70 per cent, and radiation damage to the resin was very slight.

Studies related to neptunium recovery include further laboratory pilot tests in the "mini" mixer-settler to improve Purex operations; more work on a contactor concept to "trap" neptunium in the Purex plant between the 1BX and 1C columns; and a detailed investigation of the nitrite-nitrate system characteristics in Purex.

The use of ion exchange resins to recover plutonium from Recuplex feed and waste streams was further explored.

A new analysis of the probable path and rate of movement of ground water from beneath 200 Areas disposal sites was prepared, incorporating the latest permeability measurements. The average velocities calculated along the most probable path of movement resulted in an average water travel time to the Columbia River of about 150 years.

A closed circuit TV system was used for the first time to examine inside surfaces of monitoring well casings. Perforation geometry, orientation, and the general condition of the well were observed.

Centrifuge tests with actual soils from beneath BC trenches resulted in measured specific retention of 2 per cent which compares favorably with the 4 per cent moisture content measured in samples from this site. Tests with Touchet soils were found to give 14 per cent specific retention but these materials are not representative of the actual trench sites.

In work for the Non-Production Fuels reprocessing, a series of test runs were completed in the Niflex pilot dissolver and the system operated satisfactorily. Dissolution of stainless steel near the bottom of the dissolver is not as rapid as intermediate and top zones. The reason for this behavior is under study. Refinements in process continue with further Darex pilot plant tests. Laboratory tests related to the Sulfex process show that irradiated uranium metal reacts with boiling 4 M sulfuric acid at the same rate as unirradiated metal; dissolved stainless steel had no effect on these rates. Some encouraging results are reported for weld materials to join Hastelloy F. Improved corrosion of the welded zone without costly heat treatment is sought.

A number of tests were completed to study the evolution of radioisotopes from low-level, short-cooled, irradiated uranium on oxidation in air at 1200 C. Iodine, tellurium, cesium, ruthenium, strontium, and barium radioisotopes were measured as they evolve from the oxidizing specimen. Fractions released of the total inventory of each element follow the order listed. The effectiveness of air filters to retain volatile radioisotopes was also studied.

Scouting experiments indicated an improvement in U, UX_1 separation in the molten $AlCl_3$.KCl/Al system when KCl is replaced with KBr. The improvement in UX_1 (Th-234) removal, when confirmed, will make this salt flux purification method even more effective for removing activity from Al-U-233 systems.

3. Physics and Instrument Research and Development

Measurements to determine safe criticality limits when dissolving 0.95% enriched fuel elements have been completed at Oak Ridge. Preliminary analysis of these measurements indicates that they do not warrant any increase in critical mass limits above those which we originally set for this dissolver.

Measurements are continuing locally to determine similar information for handling 3% enriched fuel elements. Here the critical mass has decreased as we have gone to smaller diameter rods in our experiments. With 0.3-inch rods this mass is of the order of 200 lbs.

For the production reactor development program measurements continued on the lattice constants for 2-1/2" O.D. solid fuel elements. Measurements have now been completed for two lattice spacings for this element. Work also continued on the measurement of parameters for cluster elements in the PCTR.

In the Plutonium Recycle Program consistent corrections for perturbing effects were made to all the data previously obtained in the PCTR on heavy water moderated lattices; significant improvements in the accuracy and consistency of the data were obtained.

The portable towers needed for this summer's experimental program in atmospheric physics were received from the U.S. Army Signal Corps. Acquisition of other equipment for this program is proceeding on schedule.

In the Shielded Personnel Monitoring Station it was discovered that some dust had been entering the room by bypassing the filters. Clean-up of the dust reduced the background and improvements to the filter system have been made to prevent bypassing.

A technique for detecting Na^{24} in people with equipment available on site was worked out for possible use in the event of a nuclear accident.

In the basic data field it was established that cross-section measurements on bulk lots of reactor grade graphite made by American, British and French laboratories are in agreement within experimental uncertainties. However, our measurements are consistently a few per cent higher than those obtained by the French and British on the same samples.

Satisfactory progress was made on the many projects in the instrument field, among which were the radiotelemetering stations and the nuclear incident alarms.

In the systems field, considerable attention was directed toward the problem of moderator level and fuel temperature oscillations in the PRTR to determine whether the natural periods for these oscillations were sufficiently close together to warrant investigation of possible resonance effects in this system.

4. Biology

Radioactive contamination of life forms showed no notable changes.

After several false starts, it appears that excellent progress is being made in culturing the organism Columnaris. This will permit controlled experiments on the possible influence of reactor effluent on the infestation of Columbia River fish by this organism.

We have previously pointed out that gastrointestinal absorption and deposition of radioelements change with age of the animals. It now appears that distribution in organs also changes with age. This occurred in recent work on Zn^{65}.

Some groups actively engaged in fallout measurements use an "observed ratio" or OR which implies a constant discrimination factor for concentration of,

for example, Sr^{90} with respect to Ca. Local work has shown this to be unreliable for Sr^{90}/Ca. This month, even more variability in "OR" for Cs^{137}/K was demonstrated. This observation was made using bean plants.

DTPA does not appear to offer much promise as a drug for oral use in treating plutonium depositions.

5. Programming

Approval was received from the AEC to re-irradiate in the MTR and ETR 20 of the previously irradiated Pu-Al elements fabricated at Hanford last summer. This re-irradiation, which has already started, will provide about 2 kg of plutonium, part about 20 w/o and part about 40 w/o Pu-240 + 241 + 242, for use in the measurement of physics parameters in the PCTR. Negotiations were started with the local AEC concerning release for PRP use of the high exposure plutonium which will be recovered from the seven ton stock of irradiated depleted uranium now at Hanford. This material should produce about 9.3 kg of plutonium of about 14 w/o Pu-240 content. Also under consideration is the three to four tons of similar material now in process of irradiation.

A new computer code, MELEAGER A, was developed for use with the IBM-709 computer. The code, an enlarged and improved version of earlier codes used with the IBM-650 computer, will handle up to 140 different materials subject to burnup and radioactive decay. Special features include ability to treat neutron flux shifts and energy spectrum changes during irradiation.

Analytical work was completed on IBM-650 computer analysis of two aspects of plutonium fuel utilization. The first examined plutonium feed of various compositions in specific reactors under construction or in operation as part of an AEC requested effort, jointly with ANL and ORNL, bearing on evaluation of plutonium pricing policies. The second examined the special characteristics associated with stainless-steel cladding (as an alternate to cladding with a lower cross-section) of plutonium fuels.

Analysis was completed and a report draft prepared concerning the calculation of the reactivity worth of plutonium and uranium-235 as enrichment in thermal reactors.

Results, subject to qualifications noted in the report, show that the value of a gram of fissile material (Pu-239 + Pu-241) in extending the exposure life of U-238 as fuel in efficient reactors is greatest if the fissile material is contained in highly-exposed plutonium, with pure Pu-239 and pure U-235 following in that order.

In view of AEC interest in the recovery of transplutonium elements, more refined calculations were used to estimate yields of the transplutonium elements from PRTR and other reactor fuels. Preliminary results indicate very low production rates of the transplutonics to be associated with the irradiation of Pu-Al spike elements in the PRTR.

In accordance with requests from Washington AEC personnel, alternate proposals involving revisions to the content of the 1959 SINE Program at HLO were

developed. Selected lecture topics to be delivered by off-site personnel were integrated into proposed alternates. In addition, the possibility of including a trip to the NRTS facilities was considered.

Technical and Other Services

A highly aggregated simulation model of HAPO and its inter-dependencies with the AEC and defense establishment has been prepared and is awaiting computation.

Work on two operations research studies and five operations analysis programs continued during the month. In addition to this, statistical and mathematical assistance on 23 problems was given within HLO and to other departments and operations.

Incomplete information from the manufacturer contributed to incorrect installation of the accelerating belt of the Van de Graaff positive ion accelerator. The resulting temporary acceleration of negative ions resulted in generation of X-rays and some unexpected exposure of three employees. The exposure of the two men wearing film badges was less than 50 mr. A third man present was not wearing his badge. Reconstruction of the incident indicates that he could not have received as much as 600 mr.

Four minor cases of plutonium deposition were confirmed during the month. Three of these cases occurred at the 234-5 Building to CPD employees. One case apparently occurred offsite at the Nevada Test Site to an employee in ROF status. This brings the total number of plutonium deposition cases which have occurred at Hanford to 228. At month's end, there were 163 employees who are currently employed and who have measurable deposition of plutonium.

The individual exposure record cards for CY 1958 were distributed to all employees with area clearances during the month.

There were 14 authorized projects at month end with total authorized funds of $6,484,078. The total estimated cost of these projects is $7,589,400. (PRTR and PFPP are recorded separately). One project was completed during the month. Two new projects are awaiting AEC approval. Project proposals for eight new projects are in preparation.

The Technical Shops overtime rate continued high due to heavy work load. Bids were received on a proposed unit price contract for off-site shop work. It is expected that one contract award will be made and that bids will be solicited later and a second contract awarded.

Arrangements have been completed for moving the Radiographic Testing Operation to the White Bluffs downcomer shop. An Informal Request is awaiting AEC approval for authorization of the move. Design work is substantially complete for installation of PRTR tube pickling and autoclaving facilities.

Project CG-731, Critical Mass Laboratory, will be delayed at least four months due to funding changes resulting from use of 54-b-4 money for the "Reactor Containment" project. The Critical Mass Laboratory will now be funded from budget item 60-1.

Supporting Functions

Physical inventory results of Physics and Instrument Research and Development Operation indicate good control over equipment and the use of proper procedures in transferring or retirement of equipment.

A request has been made of the Commission to change the classification of zirconium from special reactor materials to that of essential material. If approved, this should reduce the restrictive procedures in the movement of zirconium.

A manual concerning travel is nearly complete in draft form and should be released in the near future.

A study of the accounting requirements for PRTR operation is under way with the assistance of the research components. It is being directed towards developing an accounting system which will facilitate the technical evaluation of the economics of alternate fuel fabrication techniques and fuel cycles.

The Armed Forces Special Weapons Project training program for medical officers was completed February 13. Feedback from the participants was extremely favorable insofar as course presentation and course content were concerned.

Four formal grievances were submitted during the month pertaining to work assignments. Two were settled at Step I and two are being processed at Step II. For the calendar year to date there have been five formal grievances within the Laboratories.

Hanford Laboratories participated extensively in the Edison Day program on February 11 and provided a technical display for the visit of the Division and Group General Managers. Plans for HLO participation in AEC sponsored tours during the spring months were completed. These plans provide an average of three tours per month during March, April, and May.

Laboratories personnel worked a total of 197,828 manhours during the month with no disabling injuries. Since September 1, 1956, a total of 5,672,868 manhours have been completed with no disabling injuries.

The medical treatment frequency for February was 1.39 which compares to 1.13 during January.

There were three security violations during the month of February.

The recruiting of Ph.D. physicists continues to cause concern. An extensive effort is being made to secure the necessary numbers of such personnel and 25 candidates are scheduled to visit during the coming months. Other Ph.D. recruiting activity is progressing favorably.

Recruiting of Technical Graduates and experienced BS/MS candidates continues to appear quite favorable. Some difficulty is being encountered in employment of new bachelor candidates in physics. It is expected that other requirements will be met.

The number of Technical Graduates on the Program has decreased to the point where it is impossible to fill available assignments. The situation will not be improved until the June graduates report on the roll.

H M Parker

Manager,
HANFORD LABORATORIES

HM Parker:kss

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REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Hydriding of Zr-2. Laboratory equipment for hydriding zirconium alloy samples was altered so a thermocouple could be attached directly to the Zr-2 sample to measure sample temperature rather than autoclave temperature. Also, a vacuum pump was installed to assist in obtaining a better removal of O_2 from the system.

With these changes it was possible to hydride Zr-2 samples with etched ZrO_2 films at temperatures as low as 350 C, but not at lower temperatures. Hydriding proceeded rapidly at temperatures above 350 C.

In one sample hydrided at 350 C, 25 psi H_2 (absolute) for one hour, a definite hydride "front" was observed to be consuming the sample. Metallographic sectioning confirmed that the hydrogen had broken through the bottom edge of the coupon and was diffusing into the metal from this point. The rest of the ZrO_2 film remained intact. In one hour the leading edge of the hydride "front" was about 1/2" from the point of entry and that section of metal was extremely brittle. The intact metal beyond the "front" was still ductile.

All the experimental results confirm the hypothesis that the ZrO_2 film on Zr-2 is protective against H_2 in so long as the ZrO_2 film is defect-free. The ZrO_2 film will only admit H_2 to the base metal when the oxygen and/or H_2O content of the H_2 is below some critical value not yet determined. This critical O_2-H_2O concentration is below 1 mm H_2O vapor pressure and may be below 10^{-2} mm. In order to obtain quantitative data a glass vacuum apparatus is now being shop fabricated.

Uranium Corrosion. Corrosion rates were determined in 300 C water (20-minute exposure) for uranium which had received different heat treatments. The five conditions tested included: (a) as extruded; (b) beta heat-treated, water quenched; (c) beta heat-treated, air cooled; (d) beta heat-treated, isothermal treatment; and (e) beta heat-treated, furnace cooled. The depth of attack in 20 minutes, measured twice on each sample with a microscope, ranged from approximately 20 mils penetration for the isothermal treatment to 25 mils for the furnace cooled sample.

The rate predicted from previous data was 1 mil/min, or 20 mils in 20 minutes. Considering that some corrosion occurs during the five minutes required to bring the autoclave to temperature, the results above are in

good agreement and show no significant effect of heat treatment on corrosion rates of uranium.

Fuel Element Rupture Kinetics. A test program is being conducted in cooperation with the Fuel Element Design Operation to evaluate the rupture kinetics of coextruded Zircaloy-2 clad fuel elements. Tests have been conducted in water at 300 C in an induction heated static autoclave. Samples were defected with a 25-mil hole drilled through the cladding into the core. Characteristically, a blister is formed at the defect during exposure. This grows slowly until it "pops open" as a result of fracturing the cladding. Further exposure results in extensive ripping and blistering of the cladding adjacent to the original blister. During the past month, four samples of U-2% Zr core elements were tested. The results are tabulated below:

Rupture Data
Zircaloy-2 Clad, Coextruded, U-2% Zr Core, 25-mil Defect

Sample	Sample Treatment	Exposure Required to Fracture Cladding
D-3	Beta heat treated, air cooled	200-300 minutes
D-4	Beta treated, cooled in vacuum furnace	100-200 "
D-5	Diffusion treated, furnace cooled	100-200 "
D-6	Diffusion treated, water quenched	420-480 "

In order to determine more accurately the time of cladding fracture and the rupture kinetics after this event occurs, several attempts have been made to measure the hydrogen liberated during the process. To date, these attempts have been largely unsuccessful, but development work will continue in this direction.

Radiometallurgy Laboratory Studies

Annealing, metallography, fracturing, and replication work continued on uranium samples of interest to the Physical Metallurgy Operation. Cycling annealing temperatures from 400 C to 800 C caused warping in some 0.075 a/o burnup uranium samples and none with other samples. Another sample of uranium was fractured at dry-ice-acetone temperatures, and fax-film replicas were obtained. Also, five thorium tensile specimens (GEH-3-25 to 30) were removed from their NaK filled capsules and examined. A portion of the inner component of the temperature monitored, coaxial fuel element (GEH-4-24) was examined, and fax-film replicas were obtained. Metallographic examination was completed on two wafers from a temperature monitored, Zr-2 clad, coextruded, natural uranium fuel element that failed because of high temperature irradiation. Hardness, metallographic examination and sampling for burnup analyses were completed on one rod from a four-rod cluster of enriched uranium (PT-IP-172-A), and color photographs of radioactive aluminum dummies were successfully obtained for Coolant Systems Development. Results and conclusions from the above work are reported in detail 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 a/o burnup is under way. A tensile specimen irradiated to 0.031 a/o burnup and cyclic annealed for three cycles (six transformations) between 400 and 700 C was examined. This specimen was badly warped and appeared to be cracked. Another specimen irradiated to 0.10 a/o burnup was annealed at 700 C for ten hours. These specimens await tensile tests to determine the effects of these heat treatments on the recovery of irradiation-induced damage.

A series of flat uranium tensile specimens have been irradiated at low temperatures to find the threshold of detectable neutron damage to uranium. The exposures range from 10^{15} to 10^{18} nvt or from 5×10^{-7} to 5×10^{-4} total atom percent burnup. Post-irradiation tensile, hardness, and annealing tests to determine the amount of damage induced and the ease of removal have been completed.

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

Unirradiated control specimens and specimens exposed to 5×10^{18} and 1.5×10^{20} nvt were selected for each metal except 347 stainless steel for isochronal annealing studies. One shoulder of each tensile specimen was cut for metallography, x-ray diffraction, and microhardness measurements. Electrical resistance measurements were made on the remaining portion of the unannealed cut tensile specimens.

Correction factors to compare these electrical resistance data with those obtained at KAPL were determined. The irradiated copper, titanium, and molybdenum specimens tested have had no significant decrease in resistance since their measurement at KAPL. An iron and a zirconium specimen irradiated in the MTR at 80 C in a fast flux of 1.4×10^{20} nvt have decreased two percent and three percent, respectively, after storage at room temperature for 33 months.

Changes in the hardness and microstructure of molybdenum containing some residual cold work were observed after irradiation at 35 ± 5 C to various total fast neutron exposures from 6.5×10^{16} to 1.2×10^{20} nvt. The hardness increased with time in-reactor. Micrographs of the irradiated molybdenum indicated an increase in the number of small grains at exposures of 1.2×10^{20} nvt. It is concluded that very high fast neutron exposures produce a grain refinement in cold worked molybdenum.

Mechanical and Physical Properties of Materials. Four specimens of Zircaloy-2 are now being tested for creep properties to determine the effect of cold work on creep for NPR process tube requirements. Temperature control of ± 2 F is being maintained in the vacuum creep units and duplicate samples of 45 percent cold worked material at 300 C (572 F), and 30,000 psi exhibit creep rates of 2.4 and 2.3 x 10^{-6} in/in/hr after 432 hours of testing.

As might be expected, increases in testing temperature in the notch bend test increase the angle of fracture and the addition of hydrides and cold-work both decrease the fracture angle.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel materials is a direct way of detecting radiation damage in these materials. Preliminary experiments aimed at determining the feasibility of irradiating films of fissionable material, thin enough for conducting transmission electron microscopy and diffraction before and after reactor irradiation, have been conducted. Thin films produced by the vacuum evaporation of uranium metal have been irradiated to exposures of 2.6 x 10^{18} and 1.3 x 10^{19} nvt, and have been studied directly in the electron microscope. The resultant films have been tentatively identified as UO_2. Oxygen contamination occurred in the shadowing unit during evaporation. After the short exposure, the homogeneous film has changed into a heterogeneous film; the longer exposure film has become extremely rough and heterogeneous, and has cracked extensively. Only two diffraction rings are observed in the irradiated films, the (111) and (220). These show a decrease in interplanar spacing of approximately one and four percent, respectively. Temperature monitors show that the irradiation temperatures were less than 100 C. Since the irradiation and subsequent electron microscope examination of thin films appears to be a sensitive tool for measuring radiation damage, further experiments on fissionable and non-fissionable thin films are in progress.

An article titled "Simple Autoradiographic Technique" has been published in the January 1959 issue of Review of Scientific Instruments.

X-Ray Diffraction Studies. The presence of vacancies in a body-centered cubic lattice has been detected by x-ray diffraction. These vacancies were induced by rapid quenching of molybdenum specimens from 1000 C. The diffraction results indicate that vacancies shrink and distort the crystal lattice. This work offers a means of verifying the interpretation of x-ray diffraction studies of irradiated molybdenum. These studies indicate that the lattice is affected in a similar manner by neutron irradiation.

Determination of crystalline textures in extruded Zircaloy-2 tubing has been undertaken in an effort to determine optimum heat and mechanical treatments. The specimens under investigation have been treated as follows: (1) annealed at 750 C for two hours, (2) annealed and cold-drawn to five percent cold work, and (3) annealed and cold-drawn to 18 percent cold work. Preliminary analysis of the data indicates an {002} - type texture for all samples, a significant difference being that the

orientation of the basal planes relative to the working direction changes drastically on going from five percent to 18 percent cold work. In the annealed sample and the five percent cold-worked sample, the majority of the basal planes was found to be aligned parallel to the working direction and parallel to the working plane. In the sample with 18 percent cold work, however, the basal planes were noted to be aligned parallel to the transverse direction and inclined at approximately 15° to the working plane. The former two samples should exhibit a much lower tensile strength in the longitudinal direction than would the more heavily cold-worked sample, due to orientation of the slip system, $\{0002\}\langle 10\bar{1}0\rangle$, parallel to the axis of the tube. The circumferential strength should not be noticeably affected. The significant change in orientation apparently is indicative of a critical amount of cold work.

Solid State Reactions. 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. X-ray data obtained for ten percent cold-worked zirconium heat treated in helium for 100 minutes at six temperatures from 300 to 800 C, indicated that recovery is occurring up to approximately 650 C. Above 650 C, the material is recrystallized, according to the information obtained from x-ray diffraction and metallography.

A knowledge of diffusion in various uranium/barrier metal/clad metal combinations is important in the design of fuel elements. Diffusion is being studied in the U/Ni/X-8001 system and in AlSi bonded, X-8001 clad, uranium slugs. Two slugs have been autoclaved 62 days at 300 C. The average of maximum UAl_3 thicknesses found in these slugs was 0.002". This layer is only 0.001" thick in as-canned slugs. Two slugs which were run fourteen days and two which were run twenty-nine days, at 304 C in the Elmo-7 hot water loop, had average maximum UAl_3 thicknesses of 0.0021 and 0.0023", respectively.

In-Reactor Measurements. A knowledge of the errors in temperature measurement using thermocouples in a neutron flux is essential for the quantitative evaluation of the effects of neutron irradiation on materials. The thermocouple lead wire assemblies were discharged from KW Reactor on February 24, 1959, after 3772 hours of exposure in a "snout" facility. At the time of discharge, all wires showed a resistance between pairs of greater than 10^7 ohms. Emf readings through the in-reactor assemblies showed no deviation at 300 C from reading taken in an ex-reactor loop.

The 300 C thermocouple stability capsule has received a total of 1312 hours of exposure at KW Reactor. The three test couples have shown no significant deviation from their ex-reactor calibration either at 300 C or at the melting point of lead.

New Fuel Element Development

Cluster Fuel Elements. Due to a defect in the aluminum shroud tube around the ETR 3x3 facility, three 7-rod cluster fuel elements were discharged from the facility after 500 MWD/T exposure. In order to continue this irradiation test to its goal exposure, the elements were successfully recharged into a new test basket with appropriate thermocouples to measure the temperature difference across the fuel elements. The assembly is now waiting to be recharged into the new process tube.

All 16 rods from four, 4-rod cluster fuel elements discharged from KER Loop 2 facility November 9, 1959, have been examined. All rods examined have shown macrocracks throughout the central core region. Microscopic examination shows finer cracks throughout the uranium structure. With one exception, the rods show cracking occurring predominantly in the central core region not affecting the bond. In one rod, however, three microcracks were found to exist in the bond layer between the uranium and Zircaloy-2 cladding. Burnup analysis indicate an exposure of 0.14 a/o burnup.

An irradiation test of 7-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. Goal exposure for the irradiation is 4500 MWD/T of which 800 MWD/T has been achieved.

Two, 7-rod cluster elements fabricated from coextruded Zircaloy-2 clad natural uranium rod are now in Radiometallurgy for examination. Exposure of these elements was 1250 MWD/T with 300 C maximum clad surface temperature.

Tubular Fuel Elements. Two rod and tube fuel elements are operating in KER Loop 4. Both are 0.030 Zircaloy-2 clad uranium, unenriched. Present exposure is 600 MWD/T. Maximum clad surface temperature continues to be 275 C.

Two tubular elements for ETR tests were completed. One element is 24 inches in length and is a tube design. The second is a 36-inch length rod and tube element. Both elements are unenriched U-2 w/o Zircaloy clad with Zircaloy-2. AEC approval for operation of the tube and tube element has been obtained for the first ETR 6x9 fuel test.

Fuel for Present Reactors. Thirty-five, eight-inch solid cores of depleted uranium (0.2% U-235) were hot pressed canned in M-388 alloy jackets. This material was canned in support of IPD's investigation into the effects of irradiation upon the bond characteristics of hot pressed fuel elements. Surface pretreatment prior to plating revealed numerous striations running parallel with the longitudinal axis of the slug and distributed throughout the core material. Preliminary investigation into the quality of the core material has revealed that the material apparently had not been beta heat treated. Further investigation and testing are in progress.

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Component Fabrication. A series of coextrusion billets prepared for extrusion on the 280-ton press in the Plutonium Fabrication Laboratory have been extruded. The billet designs and component fabrication were adjusted to learn the influence of copper clad thickness and uranium structure on the uranium-Zircaloy-2 interface. The billets were sealed, both Zircaloy-2 and copper, by the electron beam welding process. Extrusions were made at a reduction ratio of 10:1 with the billet preheat at 650 C, die preheat 550 C, and container heated to 575 C. The following table shows the billet conditions that were extruded:

Billet No.	Copper Clad Thickness-inch	Uranium Billet	Preheat Time Hrs at 650 C	Extrusion Force-ton
3	0.032	Beta heat treated dingot	1-1/2	175
1	0.063	Alpha rolled dingot	3	275
2	0.063	Beta heat treated dingot	3-2/3	260

After copper removal, all three rods were approximately 0.615" diameter. There is a pronounced improvement in smoothness of the uranium-Zircaloy-2 interface with the fine grained alpha-rolled core compared to the beta heat treated core with the same copper thickness. Reducing the copper thickness produced some improvement, but the effect was not as great as that produced by uranium structure. All the rods appear well bonded. Seven billets have been prepared for coextrusion at Nuclear Metals, Inc., the first week in March. These include three machined uranium assemblies and four assemblies prepared by casting the uranium directly into the Zircaloy-2 container. The primary purpose of the extrusion will be to evaluate the comparative behavior of cast, cast and heat treated, and wrought-machined cores.

Closure and Joining. It is necessary to develop a simple high production, low cost, high quality end closure system for coextruded Zircaloy-2 clad uranium fuel rods. A method of attaching end fittings to coextruded rods which includes a three-step operation has been developed. The steps are to form the Zircaloy-2 jacket over the end of the rod by press forming; then a projection weld is made between the cap and the face of the fuel rod by using a modified resistance welding machine to effect the projection weld. After projection welding the cap is fusion welded to the fuel rod using the Electron Beam Vacuum Welding process. This method appears to meet the several requirements for end closure of rods. The method is simple, fast, and results are of an extremely high quality.

There is need for tests which measure the relative quality of end closures on coextruded Zircaloy-clad fuel rods, because irradiation of small numbers of test elements does not distinguish one closure from another unless one type fails frequently. An end closure produced by a combination of swaging in a nosing die and welding was tested at 0 C with a hydraulic pressure of 19,000 psig between the end cap and the uranium. This pressure produced

a calculated biaxial stress in the 30-mil cladding of 70,000 psi, yet there was negligible yielding of either the jacket or the weld. Provisions for making this same type of test at NPR fuel element jacket temperatures and on other types of closures were completed. These tests should produce failures and permit comparison between closure types.

Allied Fuel Studies. Knowledge of the swelling behavior of unalloyed clad uranium operating with a cladding surface temperature of 250-350 C and a maximum fuel temperature of 450-700 C is of importance for Hanford's fuel element development work. To provide initial uranium swelling data, five experimental assemblies with uranium fuel rods clad by coextrusion with 0.030" Zircaloy-2 are being or have been irradiated in the MTR and ETR. GEH-3-32, 3-57, 3-58, and 3-59, have reached approximately 80%, 65%, 50%, and 30%, respectively, of their goal exposures at average uranium temperatures of 540 C, 550 C, 750 C, and 650 C, respectively, Discharge of these four assemblies is expected in late April or early May. Six additional irradiation assemblies are being prepared for exposure in the MTR and ETR to compare the swelling behavior of 0.020" and 0.030" Zircaloy-2 clad uranium under similar reactor conditions of temperature and exposure.

To obtain further information on the dependence of fuel element swelling upon cladding and uranium temperature, cladding thickness, and exposure, a series of NaK capsule experiments has been designed for irradiation in process tube of Hanford reactors. Assembly of the first 24 capsules, using four process tubes containing six capsules each, is approximately 80 percent complete. These capsules should be charged in D Reactor in March.

Coextruded U-2 w/o Zircaloy alloy fuel rod with Zircaloy-2 cladding has been defect tested in an autoclave. During the early stages of failure, the "as-extruded" beta-treated H_2O quenched and diffusion-treated H_2O quenched specimen behaved in the most desirable manner. Beta heat treated and slowly cooled specimens failed quicker and with more clad distortion. The best behaved alloy specimen appears to last three to five times longer during the initial stage of failure than unalloyed uranium specimens in their best condition.

Corrosion rates and defect behaviors of defected coextruded Zircaloy-2 clad unalloyed fuel rods are still being determined under static (autoclave) and dynamic (ex-reactor loop) conditions. In contrast to the alloyed rods, beta treated and H_2O quenched specimens appear to fail the most rapidly and with a great degree of clad distortion. Slowly cooled specimens behave the best in that a minimum amount of clad distortion accompanies the uranium fuel corrosion.

A unit has been designed, fabricated, and bench tested that will permit push button ruptures of irradiated fuel elements. The elements can be irradiated to high exposure in the KER through holes and transported to Arco for failure in the 3x3 facility. The mechanism that produces the rupture can be attached by remote procedures in the ETR canal and the

assembled test then loaded in the 3x3 process tube. Five 7-rod clusters are being prepared for subsequent rupture tests in the ETR.

The 3x3 test facility in the ETR has been operating since October 1958. The shroud tube on the in-reactor section failed on February 2, 1959, because of porosity in one of the welded areas. The defective tube has been removed, the standby tube has been installed and is being pressure checked. A third replacement tube is being designed for immediate purchase.

Preliminary tests of a grip to be used for stretch straightening rods and tubes indicate that it will be superior to a "Templin" type grip. A 0.600" OD x 0.030" wall tube was stretch straightened using a "Templin" grip on one end and the grip of our design on the other. The tube end in the "Templin" showed ovality even when plugged. No ovality was noted at the other end which was open and held in our grip.

2. REACTOR PROGRAM

Coolant Systems Development

Corrosion of Carbon Steel. Either 500 ppm of $Na_2Cr_2O_7$-XH_2O, or 1000 ppm of Octadecyl base filming amine completely inhibits carbon steel corrosion in 25 C filtered water. Samples used in these tests were previously immersed in Turco 4306-B solution for one hour at 60 C. Similar samples are still under test in 200 and 300 ppm $Na_2Cr_2O_7$-XH_2O. Visual observation of these tests indicates that both concentrations significantly inhibit corrosion in filtered water. Carbon steel samples exposed to C effluent water for 8.2 months were corroded at a rate of 0.63 mil/month. Samples in H effluent water for 9.9 months were corroded at a rate of 0.52 mil/month. Maximum temperatures were about 80 C.

Non-Uniform Corrosion Studies. The caustic embrittlement test on A-212 carbon steel has been operating for 700 hours and will be terminated after 1000 hours. No indications of cracking have been evidenced to date on this specimen.

A more complicated test apparatus is being designed to study the effect of caustic embrittlement on cracking. This device will consist of a heat exchanger which will expose a tube of A-212 carbon steel, type 304 stainless steel, or other material to concentrating loop water at various degrees of superheat.

Zircaloy-2 fretting corrosion is being tested in Elmo-5 at 290 C and pH 10. The Zr-2 spring wire moving on a Zr-2 coupon has produced no visible attack. Although further testing is being conducted, there is no evidence to date of fretting corrosion on Zircaloy, based on these tests.

Stressed stainless steel coupons, which were run through the Turco 4501 decontamination process in Elmo-10 and charged into Elmo-5, were discharged after 1427 hours exposure in pH 10 and 290 C water. During exposure, samples were stressed at 0, 7500, 15,000, and 22,500 psi. No

signs of stress cracking or crevice corrosion were found. The coupons were placed in the stress holders in pairs. One coupon of each pair had a 10-mil depression machined in its surface. The depression was placed adjacent to the other coupon of the pair to form a crevice. Penetrations were 0.016 ± 0.003 mil, and no effect of stress was apparent.

In-Reactor Corrosion of Aluminum. To extrapolate from out-of-reactor to in-reactor corrosion rates, it is necessary to know the temperature drops through the water and corrosion-product films. These are being determined by two different methods.

In one series of experiments, thermocouples are placed in the aluminum can wall and in the adjacent bulk water. The temperatures are read as a function of time. In one experiment just completed the temperature differential in degrees Fahrenheit between the bulk water and the aluminum surface (e.g., across both the water film and the corrosion-product film) was 124 F or 70 C. These results are being checked by additional experiments. A design for an assembly to determine temperature drops through films for Zircaloy-clad fuel elements is being formulated.

As a second parallel effort, a series of aluminum tubes are being corroded out-of-reactor in high temperature deionized water in the San Jose Loop. The corrosion coupons and test assemblies from the first experiment have been received and are being examined to determine corrosion penetrations. Weight gain measurements on the coupons average about 4.3 mg/cm^2 after 1000 hours. The test assemblies operated at 1.4×10^5 $Btu/hr\text{-}ft^2$ heat flux, 500 F, and pH 6.6. A new test is being started to operate for 2000 hours, 500 F, and pH 6.6 for 2000 hours. The data from this test will be available by the end of the fiscal year.

Film and Scale Removal. Candidate aluminum film removal solutions for removing corrosion products formed in high temperature water were narrowed down to nitric and phosphoric acid solutions. A two-step process using phosphoric acid inhibited with chromic acid followed by nitric acid inhibited with chromic acid successfully removes corrosion product films with an accompanying metal weight loss of approximately 0.05 mil. Further work is required to find optimum temperatures and concentrations.

A new sulfuric acid inhibitor, Rodine 82, manufactured by American Chemical Paint Company was tested as an inhibitor in de-rusting solutions. Previous solutions have contained Rodine 81 inhibitor. A-212 carbon steel coupons in Rodine 81- and Rodine 82-inhibited 10% sulfuric acid at 70 C exhibited 0.131 and 0.023 mil penetration, respectively, after two hours. Rodine 82 is also an effective inhibitor for phosphoric acid. A-212 coupons in Rodine 82-inhibited 10% phosphoric acid at 70 C exhibited 0.0059 mil penetration after two hours. Phosphoric acid is almost as effective as sulfuric acid for removing rust deposits.

Decontamination of Carbon Steel. A decontamination prototype was designed, assembled, and operated during the past two months. This consists essentially of a small recirculating water loop adapted for remote control. The

purpose of the testing was to evaluate available methods for decontamination of carbon steel loops. An irradiated wafer was placed in the test section and exposed to water at 300 C. The resulting highly active suspension of UO_2 and fission products was recirculated through the loop to simulate conditions in a carbon steel reactor after a rupture. Following this simulated rupture the activity level in the vicinity of the loop equipment, as read by a fixed position probe, was approximately 7 r at one foot. The first decontamination method tested, Turco 4512, gave a very low decontamination factor (2.0). After three separate complete decontamination cycles using three different procedures, the accumulated D.F. was still only approximately 30. In the face of this limited success it is concluded that at present there is no proven satisfactory method for decontaminating complex carbon steel systems. However, work is continuing in an effort to develop some satisfactory procedure.

Slug Rupture Testing. Two coextruded uranium and Zircaloy-2 4-rod cluster fuel elements were exposed for a third hour in 300 C water in Elmo-4. Four of the rods were defected with deep slits, three inches long, 30 mils wide, and 300 mils deep. The two rods which were beta heat-treated had only minor swelling at the ends of the slits, while the as-extruded rods had swelling and cracking extending for 1-1/2 inches from both ends of the slit. The weight losses for all rods were almost identical.

The other cluster element was composed of beta heat-treated rods. Two of the rods were defected with 25-mil holes in the side, and the other two rods were defected in the end cap. One of the side pinholes had only 1/4" diameter raised mound while the other side pin hole rod had six raised and cracked mounds covering about three inches in length. One end-defected piece failed to rupture while the other had only a thin crack around the end cap.

A single coextruded uranium and Zr-2 rod, 0.593" OD, was received for testing in the prototype for rupturing fuel elements under heat transfer conditions. The piece was imperfectly made and broke at the braze line. Only a small portion of the area had been brazed. This element is being repaired and will be tested next month.

Hydrogen Detector. Two test runs were made for calibration of the palladium-platinum resistance type hydrogen detector. The instrument operates on the principle that the resistance of the palladium wire is directly increased by hydrogen concentration in the water while the platinum is unaffected. The difference in resistance can, therefore, be calibrated as hydrogen concentration. Preliminary results are quite promising. If successful, the detector will be placed on the Elmo-4 slug rupture loop to determine whether the first stages of a slug rupture can be detected from the hydrogen evolved. It will also be evaluated for installation on a KER Loop and/or the NPR.

Tests in KER In-Reactor Facilities. The pressure drop across the in-reactor portion of Loop 3, containing eight 7-rod clusters and a thermocouple dummy, increased from 36 to 49 psi over one month. One probable explanation was that this pressure drop was caused by precipitation of aluminum oxide at some point in the system. The coolant was deionized water at a pH of 6 to 7 with no phosphate or other inhibitor. Under these conditions the corrosion rate is relatively high.

Loop 3 was recharged February 4 with 25 depleted uranium fuel elements, jacketed in X-8001 aluminum. This test is to study the changes which occur in the U-Si-Al bond, and to determine whether this bond can withstand high temperature irradiation without damage. An aluminum-clad thermocouple slug is included in the charge to study the build-up of thermally insulating crud or corrosion product scale. Operation is at pH 4.5 with H_3PO_4 and 245 C outlet.

The pressure drop in both Loops 1 and 4 increased suddenly and has since been falling off slowly. It is suspected that the collector ring in the outlet nozzle became clogged with material cast loose in the process tube. Additional tests have been run to determine the efficiency of mixing of the water in the channels of the 7-rod cluster fuel element. The results were generally in agreement with those reported last month and indicated that special mixing devices were unnecessary.

Corrosion in Organic Coolants. Corrosion coupons were discharged after 50 days at 700 F in wet monoisopropyl biphenyl containing approximately 20 ppm water. The three types of magnesium, Az-31, 98.8% mg, and British Magnox were all in excellent condition. Corrosion rates of about 1 mil/month were determined for all three. However, it is suspected that at higher water concentrations there would be a considerable difference in the corrosion rates of the three, and a new run at 45 to 50 ppm water is now under way. The carbon steel and M-388 aluminum coupons were essentially unchanged in appearance and weight. The Zr-2 coupons were so badly hydrided that they shattered in trying to remove them.

Structural Materials Development

Zircaloy Process Tubing - Burst Tests. The welded end plug plus mechanical back-up type closure for the NPR process tube was tested at 343 C. The end closure failed by shearing from the split-ring groove on the end of the tube. A modification of this type closure is ready to be tested. Another type NPR process tube closure which utilizes a thin ring of ductile metal to form the seal was tested with encouraging results. The seal held to 14,900 psig at room temperature but failed at 10,500 psig at 343 C. This closure pressure-cycled satisfactorily in both tests. The sealing surfaces consist of a V-shaped groove with a 43-degree included angle on the flange. A ring of ductile metal is placed between these surfaces to provide the seal. The flanges are held on the tube by the usual split ring arrangement.

Nonmetallic Materials Development

Graphite Development. Purification of graphite by the "F" or "C" processes in which bars are bathed in a purifying gas at high temperature is followed by a cooling period during which the purifying furnace is flushed with an inert gas. Helium has been used for flushing in previous production of purified reactor graphites; however, interest in alternate gases has increased since the availability of helium has become limited. The purity of Speer Carbon Company graphites manufactured from Texas Lockport coke was measured in the Hanford Test Reactor. Samples from a heat let down in argon after graphitization to 2800 C have been compared with those from a heat let down in nitrogen. The average dih purity for bars let down in argon was +1.10 which is comparable to the highest purities attained in previous production using helium. The graphite let down in nitrogen had an average dih purity of +0.86 which is lower than that for most purified graphite but higher than AGOT processed graphite with dih purities of +0.255 ± 0.075.

Samples of graphite with one percent iron oxide added to the base mix for control of puffing during the baking cycle were let down in argon. The average dih purity was +0.67. Previous purity tests to determine the effect of iron oxide additives on final purity indicated purities higher than +1.0 dih could be attained. The reason for this variation in results will be investigated further.

Graphites made with Sohio Lima coke as an alternate to Texas Lockport had an average dih purity of +1.04 when let down in argon. Samples of these graphites are being prepared for irradiation as a part of the evaluation of graphites for the NPR.

High Temperature Graphite Irradiation. A four-cycle, high temperature MTR irradiation, GEH-9-7, was successfully completed on February 2. Goal temperatures of 750, 750, 1050, and 975 C were maintained on four TSGBF graphite samples. After a short cooling-off period the experiment will be disassembled in the MTR hot cell and the samples returned to Hanford for testing. The next experiment, GEH-9-8, was charged and is operating at the temperatures maintained in GEH-9-7. It will be discharged after four cycles on April 27. This capsule contains two TSGBF and two CSF samples. The CSF samples were machined from a selected bar which will also be used for samples to be run in the ETR and at Hanford. GEH-9-9, a spare assembly, is being readied to provide an additional MTR graphite irradiation in the event that the L-42 position in the MTR is available for Hanford use following the discharge of GEH-9-8.

Development, testing, and construction of components for GEH-19, the instrumented MTR L-48 shim rod is progressing rapidly on a priority basis. Fabrication of a prototypical test head containing the magnet-connecting mechanism has been completed and has successfully passed "drop tests" at the MTR. Laboratory construction of the experimental section is progressing. A technique for evacuation, leak testing, and sealing is under development.

The test thimble for the first high temperature graphite experiment for the ETR, GEH-13-1, has been completed and shipped. Plans call for charging this thimble the first week in March. Graphite samples in the first GEH-13 experiments will be irradiated in the E-5 and N-14 positions for approximately two months.

Intermediate Temperature Graphite Irradiation, IP-22A. The assembly of IP-22A which was designed to study the radiation effects on graphite in the intermediate temperature range of 200 C to about 400 C has been completed. The experimental unit and four temperature recorder-controllers are ready for loading into the reactor scheduled for some time in March. The assembly consists of four sections with each section containing two CSF graphite samples heated by individually controlled heaters.

In this first irradiation, two different types of heaters are also to be evaluated. In one type, the heater wire is enclosed in a spray-coated alumina layer surrounding the aluminum heater core, while, in the other, the resistance wire is stainless-steel sheathed and insulated by alumina. Temperature settings of 200 C and 300 C are planned for each type of heater-sample assembly. The integrated flux level to which the graphite is subjected will be determined by flux monitors of cobalt, cadmium-covered cobalt, and nickel wires installed in the space between each section.

Three CSF graphite samples from the same bar used in IP-22A have been readied for loading in the controlled temperature (80 C) facility in the 2B test hole at KW. A fourth piece of graphite to be located directly below a channel was drilled to accommodate a flux monitor to gain additional information on the integrated flux level.

X-Ray Study of Radiation Damage. An analysis of the intensity of x-ray diffraction lines from CSF graphite irradiated at 400 to 500 C up to 4500 MWD/AT indicates an initial increase in the integrated and peak intensities followed by a decrease to just below the initial values. This behavior may be contrasted to that exhibited by CSF from 30 C irradiations where the intensities decreased continuously with increasing exposure. These measurements are in qualitative agreement with other physical property measurements in indicating that radiation damage to the crystallites occurs at a very slow rate at these higher temperatures.

Thermal Annealing of Graphite Irradiated at High Temperature. Length contraction of graphite samples subjected to neutron bombardment at temperatures greater than 350 C has been attributed to a closer packing of the crystallites within the coke particles or of the coke particles relative to one another due to radiation-induced stress relief. These changes in structure would not be expected to undergo thermal annealing as does the radiation damage in which atoms are displaced within the crystal lattice structure. To test this possible mechanism, graphite samples that have contracted during high temperature irradiation are being annealed at intervals of 500 C to a final temperature of 2600 C.

Pitch coke experimental graphites fabricated by Battelle Memorial Institute and irradiated to 742 MD/AT at 450 C contracted in length from -0.02 percent to -0.05 percent. The crystal layer spacing, C_o, increased from 6.782 Å to 6.792 Å. After the initial annealing at 600 C for six hours, no changes occurred in these properties. High temperature annealings are in progress.

Radiation Damage to Plastics and Elastomers. Radiation effects have been determined on two new plastics. A polyvinyl fluoride, an experimental material from duPont, appears to undergo chain cleavage out to a dose of about 3×10^8 r based upon decreases in tensile strength. At 5×10^8 r the tensile strength begins to increase, suggesting cross linking. The elongation is decreased continuously with the radiation dose. At 5×10^8 r, the material still possessed some integrity although it had lost most of its tensile strength and elongation. It did not break when bent 180 degrees. This material appears to be the best fluorine-containing plastic evaluated to date.

Estane VC, an experimental polyurethane plastic from B. F. Goodrich Chemical Co., has been evaluated for its radiation resistance at room temperature to 1×10^9 r. Even after this high dose, it possessed a fair amount of its original flexibility, strength, and toughness and did not break when subjected to the bend test. It appears that this material is undergoing chain cleavage to a dose of 5×10^8 r. Beyond this dose, the tensile strength loss is constant indicating that other mechanisms of damage are predominating. From a radiation damage standpoint, this plastic appears to be among the best evaluated to date, although it has not yet been tested at elevated temperature.

Two reports dealing with plastics have been published during the last month: HW-56478, "Elastomers for Use in Radiation Fields, Parts VII and VIII," and "How Hot Water Affects Elastomers," which appears in the February issue of Rubber Age.

Thermal Hydraulics Studies

Reactor Flow Hazard Studies. Heat transfer experiments were performed to determine the amount of protection remaining in the Panellit gage system at "C" Reactor when a process tube is operating with a ruptured rear hydraulic connector. Such information is of interest since it appears that it is not mandatory to decrease power level upon the loss of a rear hydraulic connector from a process tube.

A full scale electrically heated mockup of a "C" geometry process tube and I & E fuel element charge was modified to simulate flow conditions without a rear hydraulic connector. Measurements of pressures and temperatures throughout the mockup were recorded on high speed recorders during flow reductions simulating both fast and slow plugging of the process tube. Preliminary interpretation of experiments performed at tube powers of 500, 1000, and 1250 KW indicated that surface temperatures of 370 C would not be exceeded provided the Panellit trip range was not

greater than 80 psi. These experiments were all performed at an initial outlet water temperature of 125 C.

Experiments were attempted to determine the heat transfer characteristics of a "K" Reactor process tube during hazardous flow conditions, for front header pressures of 240 psig. During the initial experiment, an electrical short between the simulated fuel elements and the process tube resulted in severe damage to the test section. Steps were initiated to install a new test section.

Hydraulics Studies. Experimental work was completed in the study of the effect on pressure drop of wire wrap mixing promoters along a 7-rod cluster fuel element made up of 0.780 inch rods. The results are presented in HW-59333. Material was ordered for additional test sections made of 0.704 and 0.740 inch rods.

Installation was completed of a test section to obtain pressure drop data for flow of steam-water mixtures around bends in square passages. Such data will be valuable in the evaluation of pressure buildup in the NPR graphite lattice following a possible rupture of a process tube.

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 30 percent complete. Arrangements were made to start the necessary electrical and mechanical modifications of the low pressure heat transfer apparatus during the first part of March.

Heat Transfer Calculations. The calculation of the temperatures within the present Hanford reactors following a complete water loss was continued with the aid of the 709 computer. Results are being obtained for the times required to reach melting temperatures within the process tube and fuel elements following complete water loss at a variety of power levels. The calculations are performed assuming equilibrium conditions at time of complete water loss and will be repeated for water loss at times of 30 seconds and 30 minutes after reactor scram.

Critical and Two-Phase Flow Studies. Experimental data were obtained for the flow of two-phase mixtures of steam-water through a 3.5-foot long tube having an internal diameter of 0.622 inch. In 22 of the runs covering a range of exit steam qualities of 0.5 to 12.7 percent by weight, critical flow conditions existed at the exit of the test section. A comparison of the actual to theoretical flow rates at critical flow conditions indicates this ratio was relatively constant at 1.8 for steam qualities between two and ten percent. Below two percent quality, however, the actual flow was considerably greater than the theoretical rate under critical flow conditions and was 7.8 times as great at 0.5 percent quality. These data were obtained at exit pressures of 20 to 110 psia.

Miscellaneous. Installation was completed of a short, electrically heated test section to study heat transfer characteristics of 7-rod cluster fuel elements. The test section consists of seven 0.625-inch rods in a 2.067-

inch process tube and was designed for specific powers up to 200 KW at pressures below 500 psig. No provisions were made to induce mixing of the coolant streams between the different channels formed by the rods and thus evaluation of hot spots in this type of fuel element should be obtainable.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 facility operated for 100 hours during the month at temperatures between 300 and 350 C, using the terphenyl-biphenyl eutectic mixture as a coolant. This eutectic mixture was not satisfactory due to deposition of the solidified biphenyl. The facility was shut down, and a new eutectic mixture is being prepared. This mixture will consist of ortho-terphenyl, meta-terphenyl and mono-isopropylbiphenyl (MIPB).

Reactor Technology Development

Thermal Shield Studies. Fabrication of the experimental assembly for in-reactor testing of the boron steel thermal shield was completed, ready for installation during the long shutdown the week of February 2.

In preparation for installation of the assembly, the 36" shield plug was removed from the hole in the shield at C Reactor with considerable difficulty. It was found that damaged masonite had caused binding of the plug in the hole. The masonite was a black foamy mass, giving the appearance of extreme thermal degradation, and a tar deposit was noted on the hole liner.

The plug was cleaned and inserted in the shield hole without installation of the boron steel assembly, to avoid delay of scheduled reactor startup.

Fast Neutron Spectrometer. The automatic programmer has been reinstalled on the 100-Channel Analyzer, an additional cooling fan has been added, final adjustments have been made, and a revised version of the setup and calibration procedures is being written. As soon as the neutron recoil spectrometer chamber can be re-assembled, the entire instrument will be moved to the ion accelerator for calibration.

Neutron Attenuation Measurements. The foils from the test on ferrophosphorus concrete baked at 320 C have been counted and the data sent to IBM. As a result of baking ferrophosphorus concrete at 320 C, the gamma dose rate through 48 inches increased by a factor of 43. This can be attributed to the increase in the thermal neutron capture gammas.

The data from the first test on ordinary concrete baked at 300 C are being analyzed. The foils from the second test at 300 C have been counted and the data sent to IBM.

The data from the first test on pure iron are being analyzed. A preliminary calibration was made for the sulfur data in terms of absolute flux.

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

Plutonium Oxide Fuels. Mixtures of PWR grade UO_2 containing 10, 20, 30, 40, 50, and 60 w/o PuO_2 were sintered in hydrogen for 44 hours at 1600 C to get additional data on solubility in this system. Densities of all the pieces were low, approximately 80 percent of theoretical; however, solid solution formation was complete in every case. The low density material should not affect lattice parameter values, but it did slightly reduce the intensity of the reflections.

Some preliminary work on measurement of powder particle size by x-ray techniques has been done. Using the method of Scherrer, the crystallite size of ball milled PWR grade UO_2 was determined from the (111) plane as 0.054 micron.

Sinterability experiments are being performed on mechanical mixtures of UO_2 containing 1/4, 1/2, 1, 2, 5, and 10 w/o of PuO_2 which have been pressed to a green density of approximately 65 percent of theoretical. Pieces of the above compositions held at 1000 C for one hour decreased slightly in density, presumably due to volatilization of binder and lubricant, and holding at 1100 C for the same time increased density roughly 1/2 percent. One hour at 1200 C resulted in an increase ranging from 1.2 to 3.5 percent, the lower densities being associated with higher plutonium concentrations.

Extrusion Billet Casting. The induction melting facility for Al-Pu alloy preparation and casting was activated. Eighty-two Al-Pu billets were cast; each billet is 2-1/2" dia. x 9-1/2" in average length. PCTR critical mass experiment fabrication required 25 Al - 5 w/o Pu alloy billets. Metallic plutonium of uniform isotopic composition was used in preparing this alloy. Melt analyses were within 4% of the nominal alloy composition. Casting variables were explored in preparing these billets; casting temperatures above 850 C resulted in normal segregation, while casting into cold molds resulted in gas entrapment. Twelve Al - 0.5 w/o Pu billets for ETR irradiation experiments and 45 Al - 1.8 w/o Pu billets for four PRP clusters were cast using Al-Pu alloys left over from the MTR fabrication. This is sufficient material for six Al-Pu spike clusters.

Extrusion Development. The 280-ton extrusion press hood has been sealed for hot operation. Al-Pu extrusions containing 5 w/o Pu have been made to a nominal 0.500 inch diameter. Full evaluation of these extrusions has not yet been completed.

A coextrusion of U-Al containing 6 w/o U and clad in 2S Al with integral ends was made. The diameter of the coextrusion varied by 0.001 inch over the 3.5-foot length, and uniform wall thickness was observed. The trailing end of the core displayed a fishtail that will require redesigning of the billet end configurations.

It was attempted to stretch straighten Al-Pu extrusions. This was unsuccessful because about five percent elongation was required to straighten the rods, and this reduced the diameter excessively. The hooded rod straightener will be available for use shortly.

Air Pressure Injection Casting. A test was devised to determine the shear strength of the metallurgical bond formed between pure aluminum and Zircaloy tubing by injection casting. Differential thermal expansion will impose a rather severe shear stress on the bond between the aluminum core and the Zircaloy tube in reactor service. The sample tested failed in the aluminum indicating that for this specimen the bond strength was stronger than the aluminum.

Fuel Element Die Casting. The development program to determine the feasibility of commercial die casting as a method of fabrication of the Pu-Al spike elements was carried out in Chicago on a prototype basis during the past month. A 400-ton cold chamber vacuum machine was used to die cast 2S Al, Al-12 w/o Si, and Al-8 w/o Mg into 54-1/2" dia. x 89.75" long stainless steel and Zircaloy tubes. The tubing was supported in a 10" square steel die block mounted horizontally between the platens of the machine. The plunger speed was 400 ft/min, and a pressure of 13,000 psi was applied during solidification. Variables affecting final density such as alloy, melt temperature, die pre-heat, size of end hole and type of tubing were investigated.

In general, it was found that densities in excess of 93 percent of theoretical could be obtained in a cold closed-end tube, regardless of tubing type. Densities of 95% were consistently found with the more castable AlSi and Al-Mg alloys at both 700 and 780 C. The density of 2S Al castings varied from 81 to 94%, and one casting of 98% of theoretical density was made into 0.056" wall Zircaloy tubing. The 2S was cast from 725 C to 815 C; however, a soldering effect between the plunger and cold chamber well was noticeable at the higher temperatures. The quality of the as-cast tubes was good. Surface oxidation was very low, and the tubing was free from distortion. A strong bond was observed, especially between stainless steel and 2S aluminum. Longitudinal sectioning of the castings showed the majority of the voids to be concentrated at the upper end of the rod. The best vacuum obtained in the tubing before casting was 24 in Hg, so the density would undoubtedly improve with better tubing evacuation. Cross-sections through the rod indicated signs of hydrogen evolution, which could be corrected by vacuum melting.

Fuel Rod Assembly and Autoclaving. Twelve full-length aluminum rods canned in Zircaloy tubing are being fabricated to investigate warpage during autoclaving. Eight of the twelve elements have been partially tested. Some were sized by drawing or swaging the tube onto the cores, and some were fabricated by presizing the tubing with a rod straightener. They were suspended vertically in an autoclave and subjected to 400 C and 1500 psig for 72 hours. Some of the elements warped quite badly; however, there does not seem to be any correlation between warping and the method of sizing. It does not appear practical to insert rods into tubes and

have a maximum diametral clearance of 0.003 to 0.004 inch. Because of variations in the outside diameter of the rods and the inside diameter of the tubes, it is not possible to maintain the required gap in all parts of the element and still have enough clearance for assembly without galling and sticking. In these first elements, there is no correlation between warp and the manner in which the end clearance in the element is distributed. All the welded end closures were satisfactory. A more complete appraisal of the data will be made when the experiment is completed. An additional ten elements are being processed to obtain more information on the warp problem and the fuel element fabrication process.

Another approach to the problem of charging the fuel element cores into the tubes is being tested. A honing apparatus is being fabricated to hone the inside of the eight-foot Zircaloy tubes. Since there is no machine on the market today for honing 1/2-inch ID tubing of this length, a tool for this special job is being developed. A representative of Sunnen Corporation, after hearing the problem, suggested cutting a mandrel of their design in two and placing a five-foot shaft in between the parted halves. This mandrel with the proper attachments will allow the stone to be extended or withdrawn by controls at the driven end. The drive for this first attempt will be a 1/2" hand drill. The Sunnen man believes the tubes can be honed the entire length to within 0.0005-inch tolerance with a 12-microinch finish. If this can be used to finish the tubes to an inside diameter of $0.505 \pm \frac{0.005}{0.000}$ inch, cores of 0.506 - 0.507 could perhaps be charged with comparative ease.

Plutonium Welding Development. Additional weld quality tests are being made on the fillet head weld. Zircaloy clad PRP fuel element dummy specimens are being subjected to fatigue and torsion tests. These tests will evaluate the suitability of this weld design and determine the existence of any detrimental notch effect which could cause failure.

Mark I Fuel Element Design Engineering. A newly designed set of end brackets for the PRTR fuel elements has been completed. This new design was made to facilitate investment casting of the parts. The new design, which is designated Mark I-F (Drawing No. H-3-13310), has gone out for bids and will be returned by March 10. They will be cast of type 304L stainless steel. In order to cut tooling costs and thereby final piece cost, the brackets were designed to cast the top bracket only, and the bottom bracket will be machined from this casting. These end brackets will be used in the first two loadings of the PRTR.

An improved quick disconnect has been designed and is being fabricated off-site. This revised design (Drawing No. H-3-13314) incorporates two major changes. A new entry angle for the ball relief groove in the Q-D cap corrected the sticking problem uncovered in autoclaving tests. However, the fuel element and Q-D must be operated in a vertical position to assure its correct release function. The second was a flange added to the Q-D sleeve. This allows the completely assembled Q-D to be pressed into the end bracket quickly and also controls the depth of seating.

A tool was developed which can be used remotely for removing the top end bracket of the Mark I-F fuel element. When attached to the top end bracket, turning the extending handles four revolutions will depress the Q-D buttons and release the fuel rods from the end bracket.

Tubing, Rod and Wire for PRTR Spike Element. A shipment of 491 Zircaloy-2 tubes and 15,000 feet of Zircaloy-2 wire for fabricating the Al-Pu alloy clusters for the PRTR arrived at HAPO this month. Of the 491 tubes, about 108 have been inspected by Radiographic Testing Operation. Seven tubes were rejected for internal discontinuities as determined by dye penetrant. About 12 tubes may be rejected for having wall thicknesses which are below the specified minimum of 0.027 inch. An additional group of 400 tubes are at Stores and another shipment of 360 tubes is in transit. The remainder of the Zircaloy-2 tubing order has been fabricated and will be shipped presently.

The aluminum (8001 alloy with 0.1 percent Ti) tubing, rod, and wire which were purchased as standby cladding material for the PRTR first charge fuel elements were received.

UO_2 Fuel Development

PRTR Fuel Elements. Fabrication of swaged rods for 19-rod cluster elements continued with major emphasis being placed on refinement of processing steps to improve the quality of the rods. The major problem encountered was inadequate rinsing of etched rods before autoclaving. Three batches of autoclaved rods were rejected because of white oxide film. After testing suspected variables, the trouble was found to be inadequate removal of the 314 Building tap water. The process which produces adequate results is rinsing in deionized water and drying with clean paper towels.

The use of the insulated tungsten electrode technique and end caps with outgas holes in both ends of the fuel rod has provided reproducible closures. Of the 88 end closure welds produced during the month, only two were rejected. One was rejected for UO_2 contamination in the weld area, and one was rejected for poor weld penetration resulting from incorrect welding machine settings.

A swage feeding device which provides more uniform swaging of fuel rods was put in operation. Use of a slip clutch in conjunction with this device has prevented fuel rod ruptures caused by the torsional force occurring when the dies of the swage machine grasp the fuel rod. A magnetic slip clutch, presently being evaluated, is expected to improve the surface finish of swaged fuel rods. Straighter fuel rods have resulted from pulling, rather than pushing the rods through the swage machine. Fabrication of an alternate feeding device is near completion. This device is expected to reduce setup time and to allow feeding of fuel rods completely through the swage machine without interruption.

Cladding failures of a type not previously experienced have occurred during the swaging of UO_2 in 0.750" OD Zircaloy-2 tubes received from Wolverine. The cause for these longitudinal split failures has not been satisfactorily explained. Other tubing, identical by all previous tests, performed satisfactorily. The swageability of various lots of tubing is now determined by swaging a short length of unfilled tubing.

Preliminary hanger and end fitting design work for the Mark II-C nested tubular fuel element was completed. This design adapts the seam weld closure technique to the 0.060" wall, integrally ribbed, Mark II-C tubing.

Fabrication Development. Experiments revealed that fused and crushed UO_2 can be compacted to densities as great as 82 percent of the theoretical, crystal density by vibratory compaction. The highest densities were obtained with the following particle size composition:

60% -6 + 10 mesh

A gamma ray absorptometer was activated for determining density of UO_2 fuel elements. The instrument is sensitive to a density variation of approximately 0.3 percent in a 0.65" diameter swaged rod. The instrument can be used to determine density at any point along a swaged rod.

Half-inch diameter UO_2 pellets sealed in 0.0075" wall stainless steel tubing were fabricated for Chemical Development Operation chemical processing studies. Thirty-nine three-foot tubes were delivered during the month.

Basic Studies. Thermal conductivity measurements were completed on the last of a series of four extruded and sintered UO_2 specimens having different densities. The work, a joint HLO-BMI effort, has confirmed the dependence of conductivity on density and has revealed a heretofore unrecognized dependence on fabrication method. The present results serve as a basis for comparison with measurements on similar irradiated specimens. The first irradiated specimens were shipped to BMI.

Cinemicrographic studies of the behavior of UO_2, Al_2O_3, MgO, ZrO_2, and ThO_2 near their respective melting points revealed similar dendritic crystal growths in all cases.

Facilities. A 300 ampere Miller welding machine was installed. Excellent arc stability and accurate timing control is provided by this equipment. This machine will be used for making the closure welds on the PRTR fuel elements. Airco and Miller welding machines will provide dual welding operation in the vacuum welding box without necessity of changing machine settings on one machine.

The 300-ton automatic tabletting press was checked out with the vendor's representative. A number of deficiencies were corrected. A few UO_2 tubes were pressed before changing the tooling to pellet dies. Fabrication of hoods and correction of several minor deficiencies were in progress.

The pusher-type hydrogen atmosphere sintering furnace was operated continuously without incident.

Structural Materials Development

Zircaloy Jacket Tubing. The final acceptance samples of ribbed jacket tubing for the nested tubular fuel element have been received from New Rochelle Tool Co. These are the 2.998" ID tubes with five ribs attached by the Thermatool welding process. The tubes have been examined and found satisfactory as far as the vendor's work is concerned. The welds are of adequate strength, and disturbance of the tube surface is entirely superficial.

The ribs on this tube are about 0.050" too high. Because of electrical and thermal limitations it has not proven possible to attach a smaller rib satisfactorily. Consequently, methods will be explored for machining these ribs to proper height. The tubes have gone somewhat out of round, although

the average diameter remains unchanged. The maximum difference in diameters on a given tube is about 0.050". The measurements will be analyzed and experiments performed on a short length of tube to establish whether they can be used in this form. A proposal from New Rochelle Tool Company is under consideration to modify the machine to apply spiral ribs, and it is expected that a new contract will be signed by month's end.

Modification No. 4 to Contract DDR-29 with Nuclear Metals, Inc., has been signed and is now in effect. Work has started on a new generation of extruded ribbed jacket tubing. These will conform to the PRTR Mark II-C fuel element specifications. The tentative schedule calls for extrusion of the composite billet assembly in mid-April and delivery of the first complete sets of tubing by June 1.

Zircaloy Process Tubing. The contract with Tube Reducing Corporation for 100 PRTR Zircaloy process tubes is progressing satisfactorily. The last 82 extrusions are currently receiving the first tube reduction. The other 53 extrusions, with the exception of one, have been tube reduced, vacuum annealed, and tapered. Of this group, a total of 20 tubes have failed during processing or have been rejected during intermediate inspections, 13 are being conditioned and shipped to Chase Brass and Copper Company for flanging.

The method of flange attachment by Chase has been approved on the basis of tests performed at Hanford on sample flanges. The method consists of screwing a threaded ring on the end of the tube, welding the tube-to-ring joints, and machining to the required dimensions. Thus far, seven tubes have been flanged under the 100-tube contract. It is expected that the first group of approximately 25 tubes will be ready for final inspection at Tube Reducing Corporation in the middle of March.

In the tests of the flange design, mentioned above, two sections of flanged, annealed, PRTR pressure tubing were hydrostatically tested to failure at 300 C. The table below gives dimensions, bursting pressures, and unit stresses of the two tubes. The flanges withstood the destructive tests satisfactorily.

Min. Wall Thickness (in.)	Bursting Pressure (psig)	Unit Stress (psi)
0.149	4100	43,400
0.147	4000	42,700

Other sections of PRTR pressure tubing, which were 40% reduced in area by cold working and vacuum annealed for two hours at 750 C, have burst at 4200, 4300, and 4100 psig with unit hoop stresses of 47,000, 47,600, and 44,000 psi, respectively.

Aluminum Alloy Process Tubing. Alcoa is under a DDR contract to fabricate 10 PRTR process tubes of C-94 aluminum alloy of T-6 temper. It appears that Alcoa has developed a process that will produce satisfactory tubes. However, the work has been done on the basis of a nine-inch taper. It is

estimated that one to two months of additional development would be required to produce tubes of current specifications, e.g., a tube with a 17-inch taper.

Corrosion Studies

Zircaloy Etching. Following the etching of Zircaloy clad fuel elements in nitric-hydrofluoric acid etch solutions, residual surface fluorides must be quantitatively removed in order to avoid accelerated corrosion during autoclaving. Conventional rinsing techniques are satisfactory for plain surfaces if very carefully controlled. More complicated surfaces containing crevices cannot be rinsed adequately by conventional techniques. Ultrasonic agitation of rinse solutions has been shown to improve crevice rinsing on a laboratory scale.

The development of a prototype rinsing facility for wire wrapped fuel rods is now in progress. A preliminary laboratory system employing a cylindrical ultrasonic transducer operating in a flow of deionized water was tested on 11 wire wrapped fuel rods. The fuel rods displayed only a few white "acid stains" in the crevices after autoclaving. However, all the rods exhibited a uniformly distributed grey cast in the normally very black oxide on the plain surfaces. The exact source of the grey cast is not yet known but could have resulted from cavitation damage to the surface metal or post-rinsing contamination from laboratory fumes. Since this grey cast has not been observed with other ultrasonically rinsed pieces, its formation can probably be avoided by proper control of conditions.

Radiometallurgy Laboratory Studies

Attempts to obtain fractographic samples of Al-Pu were unsuccessful when fracturing operations tried at liquid nitrogen temperatures resulted only in bending the samples.

Examination of the PuO_2-UO_2 powder, 3-rod cluster fuel element (GEH-4-28) continued. The oxide in two of the rods showed a drastic density increase with the oxide contracting upwards in the fuel rod to produce a 3/16" diameter axial hole. Samples cut from a 4-rod stainless steel jacketed, solid uranium core cluster element were polished and examined. Metallography and the collection of fission gas were completed from one rod of a 3-rod swaged UO_2 fuel element (GEH-4-33). Results and conclusions from the above Radiometallurgy studies are reported in detail in connection with the respective development programs.

Thermal Hydraulics Studies

Installation of the electrically heated mockup of the Mark II-B fuel element was completed, and experimentation was initiated. Flow and temperature distributions throughout the element were obtained for tube powers in the range between 150 and 300 KW when the total flow, system

pressure, and inlet water temperature were held constant at 127 gpm, 1075 psig, and 478 F. In all cases flow splits and temperatures were very close to design conditions. One run was performed at 300 KW and 1075 psig with the flow gradually reduced to the point where bulk boiling was initiated at the end of the test section. No serious variation in the flow split between flow channels was experienced, and there were no indications of hydraulic instability. Plans were made for similar experimentation at higher heat generation rates.

Fabrication of the parts for an electrically heated mockup of the Mark I fuel element was completed.

Modifications to the vertical section of the high pressure heat transfer apparatus were started, to allow installation of the test sections designed to study subcooled burnout for the PRTR fuel elements.

Equipment was set up and operated to test the response time characteristics of a prototype strap-on thermohm for the PRTR. In general, the response times ranged from 18 to 22 seconds for a 63 percent response to a step change. However, an oxide film was noted between the thermohm and the pipe wall, and it was thought that the response times had been slowed accordingly.

Revised water loss calculations for a complete parting of the top 14-inch header of the PRTR have been completed. The results indicate that blow down will occur in the reactor leg in 16.4 seconds and in the heat exchanger leg in 6.8 seconds. After blow down of the reactor leg, it is estimated that steam will pass by the fuel elements for an additional 18 seconds. Thus, 34.4 seconds after this assumed piping failure, the fuel elements will be surrounded by a stagnant steam atmosphere.

The results of these calculations are part of the information being supplied to BMI in their evaluation of fuel element temperatures following various piping failures for the PRTR.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. Scoping of the mockup for testing the charge-discharge machine was begun. The mockup will be installed over the Process Tube Test Shaft in the 314 Building.

Design Test PR-10 - Primary Loop Mockup. Three cold performance tests of the full size PRTR pumps were completed, using separate pump cases and impellers. The initial galling difficulty during the first cold performance test was corrected by increasing the clearances at the thermal barrier throttle bushing. One pump case is being retained at the Byron Jackson Pump Company's plant for the hundred-hour hot tests of the pumps. The second case has been received and is being installed in Phase II of the Single Tube Prototype Mockup (STPM).

Severe cracking occurred in an eight-inch stainless steel weldneck flange as it was being welded to the eight-inch primary pump discharge check valve. A new flange has been ordered, and completion of the STPM will be delayed approximately two weeks. As dye penetrant and radiographic tests revealed cracks in two 2-1/2-inch flanges, all stainless steel flanges used in the STPM will be radiographed, both before and after welding.

Design Test PR-13 - Injection Pump Test. After 221 hours of operation, the first routine maintenance inspection of the injection pump revealed galling of the babbitt bearing inserts and the presence of fine steel particles in the pump's oil system. The 17-7 PH stainless steel plungers were also badly scored, presumably by the teflon impregnated asbestos packing. An engineer from the vendor will inspect the first pump and is bringing Type 440-C stainless steel plungers and a different type of packing to install in the second injection pump. As soon as the replacements have been made, the second injection pump will be tested.

Design Test PR-20 - Calandria Characteristics. Work was completed on dump valve synchronization to provide the instantaneous opening of two, three, or four dump valves. The dump tests, using these valve combinations, have been completed, and the high speed movie film is being processed.

Design Test PR-24 - Shroud Tube Bellows. The six-inch bellows from the Master Products Company were inspected after corrosion testing. The inner ply of the bellows had ruptured, and the bellows were rejected. Flexure testing of the six-inch bellows from the Solar Aircraft Company indicated that the bellows were too stiff, as they failed after only 4000 cycles.

Design Test PR-40 - Shim Control Mockup. The material for the floating control rod concept was received, and two short test sections fabricated for preliminary study. One test section was fabricated with cobalt wire imbedded in the buoyant Foamsil material. The second test section was made by flame spraying the cobalt on the Foamsil.

Two eight-foot long lead screws were received. These screws are being installed in a mockup of the positive drive concept of the shim control system.

Design Test PR-50 - Reactor Piping Seal Testing. The fully prototype Process Tube Assembly "C" was completed and hydrostatic tested. The nozzle cap seal leaked under hydrostatic testing and is being altered to provide a tighter seal. All other water seals and all gas seals were leak tight. This process tube assembly will be installed on Elmo-7 upon completion of hydrostatic tests.

Design Test PR-51 - Reactor Piping Structural Integrity. The shortest outlet jumper-header jumper combination has been installed on the flexure cycling mockup for hot testing of this combination. The jumper heating apparatus is 95 percent complete and, in acceptance testing, has been operated up to 250 F and 1000 psi with no difficulties.

Design Test PR-52 - Process Tube Thermal Cycling and Pressure Testing. The full size process tube assembly successfully passed additional hydrostatic testing and brief thermocycling to 475 F at 830 psi pressure. All water and gas seals were leak tight. Testing at full PRTR conditions will start on March 2.

Design Test PR-80 - Air Cooling Duct Test. The detailed design of the air duct mockup was completed. Fabrication is currently 35 percent complete.

Single Tube Prototype Mockup. The prototype PRTR pump was received and has been installed in Phase I of the mockup. This pump was successfully tested in the STPM to 530 F, 1125 psi suction pressure, and 150 gpm flow. The leakage rate from the primary mechanical seal was 0.3 gallon per hour during isothermal operation of the mockup at 525 F. Continuous testing of the pump will begin on March 2.

Inconel "X" Supercritical Pressure Mockup. To determine the force released upon the breakage of a tube at supercritical conditions, a stainless steel tube was ruptured at 1100 F and 4500 psi. No adverse forces were present. Inconel "X" tube was installed in the mockup and is currently being tested at 1100 F and 4500 psi.

Zirconium Tube Burst Tests. A local overheating rupture test at 3000 psi and 600 F was conducted using B-D-F size Zircaloy process tubing. The entire two-foot test section completely shattered. Similar results were obtained from a burst test at 2750 psi and 600 F.

Reactor Technology Development

Process Instrumentation. The final report on the design test results on flow transmitters for PRTR was issued. The transmitters will continue to be evaluated on extended life tests and on prototypical flow loops. The two Panellit units are on a life cycle test, and one of the two has accumulated over 1-1/4 million cycles without apparent damage.

The final report on the design test results on resistance temperature detectors was issued. Testing will continue on these units also for as long as it is practical. A response time test repeated on one unit indicated a significant increase in response time after the unit had been exposed to radiation and high temperatures (725 F).

A capacitance probe and the associated instrumentation has been assembled to demonstrate a method for checking the rate of drop of the D_2O in the calandria of PRTR after a scram.

Reactor Safety and Hazards Review. Work was initiated during the month to develop process specifications which will be included in the PRTR final hazards review report.

A rough draft report on a study of alternates to containment for possible application to PRTR and other similar reactors is being circulated for comment. It is planned to have the report ready for publishing by mid-March.

Information is being extracted from the literature on the safety and hazards aspects of various reactors for comparison to PRTR. Information has been obtained on Dresden, APPR, PWR, Yankee, and EBWR to date.

Battelle Memorial Institute is progressing on a research and development contract which authorizes a study of possible loss-of-coolant incidents for the PRTR. Under this contract four loss-of-coolant incidents will be analyzed.

1. A double 14-inch top header break. (Defined as complete rupture of the top 14-inch header, with the ends of the pipe offset such that the flow of coolant from each end does not interfere with flow from the other end.)

2. A single 14-inch top header break. (Defined as a rupture in the 14-inch top header with an equivalent diameter of 14 inches.)

3. A top process tube jumper rupture.

4. A bottom process tube jumper rupture.

PRTR Physics. As a result of a recently completed three-group vertical analysis of the PRTR, a report, HW-59373, "The Effect of Moderator Height on Reactivity and Vertical Flux Distribution in PRTR," has been prepared and will be issued shortly.

The whole-reactor effect of xenon on reactivity in the PRTR is being determined in a more detailed fashion using the "GEDA" or analog computer. Where formerly an average flux had been ascribed to the reactor as a whole, the value of the flux is now being supplied for each of six natural regions in each vertically symmetrical half of the reactor. Also, the difference in the xenon yields of Pu and U are now accounted for in the analysis.

Calculation has been completed on the radiation expected in the gas loop resulting from gaseous diffusion of fission products. This work will be reported shortly, together with the completed calculation of radiation from fuel debris in the gas loop filter.

Fast Reactor Conceptual Design Study. A conceptual design study of a sodium cooled fast reactor utilizing small spherical fuel elements has been initiated. A unit to provide about 300 thermal megawatts was selected as a design basis. Because of the high specific power inherent in fast reactors, large sodium flow rates are required. Calculations indicate that the pressure drop across the core would be quite high for specific powers approaching one magawatt per liter of core, and an

investigation of the optimum balance between specific power and pressure drop is being carried out. Preliminary calculations using an eleven-neutron-group model including inelastic scattering resulted in a total conversion ratio of core plus blanket of 1.4 and a critical mass of 535 kilograms U-235.

Design Development

Phase I PRTR Construction Status. The Phase I PRTR contractor is approximately 79% completed versus 89.3% scheduled. Erection of the dome will be completed except for the top "dollar" plate by the end of the first week in March.

The main personnel airlock has been moved into position. The reactor hall crane has been set into position inside the containment vessel, on temporary shorings.

Phase II PRTR Construction Status. The Phase II PRTR contractor is 74% completed versus 80% scheduled. A design change was issued to relocate the instrument shop to provide additional control room space for experimental loop panels.

Phase II-A PRTR Construction Status. The Phase II-A PRTR contractor is estimated to be 42% completed versus 39% scheduled. Difficulty was encountered on the leak test of the 36" corrugated pipe between manhole #3 and the outfall structure, because the fit-up at the three-piece joint points was not consistent. The contractor has been issued a design change to test coat three sections of pipe. Assuming satisfactory results from this test, the joints will be coated on the inside of the pipe in order to reduce the leakage to an acceptable point.

Phase III PRTR Construction Status. The contractor submitted data on the Hayward & Tyler submersible pumps as an or-equal to the Byron & Jackson pumps specified. This material was returned not approved for lack of information. Pump performance curves were submitted showing a head of 150 feet measured at the pump bowl whereas this amount is required at the discharge flange. A meeting was held the last of the month with representatives of the Phase III contractor and Hayward & Tyler pump manufacturers in which they indicated that they could resolve all items to our satisfaction. Based on this, tentative approval was given for a water-filled motor as a substitute for the Byron & Jackson oil-filled motor.

Design Analysis. A study of events following a process tube leak in the PRTR has been completed. A report has been prepared presenting the results of the study and recommending that pressure relief mechanisms be added to minimize damage to the calandria and moderator storage tank in the event of a leak.

A study of piping stresses throughout the PRTR primary cooling system was begun.

Process Tubes. Minor dimension and tolerance revisions have been made on the process tube as agreed on with the manufacturer. A revised flange design was tested satisfactorily and approved for construction.

Instrumentation and Control. The automatic controller design was received from Minneapolis-Honeywell and reviewed.

A document covering the dynamic control characteristics of the PRTR was completed. The document covers the system analysis work done on the reactor system over the past year.

The fuel element rupture detection system design criteria was issued for comment.

An IBM-650 program for evaluating fuel element heat transfer transients was completed and tested. Preliminary results indicated that the heat transfer lag was apparently only one third as large as had been assumed. Since the IBM-650 computing time was rather long for each solution obtained, it was decided to re-program the problem for the IBM-709, and this work is currently under way.

Shielding. Revision of the side shield drawings to eliminate the water filled moat and to substitute movable lead doors has been completed.

A revision to change from a once-through cooling system for the top and bottom shield to a recirculating cooling system has been prepared and approved.

Fuel Element Examination Facility. Four bids were received for the design and construction of the Primary Manipulator. The apparent low bidder is the W. F. and John Barnes Company.

Load Out Equipment. A comment issue of the design criteria was completed. Preparation of the final issue, including scope drawings, was started.

Plutonium Fabrication Pilot Plant

Phase II Construction. Completion of Phase II construction is estimated at 77% compared with 86% scheduled. It appears that Hoffman Construction Company's request for a time extension of 14 days, based on alleged delays as a result of removing a design "hold" on certain floor exhaust filter boxes, will be granted.

The appearance of the chemical-resistant coating application in Room 132, the swage room, is poor. Inspection has shown a number of non-decontaminable defects, some of which have been corrected.

Phase III Construction. George Grant Company was awarded the Phase III contract with a bid of $287,800.

Procurement. Procurement status may be summarized as follows:

41 purchase orders and one design contract have been placed, totaling	$ 734,000
7 requisitions are in bidding, estimated at	291,000
1 requisition is being prepared, estimated at	150,000
Total	$1,175,000

Requisitions for the sintering furnaces and accessories were prepared and processed.

Scope. Hooding for the 20-inch rolling mill and the 1250-ton extrusion press was deleted from the project scope.

A neutron burst radiation detection system for the PFPP was added to the scope. A scope revision to include an etching facility has been requested.

Phase III Design. Design revisions to the gamma absorptiometer for the oxide line were completed, changing this instrument from an ionization chamber detector to a scintillation detector.

Installation drawings for the 20-inch rolling mill and the 1250-ton extrusion press are scheduled for July, after receipt of vendor designs for these large equipment pieces.

2. BASIC SWELLING STUDIES PROGRAM

Mechanisms and Theory. Optical and electron microscopy afford a direct physical means for studying certain aspects of swelling, namely, the number and size of pores in uranium. Holes with diameters between 0.1 and 0.5 micron have been detected in the longitudinal section of the cap end of a rod irradiated at approximately 400 C to a burnup of 0.2 a/o, from which specimens will be subjected to post-annealing studies. Micrographs from a vertical and horizontal traverse of the cap section are being analyzed for changes in the size and number of bubble holes as a function of distance from the cap and cladding. A longitudinal section of a coaxial fuel specimen in which the inner member had attained temperatures near the melting point has been examined for bubble sizes. Large bubbles with diameters as great as 40 microns were present in the hottest regions and their size decreased to 0.5 micron in the cooler regions. As many small 0.5 micron diameter holes were found in the hottest region as in the cooler region.

Diffusion of gaseous fission products through the uranium lattice is important in both the rate of formation and the rate of gas pressure increase in pores. Studies of the diffusion of xenon through uranium are therefore being made. Design modifications of equipment for these studies have been completed and submitted to Technical Shops for fabrication.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility. Comment issues of all sections of the design criteria and of scope drawings were issued and reviewed during the month.

In order to assure adequate protection to the aluminum shroud tube surrounding the in-reactor test section of the loop, it will be necessary to provide a flow of coolant gas in the annulus surrounding the test section. Preliminary studies indicate that it is feasible to utilize the helium gas between the shroud tube and the test section as the coolant, without providing an additional cooling annulus. Scope design is proceeding on this basis. A blower and heat exchanger has been added to the loop equipment to circulate the helium through the annulus.

The gas loop was initially scoped to have an outlet gas temperature of 1100 F. With the trend in gas cooled reactors towards higher temperatures, the feasibility of increasing the gas loop outlet temperature was investigated. By using Inconel-X in the heat exchangers, in-reactor test section and outlet piping, it appears likely that a 1500 F outlet gas temperature may be attained. The maximum pressure of 500 psi and flow of 15,000 pounds of carbon dioxide per hour remain unchanged. The test section running through the reactor will consist of two concentric Inconel-X tubes with the annular gas space providing thermal insulation. Flow in the vertical test section will be from top to bottom of the reactor through the inner three-inch (ID) tube. Methods of providing gas coolant flow in the annular space between the outer Inconel-X tube and the aluminum shroud tube of the reactor are being investigated. Preparation of design criteria and scope drawings by the Design Development Operation is in progress.

Gamma Irradiation Facility. Gas-graphite reactions are accelerated by gamma radiation. For example, oxidizing gases (CO_2, O_2, H_2O) react with graphite at room temperature when ionized and excited in a gamma field. As the temperature increases to the point where thermal reaction rates become significant, radiation-activated and thermally-activated reactions both become important. This is often the temperature range in which a reactor coolant is expected to serve. The effect on the reaction rate of temperature, pressure, radiation intensity, sample geometry, flow rate, and nature of the graphite is relatively unknown in this temperature range for prospective coolants. The construction of an irradiation facility for the study of some of these variables has been started. The facility will be located in the 3730 Building and will consist of a 14-foot deep, seven-foot diameter tank below the floor, with a 42-inch high restraining wall above the floor level. A 15,000 curie cobalt-60 gamma source in the form of nine-inch long stainless steel clad rods will be placed at the bottom of the water-filled tank. This will provide a much needed, flexible, high level irradiation facility for the gas-graphite studies.

Graphite Oxidation Studies. Weight loss studies of graphite oxidized in CO_2 at various temperatures are being continued. Attention has been turned to CSF graphite, and the first sample has been oxidized at 700 C for 715 hours to a total loss of 0.87 percent of original graphite weight. The linear portion of the weight loss curve showed a loss of 6.78×10^{-6} gm/gm hr.

Present weight loss studies of KC graphite were terminated with compression strength measurements. Each two-inch long by 0.42-inch diameter cylinder was cut into two one-inch lengths and the ends were polished. Similar samples were prepared from associated unoxidized specimens of KC graphite, and all samples were tested under the same conditions of crosshead speed. For the unoxidized samples of KC graphite of this size the average break-point strength was 3,955 pounds per square inch. This was decreased by about 6.5 percent for each percent weight loss by oxidation which compares favorably with published results (HW-42498) of studies of graphite oxidation by oxygen.

Testing Methods for Coated Graphites. A necessary condition for the measurement of the properties of any material is the development of adequate testing methods. Silicon carbide, as applied to graphite, is dependent on several factors for its effectiveness as a protective coating. The surface of the coating must be continuous and without cracks. The carbide-to-graphite bond must be strong and relatively free from strain effects under thermal cycling stress. For nuclear applications the coating must be resistant to radiation damage and undergo no major physical change up to 1000 C in an oxidizing atmosphere. Development of methods for measuring these conditional properties are under investigation. The progress to date is listed below along with discussions of the expected methods of approach.

1. Visual inspection and micro-photography: The first inspection of the coated material will include examination for gross defects and stereo-photography for characterization of surface defects.

2. Heat stability: This test has been tried on some samples of coated material from the National Carbon Company and will be used on all other coatings as they are received. The sample is placed in a quartz tube and heated for five hours at 1000 C in a helium atmosphere. Physical dimensions and weight changes of the sample are determined until the sample reaches a stable condition. Any visual change in the condition of the sample is noted.

3. Thermal cycling: A tentative test has been devised to measure the effects of thermal cycling. A coated graphite sample was placed in a quartz tube and heated by induction using a Lepel induction furnace. The conditions of the test were such that the sample changed from room temperature to 900 C in 15 seconds. The coating appeared continuous except for two regions where

rapid expansion of absorbed gases ruptured the graphite body. Although this test is more stringent than would be required, it appears that, under controlled conditions, it will provide a good method for measuring the silicon carbide-to-graphite bonding strength.

4. Oxidation resistance: Equipment is being constructed for measuring the oxidation resistance of the carbide. The method of approach is the same as is being presently used for graphite oxidation work.

5. Other tests: It is expected that other tests to determine nuclear purity, gas permeability, and radiation damage changes will have to be developed in the future.

D. CUSTOMER WORK

Radiometallurgical Examinations

I & E Hole Failure - 2582-C (RM-249). Another I & E enriched fuel element from Tube 2582-C was examined as a "near failure". Examination of wafers cut from the element has shown that the inner spire was corroded over an axial length of about two inches, but only on one-half of the spire. The corrosion area starts about 1-1/4 inches from the female end of the element. Wafers taken from both extremes of the corroded area revealed the presence of a large water channel in the AlSi layer. Detailed examination of the wafer closest to the female end showed that the braze layer around the spire had broken away from the uranium core and that this separation extends almost completely around the spire. Also, a possible tearing type crack in the jacket was seen in the center of the corrosion area. Examination of this element is continuing.

Examination of Depleted Uranium (RM-253). Examination of the female cap from 253-D, an I & E element from PT-IP-132-AC, which had suffered an internal tube rupture half way down the element, has revealed the probable water entry site. At a point just below the outer weld bead, a welding gas bubble was found with a pin-hole penetration of the can wall at that point. The temperatures of the aluminum can wall and cap at this point were quite high, since the AlSi is almost completely diffused into the can wall and cap, and the grain structure surrounding the gas bubble is both columnar and of very large size. The underside of the cap shows a water channel lying in the AlSi layer. The water channel had previously been traced up the spire from the rupture area to the female cap.

Metallography Laboratories

Uranium canned in zirconium or coupled with zirconium is difficult to macroetch. The effect of the zirconium is to alter the etching characteristics of uranium in such a way as to make it extremely difficult to delineate the desired macrostructure. A modified bright-field macro-

etch was devised which will reveal the grains and flow lines in the uranium and alleviate the difficulties encountered previously.

A procedure has been established for polishing both the unirradiated and irradiated samples for the KAPL program. The activity of the irradiated samples although of a relatively low level calls for a minimum of exposure time for the operator. The time limit is provided for by maximum utilization of a Syntron vibratory polishing machine in which no operator contact is needed during the polishing sequences, and the specimen is shielded by a sample holder.

Samples Processed During the Month

Total samples processed: 271

Photographs:

Micrographs	240
Macrographs	79
Total	319

F. W. McCullough

Manager, Reactor and Fuels Research
and Development

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
WS Kelly	2/3-7	Philo Plant #6, Ohio Power Co., Zanesville, O.	Discuss high pressure piping technology.	J Struick J Clever	No
		Babcock & Wilcox, Alliance, O.	"	CE Jones	No
		EBWR, ANL, Lemont, Ill.	Discuss fuel element handling problems.	E Wimunc	No
JC Fox	2/4	Philo Plant #6, Ohio Power Co., Zanesville, O.	Discuss high pressure steam technology	J Struick J Clever	No
	2/5	Babcock & Wilcox, Alliance, O.	"	CE Jones	No
	2/6	Dravo Corp., Marietta, O.	Discuss PRTR ring header fabrication.	EJ Kunsman	No
	2/12	Willamette Iron & Steel, Portland, Ore.	Discuss PRTR fuel handler fabrication.	A Kitchen	No
EE Utz	2/7-14	Tech. Measurement Corp., North Haven, Conn.	Observe initial setup & debugging procedure of 100-channel analyzer.	GR Utting	No
NG Wittenbrock	2/2-3	BMI, Columbus, O.	Discuss R&D contract.	AW Lemmon C Alexander	Yes
	2/4	Philo Plant #6, Ohio Power Co., Zanesville, O.	Discuss supercritical steam generating plant	J Struick J Clever R Bailey	No
DE Rasmussen	2/2	Barnes Eng. Co., Stamford, Conn.	Consult on PRTR oil detection problems.	SN Bobo H Miserocchi D Galonska	No
	2/3	Saginaw Steering Gear Div., Saginaw, Mich.	Consult on shim controls.	Mr. Metzger	
	2/4	Amer.Elec.Power Sys., Philo #6, Zanesville, O.	Consult on supercritical studies.	Mr. Streiker J Struick	No
	2/5	Babcock & Wilcox, Alliance, O.	"	CE Jones R Jager	No
	2/6	ANL, Lemont, Ill.	Consult on PRTR shim control problems.	J McMillan	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
LG Merker	2/18	Steel Products Co., Seattle, Wn.	Consult with vendor (PFPP)	SD White	No
		Van Vetter Co., Seattle, Wn.	"	--	No
HE Hanthorn	2/4-5	Northwest Copper Works, Portland, Ore.	"	O Garrison	No
RM Fryar	2/1-7	Stoakes Vacuum, Philadelphia, Pa. Fenn Mfg. Co., Hartford, Conn. Industrial Proc. Eng., Newark, N.J. NW Copper Works, Portland, Ore.	PFPP vendor contracts.	--	No
JE Minor DC Kaulitz JM Davidson	2/2-3	GE Hotpoint Div., Chicago, Ill.	Attend MTR-ETR users' meeting.	T Glasson-KAPL J Provost-ANP	No
JE Minor	2/4-5	BMI, Columbus, O.	Discuss hot cell facilities.	FR Shober	Yes
DC Kaulitz	2/4	Gertner Scientific Co., Chicago, Ill.	Discuss underwater examination equipment.	L Higgins	No
GS Allison JP Pilger	2/9	Buckner Weatherby Co., Seattle, Wn.	Investigate the Jaypax process.	J McCullough	No
DC Kaulitz	2/10-12	AEC-IOO & Phillips Pet.Co., Idaho Falls, Ida.	Consult on reapir of 3x3 facility.	R Neidner	Yes
TT Claudson FE Young	2/16-18	"	Inspect experimental fuel elements & assembly of elements into ETR 3x3 basket.	R Neidner	Yes
PA Ard	2/11	East Side Tool & Dye Wks., Portlane, Ore.	Observe assembly of extrusion press container block.	TL Stoudt	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
SH Bush RD Nelson TC Nelson	2/15-17	AIME Annual Meeting San Francisco, Calif.	Attend meeting. Present paper. Attend meeting.	--	No
SH Bush	2/18	APED & Vallecitos Lab., San Jose & Pleasanton, Calif.	Contacts re heat treatment of uranium	EW O'Rorke AN Holden	No
TT Claudson	2/19	Oregon Metallurgical Corp., Albany, Ore.	Inspect fuel element components.	W Aschoff	No
DR Stenquist	2/19	W.B. Edmiston & Sons, Inc., Yakima, Wn.	Inspect swage-feeding device.	WB Edmiston	No
RJ Lobsinger	2/13	APED, San Jose, Calif.	Discuss details of test to be run for HAPO.	WL Pearl	No
JA Ayres	2/17	GE - Schenectady	Attend Corrosion Symposium & present paper.	RT Foley	No
JW Riches	2/16-20	Tube Reducing Corp., Wallingford, N.J.	Consult on zirconium fabrication.	EH Fisher	No
JH Rector WB Weihermiller	2/2-3	UCRL, Livermore, Calif.	Attend gaging meeting.	M Harris	Yes
RK Koler TD Chikalla	2/5-15	Kux Machine Co., Chicago, Ill. ANL, Lemont, Ill.	Supervise die casting development program. Discuss fabrication problems.	JJ Kux AB Shuck	No Yes
AA Zoutte	2/8-10	Crucible Steel Corp., Pittsburgh, Pa. Wright Dev. Center, Dayton, O.	Discuss internal friction. "	Dr. Church EJ Myers	No No

UNCLASSIFIED

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
YB Katayama	2/9-10 2/16-17	UCRL, Livermore, Calif. Dow Chemical Co., Denver, Colo.	Discuss corrosion problems. "	WJ Ramsey JF Willging JV Welsh	Yes Yes
RD Nelson	2/18-20	Stanford University, Palo Alto, Calif.	Discuss metallurgy problems.	Consulting professors	No
TC Nelson	2/18-20	U. of California, Berkeley, Calif.	"	"	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
A Holt	2/3	WAPD, Pittsburgh, Pa.	Discuss PRTR.	WA Burns DJ Foley H Harty	No	700, 760
WD Buckley	2/10	Perry Institute, Yakima, Wn.	Discuss forming processes.	LJ Chockie RJ Anicetti	No	300, 325, 326
FW DeMoney	2/10	Kaiser Aluminum, Spokane, Wn.	Review of physical testing procedures.	LJ Chockie	No	300, 325, 326, 327
WC Paynton AR Matheson	2/11-12	Metals & Controls, Attleboro, Mass.	Discuss fabrication, design & testing of nuclear fuel elements.	JJ Cadwell SH Bush JE Minor	Yes	300, 303; 700; 100-K, 105-KE
J Tolin G Garfield	2/17	Res.Welding & Eng., Compton, Calif.	Discuss welding contract.	JJ Cadwell JE Minor DC Kaulitz	No	300, 326
JD Rogers	2/23-25	Philips Elec.Corp., San Francisco	Service electron microscope.	B Mastel	No	300, 326

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
RA Meyer D Schweitzer D Gurinsky W Kosiba	2/10-11	BNL, Upton, N.Y. " Gen. Atomics, San Diego, Calif.	Discuss gas-graphite reactions & radiation damage effects.	RE Nightingale DE Baker EM Woodruff FW Woodfield	Yes	300, 326
F Shober	2/11	BMI, Columbus, O.	Assistance to Hanford graphite work.	RE Nightingale WA Snyder EM Woodruff	Yes	300, 326
RW Fuller	2/18	duPont Co., Los Angeles, Calif.	Unclassified engineering	R Harrington RR Henderson	No	300, 326
CWJ Wende	2/3	duPont Co., Savannah River Plant	Discuss reactor R&D.	FW Albaugh FW Woodfield JA Ayres JM Batch	Yes	300, 325, 328, 306, 305-B; 100-K, 1706-KE; 100-D, 1707
			Discuss trans-Pu & Palm fabrication.	OJ Wick ID Thomas	"	200-W, 231-Z, 2704-Z
WR Hibbard	2/11	GERL, Schenectady	Discuss alloy development programs.	FW Albaugh FW Woodfield JJ Cadwell OJ Wick	Yes	300, 328, 325, 306; 100-K, KER; 200-W, 231-Z
A Werner B Ashworth	2/3	UCRL, Livermore, Calif.	Discuss fabrication facilities.	OJ Wick RW Stewart	Yes	200-W, 231-Z, 2704-Z
S Dickerson	2/10	BMI, Columbus, O.	Discuss Pu fabrication facilities & radiation protection.	OJ Wick ID Thomas RW Stewart	No	200-W, 2704-Z

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

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FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety in the Fuels Preparation Department

At the request of FPD, nuclear safety for the off-site shipment of 1.60% U^{235} washers (2500 lbs.) was studied. This is about a factor of 4 greater than the minimum critical mass for fuels of this enrichment. This material is to be shipped by commercial rail transportation with the normal freight car loadings. It was determined that the total number of washers can be shipped in one shipment (2 boxes) under the following conditions:

1. The washers are placed in iron tubes (2-inch I.D. x 1/4-inch wall thickness).

2. The tubes of washers are packed in two boxes, 12 inches x 12 inches x 7 feet. The 12-inch dimension is a maximum; the 7-foot dimension was set as the maximum length box the railroad company would take.

3. The box of fuel should be centered in another container so that the distance between fuel box and outer shell is $\geq$ 12 inches (birdcage effect). The spacing between fuel pieces in the two adjacent boxes is then $\geq$ 24 inches.

The iron pipe used in this case was not evaluated for its poisoning properties.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

Experiments to obtain indirect information on the lattice neutron temperature have been conducted up to a graphite temperature of 640°C as reported in the preceding monthly report. The main effects which these experiments demonstrate are the effective increase in neutron temperature brought about by a highly absorbing fuel element and the effective decrease brought about by the insertion of cold, coolant water into the lattice cell. The results obtained indicate an increase in the neutron temperature in a fuel element on loss of cooling water when graphite temperatures are in the range 100-500°C. The uncooled slug has a higher effective temperature than the graphite throughout this range, while the cooled slug has an effective temperature approximating that of the graphite.

Blocking Effect of Coolant

The neutron blocking effect of the coolant has been measured for a single column of 8-inch fuel elements in a thermal column with a graphite temperature of 677°K. The tube block temperature was 584°K. The data shown below are the ratio of the average activity of the 4 manganese foils mounted on the process tube to the average of the 4 manganese foils mounted on an 8-inch natural uranium fuel element. 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 Mn Foil Activity	Case	Temp.
1.047 ± 1/2%	Dry	677°K
1.180 ± 1/2%	H_2O Cooled	677°K

Thermal Neutron Flux in a Medium with a Temperature Discontinuity

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. These geometries are (a) a slab of width w at temperature T_1 embedded in a medium at temperature T_2 and (b) a cylinder of radius R at temperature T_1 surrounded by a medium at temperature T_2.

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

The spatial dependence of the thermal activity of a 1/v detector in the vicinity of a temperature discontinuity has been experimentally determined, as reported previously. Traverses were obtained for a range of temperature differences. Attempts have been made to fit these experimental curves with a simple diffusion theory, which employs a transfer cross section for neutron exchange between the equilibrium neutron energy distributions of the two regions. Calculations completed this past month for each temperature difference consistently indicate a much smaller transfer cross section than was originally expected. Interpretation of this result will not be made until the calculations are extended to smaller cross sections.

Preparation of data with smaller transfer cross sections has been completed and delivered to the 709 computer people for machine computation of additional activity traverses.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for 2.5-inch Fuel Elements

Measurements of material bucklings of lattices with 2.5-inch solid fuel elements are listed below:

[redacted]

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Lattice Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios Al/U	H_2O/U	C/U
8 3/8" dry	- 234	0.185	--	12.67
8 3/8" wet	- 90	0.185	0.403	12.67
10 3/8" dry	+ 28.5	0.185	--	20.31
10 3/8" wet	- 3	0.185	0.403	20.31

Buckling values are tentative using an assumed extrapolation distance, λ, of 1.66 inches. Horizontal traverses to determine actual λ's are not yet analyzed. Final bucklings can be quoted when this analysis is complete. The approximate crossover lattice spacing is 9.8 inches with a carbon-to-uranium volume ratio of 17.95.

Extrapolation Distance Study

In the pile with 1.92-inch elements in an 8 3/8-inch lattice, a special horizontal traverse was taken with several counting slots in addition to the usual slots between process tubes. This row of slots was placed in the filler layer, and thus represented a traverse along the edge of the lattice cells with many points available to fit the horizontal cosine flux varation. This traverse will allow a more accurate determination of λ because of the additional data available for fitting. The fine structure of the flux along the edge of the cell was calculated according to the method of Cohen (NSE, 1, 268, 1956). The resulting flux variation is

$$\phi = \left[\cos \frac{\pi x}{2W}\right]\left[1.064 + 0.064 \cos \frac{\pi x}{l}\right]$$

where W is the effective pile half-width and l is the half lattice spacing. The fine structure correction ($0.064 \cos \frac{\pi x}{l}$) appears to be too large according to the actual experimental traverse. Although the fit is not very sensitive to this correction, a better fit is made with a coefficient of from 0.03 to 0.05.

PCTR Measurements of k_∞ and f of Selected Cluster Elements

From PCTR measurements the "1/v" thermal utilizations, f, and k_∞ with water coolant have been determined for a 7-rod cluster of natural uranium rods of 0.924-inch diameter in a 10 1/2-inch graphite lattice. A preliminary value of k_∞ with water coolant is 0.998 ± 0.002. The values of f are 0.867 with water coolant and 0.938 with air coolant. The volume ratios of graphite, aluminum, and water-to-uranium were 21.99, 0.354, and 0.668, respectively.

The fuel rods were 7.648 inches in length interrupted by aluminum spacers 0.4 inch in length. Inasmuch as the rise of the average flux in the outer rod is about 25% at the end of the fuel piece, it is worthwhile to compare the results of various approaches to the calculation of f.

The first line in the table below gives the "real" utilization, using observed fluxes in the uranium and spacers. The second line is that calculated when the approximations are made that there is no axial flux rise in the fuel and the flux in the spacer is that of the rod jacket. The third line is appropriate to an assembly in which neither the spacers nor supporting polyethylene spiders exist. The fourth decimal is retained for accuracy in the comparison only.

THERMAL UTILIZATIONS OF 7-ROD CLUSTERS

	Air Coolant	Water Coolant
Actual, with spacers	0.9375	0.8670
Neglecting flux rises	0.9369	0.8653
Without spacers	0.9429	0.8729

The approximation of line 2 is then very good (0.2% or less) compared to an over-all uncertainty of one or two percent in the theoretical calculation of f for cluster geometries.

It is likewise interesting to compare observed flux ratios (away from the slug ends) with those calculated by applying the P_3 approximation to the cylindricized fuel assembly, as given below.

		Air Coolant	Water Coolant
$\left(\frac{\phi_{\text{inner rod}}}{\phi_{\text{outer rod}}}\right)_U$	Observed	0.764	0.626
	P_3	0.628	0.635
$\left(\frac{\phi_{\text{inner region}}}{\phi_{\text{outer region}}}\right)_{H_2O}$	Observed		0.458
	P_3		0.394

It is thus seen that with air coolant, the cylindrical approximation underestimates the flux in the center rod by neglecting the exposure through the gaps and regions of low uranium thickness. With the water-cooled assembly, this effect is not serious because of the blocking and absorption processes of the water in the actual geometry.

Coordinated Theoretical - Experimental Program

The available HAPO exponential pile data for solid natural uranium rods in dry graphite lattices has now been corrected for the aluminum content. These corrected buckling values will serve as reference data for calculations by various methods of the buckling of the simple system of bare natural uranium rods imbedded in a graphite moderator. Calculations using diffusion theory in the moderator and blackness boundary conditions at the fuel surface are now being made.

Intercalibration of Graphite Purity

The purity measurements obtained on the graphite bars from France and the United Kingdom have now been evaluated and compared with French and British measurements on the same graphite. A comparison has also been made between American and British measurements on American graphite. French measurements on American graphite have not yet been completed. The average 2200 m/s absorption cross sections obtained for the graphite samples involved are tabulated below. The measurements agree to within approximately one standard deviation (0.14 mb) in our measurements.

American graphite sent to United Kingdom

American value	3.82 mb.
British value	3.69 mb.

American graphite sent to France

American value	3.74 mb
French value	--

British graphite sent to USA

American value	4.04 mb
British value	3.94 mb

French graphite sent to USA

American value	3.77 mb
French value	3.60 mb

The listed results have been corrected for nitrogen absorption by the laboratory which performed the measurements.

New Production Reactor Nuclear Safety

Nuclear safety criteria for use in the design of casks and a storage facility for 0.95% U^{235} fuels (0.664-inch diameter rods) and for 1.50% U^{235} fuels (0.74-inch diameter rods) were determined. These criteria were discussed with the Process Design Operation (IPD).

Mechanism of Graphite Damage

Development continued of techniques for measuring energy loss of an electron beam in thin layers for application to the graphite radiation damage study. A system consisting of the electron beam calorimeter, the condenser-divider voltmeter, and the precision beam current integrator was used to measure energy loss in aluminum foils. The results were 5 to 10% higher than would be calculated from the Bethe-Bloch formula; the difference is assumed to be due to multiple scattering within the foils.

Instrumentation

A recording two-color pyrometer system for reactor temperature measurement is being assembled using readily available components as much as possible. The system is being put together to determine the temperature range and accuracy limitations attainable using CdS or lead sulfide photoresistors or photomultipliers as detectors. The equipment will also help determine the size of sight holes needed if the system can be applied to reactor temperature measurement.

The investigation of new neutron detectors continued with emphasis on solid state devices. A review is being made of the Westinghouse miniature solid state neutron detector. An attempt is being made to make them available for use at this plant.

Fabrication of the printed circuit boards containing circuitry for the input address logic and core drive for the simple computer using magnetic cores has been completed and are ready for assembly. These circuits are transistorized and each complete circuit is built on a separate board to permit plug-in units. This computer will be applied to a monitoring problem to demonstrate the use of magnetic cores as data storage elements.

Assistance is being given to the Equipment Development Operation in designing a scanning mechanism 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.

Assistance was given to the Equipment Development Operation in reviewing proposals and bids on a high-speed scanning system.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazard Specifications

Nuclear Safety in Hanford Laboratories Operation

Specifications for "Enriched Uranium Criticality Control" of the Chemical Development Operation have been approved. A number of questions on plutonium and plutonium alloy criticality have been submitted by members of the Plutonium Metallurgy Operation. A study was made to answer these questions; the results will be covered in a separate report.

Nuclear Safety in 234-5 Building Processing

Nuclear safety in the storage of plutonium metal in Vault 175 was investigated; CPD desires to store 288 Kg of metal in this room. Storage compartments are to be built on posts that are located throughout the vault. The center-to-center distance between posts is 15 inches. Five storage compartments are to be built on each post on 18-inch centers. These compartments are to be positioned on the adjacent posts so that the distance between centers of compartments will not be less than 18 inches. It was determined that 115 such compartments, each containing a maximum of 2.5 Kg plutonium metal, would be safe.

Plutonium Critical Mass Laboratory

The Project Proposal for the Critical Mass Laboratory (Project CG-731, Revision No. 3), HW-58618, was reviewed by the HOO-AEC and was transmitted to Washington, D. C., with recommendation for approval.

Approval was received from the Division of Production of the AEC for construction of the Plutonium Critical Mass Laboratory; however, the funds are to come from the FY-1960 Budget. There will be no funds available to initiate procurement of equipment or construction until Congress has approved the FY-1960 Budget. Based on past experience these funds are expected to become available in September of 1959.

An addendum is being prepared to the bid package for this project requesting the construction contractor to submit a bid on an alternate to substitute a concrete block control building in lieu of the Army mess hall.

Criticality Studies in Support of Processing Power Reactor Fuels

Criticality studies were continued in support of processing power reactor fuels with experimental work proceeding on both heterogeneous and homogeneous systems with 3 percent enriched uranium.

1. Experiments with Heterogeneous Systems

The first critical approach measurements were made with the 0.30-inch diameter rods of 3.063 percent enrichment. Multiplication measurements were completed for determining the critical mass of the small rods in cylindrical arrays with a fuel column length of 16 inches; the fuel rods were encased in lucite tubes; a hexagonal pattern was used for the lattices which were water moderated and totally water reflected. Measurements were made with four different lattice spacings; in each case the final loading contained about 96 percent of the critical mass for the cylindrical array as determined from the neutron multiplication curves during the critical approach. The results of these measurements are given below:

CRITICAL APPROACH EXPERIMENTS

(3.063 Percent Enriched Uranium, 0.300-inch Diameter Rods)

Spacing Between Rods in Inches (Hexagonal Lattice)	H_2O/U (Volume Ratio)	No. of Rods for Criticality (16-inch Fuel Column)	Critical Mass		Buckling (10^{-6} cm^{-2})
			Cylindrical Array	Spherical Array	
0.60	3.41	387.5	299 lbs.	274 lbs.	14,960
0.70	5.00	296.5	229	207	16,130
0.80	6.84	272.3	210	193	14,540
0.90	8.92	285.7	221	206	12,400

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The material bucklings and the critical masses for spherical geometry were calculated under the assumption that the values of the reflector savings as given in BNL-C-7592 would be applicable to these cases.

The minimum critical mass in spherical geometry is ~193 lbs. of uranium which occurs at an H_2O/U volume ratio of ~7. The maximum buckling is ~16,130 x 10^{-6} cm^{-2} for an H_2O/U volume ratio of ~5; thus, the smallest critical mass is obtained with an H_2O/U ratio of ~7 and the smallest critical volume with the ratio of ~5; the smallest critical volume contains more than the minimum critical mass. The minimum critical mass is shifting towards higher H_2O/U volume ratios with decreasing rod diameters.

2. Experiments with Homogeneous Systems

Measurements of k_∞ were made for 3 percent enriched UO_3-polyethylene moderated systems at H/U atomic ratios of 8, 10, and 12 and for water moderation at H/U atomic ratios of 7 and approximately 10.

A measurement of the fast effect (ϵ) is being made in the polyethylene moderated system at an H/U ratio of about 6.

Exponential Measurements with 1.25 Percent Enriched Uranium

Exponential experiments were continued with the 1.25 percent enriched uranium in water moderated heterogeneous systems. The fuel elements were 1.336 inches O.D., with a 0.500-inch I.D. and 7.5 inches length; the fuel elements were contained in aluminum tubes of 0.028-inch wall thickness. The buckling was determined for two different lattices with the fuel cores dry; the results are given below:

Separation Between Rods (inches)	H_2O/U (by volume)	Buckling (Fuel Cores Dry)
2.1	1.85	4955 x 10^{-6} cm^{-2}
2.2	2.16	4706 x 10^{-6} cm^{-2}

Previous measurements were made with the fuel cores wet in these lattices.

The Value of k_∞ for 2 Percent Enriched UF_4-Paraffin Mixture

Further analyses have been made of the data obtained from experiments conducted in January. The corrected value of k_∞ for the 2 percent enriched UF_4-paraffin mixture with the H/U^{235} atomic ratio of 195 is 1.206.

A preliminary error analysis gives a value of ± 0.010 as the standard deviation of the measured k_∞.

Oak Ridge Critical Mass Experiments and Mass Limit for E-Metal

Personnel of Oak Ridge National Laboratory have now completed several criticality measurements with 0.95% enriched fuel elements in a uniform array for

an H_2O/U volume ratio of 1.1; the critical mass was determined for two different cylinder heights.

The experiments which have been completed to date with uniform arrays have included critical mass determinations for two different H_2O/U volume ratios in a cylindrical array for various cylinder heights.

In addition to the above experiments, several different attempts have been made to obtain criticality with a random array of fuel elements in a mockup of a Hanford dissolver. In the most recent attempt a total of 18.7 tons of uranium were placed in the "dissolver" without reaching criticality. Further, it has not been possible to extrapolate these data to determine a good estimate for the critical mass in the random array. The experiments show only that the critical mass is greater than 18.7 tons; from the available data we cannot specify accurately how much greater this critical mass might be, nor is it advisable to continue these studies further at this time; final conclusions must be made with the data available.

We have reviewed the critical mass limits for the E-Metal in view of the most recent critical mass data from Oak Ridge. Since the Oak Ridge experiments are essentially complete, we expect to receive no further information which will affect these conclusions.

The results of the most recent measurements, which were made at the H_2O/U volume ratio of 1.1, are given below:

Array Height	Critical No. of Rods Cylindrical Array	Critical Mass
48 inches	589 (4712 slugs)	12.38 tons
42 inches	673 (4711 slugs)	12.38 tons

These data are of particular interest since the H_2O/U volume is close to that for the random array; these measurements were necessary in order to effectively compare the critical mass of the uniform array to that of a random array. The fact that the critical mass was essentially the same for the two different cylinder heights simply means the height corresponding to minimum critical mass would have had some value lying between the above two heights, i. e., in one case, the radius is too small, and in the other case, too large, to give the condition for minimum critical mass.

Our conclusions regarding the Oak Ridge experiments and a relevant technical discussion is given in HW-59301, Random Loading of E-Metal Dissolver, by N. Ketzlach.

The mass limit which is safe for double batching under the most hazardous conceivable conditions lies between 1.7 and 2.4 tons; if a uniform loading of the dissolver can be assured, the safe mass limit of 2.4 tons may be used.

Criticality Alarms

Some approximate calculations have been made of the thermal and nonthermal neutron leakage from subcritical spherical systems of plutonium in solution. The effect of both plutonium concentration and volume of sphere has been considered. The results show that the relative changes in thermal and nonthermal leakage are approximately the same for a given change in the system. The nonthermal leakage is several orders of magnitude greater than the thermal leakage, however. Leakage rates are calculated to increase by about a factor of 10 for an increase in system volume from 0.5 to 0.9 of its critical volume, relatively independent of plutonium concentration.

Two prototype nuclear incident alarms are being fabricated--expected completion is by March 1. Several photocells have been ordered for experimentation with these and NaI crystals as detectors to be used, probably, with transistorized circuitry with a chopped input. Some work was completed using phototransistor detectors. They were found to be too insensitive for the application where one r/hr trigger levels are required. Minimum trigger level for a phototransistor system and following transistor amplifier is about 25 to 50 r/hr.

Neutron Age Measurements

The asymptotic behavior of the various flux traverses obtained in the age experiment has been studied. The photoneutron background is in fair agreement with the Compton cross section. About 14 percent of the Compton-scattered photons remain above the deuterium photoneutron threshold. The neutron flux measurements indicate that only 5 percent remain effective in producing neutrons, or that some competing absorption process is present.

Mass Spectrometer for Plutonium Analyses

Progress toward putting the mass spectrometer for this program into operation has been confined to altering the electronic instrumentation according to the final design of components of the other mass spectrometer.

CROSS SECTION PROGRAM

Absolute Fission Cross Section for U^{235}

The resolving time characteristics of the beta-gamma coincidence counting arrangement which was used in the U^{235} fission cross-section measurement were re-examined. The pulse shaping circuits at the input of the coincidence analyzer were found to determine the beta and gamma circuit resolving times. These resolving times were used to recalculate the absolute activities of the gold foils used in the U^{235} fission cross-section measurement. An increase in the value of the U^{235} fission cross section of 0.4 percent was obtained.

Slow Neutron Scattering Cross Section of Water

Data taken this month included the completion of the study of the scattering of neutrons of 0.1 ev incident energy from a 30 mil thick, room temperature water sample. A similar study with 0.15 ev incident neutrons was

initiated. Such a study consists of the measurement of the scattered neutron spectra in the vicinity of the elastic peak at various scattering angles ϕ (5°, 10°, 20°, 30°, 45°), a measurement of the angular distribution of elastically scattered neutrons (5 to 85 degrees), and at least one vanadium spectrum for normalization purposes. An analysis of the 0.1 ev data reveals that the elastic component (as defined by Brockhouse) has an angular distribution which resembles (within statistics) the function

$$\frac{d\sigma}{d\Omega} = \text{const.} \exp\left[-Q^2 u^2\right]$$

$$\text{where } Q = \frac{4\pi}{\lambda} \sin\frac{\phi}{2}$$

$$u = 0.30\ A^{\circ} \pm 0.05\ A^{\circ}$$

Vanadium data has not yet been taken which would permit an absolute comparison of the 0.1 ev and 0.15 ev data.

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

Two 99.75-percent Pu^{240} fission foils and four 96.6-percent Pu^{241} fission foils have been mounted in a multiple plate gas ionization fission chamber for fission cross-section measurements. Measurements are presently being made in the region of 0.1 ev neutron energy.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Correlation of Data on Heavy Water Moderated Cluster Lattices

The calculations of the effects of the moderator-containing cans on values of k_{∞} measured in the PCTR were completed. The effect is estimated as not more than (1 ± 2) mk (1 mk = 10^{-3} in k_{∞}) for the lattices studied. The error estimate is based on the self-consistency of the calculations.

The can corrections did not prove sufficiently large to remove some inconsistencies in the PCTR-derived data, so values of k_{∞} and f were recalculated for all lattices studied, using a single set of cross sections. The recalculated results for (k_{∞}-1) were as much as ten percent different from those quoted previously. The reasons for the discrepancies were not immediately apparent in all cases but in several cases the differences were caused by interpretation of experiments designed to determine the containing can effects.

Mummery's[1] method of plotting ln k_{∞}/f versus the fuel-to-moderator volume ratio is being applied to the measured lattice parameters. This method gives, for the D_2O-cooled cluster of 19 UO_2 rods in an 8-inch lattice, a resonance

(1) Mummery, P. N., "The Experimental Basis of Lattice Calculations," A/CONF. 8/P/429 (Geneva, 1955).

escape probability of (0.873 ± 0.014). The value measured directly is (0.865 ± 0.009). The number of fission neutrons emitted per thermal neutron absorbed in fuel, η , is given as (1.321 ± 0.024). These calculations are still in progress.

Nuclear Safety in the Plutonium Recycle Program

A study of the nuclear safety in the storage and transportation of 1.8% Pu-Al PRTR fuel elements (7 rod clusters, 7'-4" long and containing a total of 270 grams Pu/cluster) was made. Drawings from the "New Fuel Storage Pit" (H-3-11078), "Fuel Transfer Storage Pit" (H-3-11097), the "Storage Basin" (H-3-11030) and for a fuel transfer cask have been reviewed. It was recommended that the present design of the Fuel Handling Equipment Extender (H-3-11096) be modified so that no two adjacent elements can be closer than 8 inches. In the present design one extender can overlap an adjacent one so that the corresponding clusters can be closer than 8 inches from each other.

Instrumentation

Fabrication of the warp measurement unit of the profilometer is 75% complete. Fabrication has begun on the diameter measuring unit. Design drawings have been completed but not checked on the eyepiece and camera section and focusing lens section. Work is now being done on the outer shell which protects the optics from moisture and acid spray.

About 50% of the design drawings for the wide-angle viewer are in the hands of the Technical Shops for estimating. About five drawings remain to be checked before submission to Technical Shops for estimates.

Assistance is being given to the Ceramic Fuels Development Operation in developing a method for determining thermal conductivity of materials by optical pyrometry. The thermal conductivity to total emissivity ratio has been determined for several graphite and UO_2 specimens. Measurement and calculation of the total emissivity is now in progress.

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

The enriched fuel pellets have been received at Hanford and will be moved to 305-B for storage and handling. The enriched foil material has also been received and is expected to be processed by Physical Metallurgy.

A study has been made to determine safe storage criteria for 1.8% U^{235} enriched UO_2 fuel elements. The following criteria should be followed to insure nuclear safety:

1. 250 pounds UO_2 can be handled independent of spacing.

2. An array of 250 pound units is safe if there are 3 feet between storage units.

3. Fuel element clusters, 7 elements/cluster, made from uranium oxide pellets may be stored in their graphite sleeves (4-inch O.D. x 3-inch I.D.) provided no other graphite is present in the storage array.

4. An infinite slab array $\leq$ 5.0 inches in thickness is safe filled with fuel element clusters containing the graphite sleeves mentioned in 3. above.

5. Another safe array may be stored perpendicular to this slab array at a minimum distance equal to the length of this array, or 5.0 feet away whichever is larger.

Theoretical PCTR Studies

The small source theory critical condition for an infinite, uniform array of similar fuel rods has been employed to predict values of thermal utilization for several lattice spacings. The results differ from experimental (PCTR) values by 1/3 to 1 percent, the error decreasing with increasing lattice spacing. This agreement supports the belief that increments in f can be calculated with reasonable accuracy, so that this small source theory formulation can be used as an alternative to the usual method of determining k_{∞} from PCTR measurements. The determination of the modified expressions when a control rod is present is now underway.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month with no unscheduled shutdowns. The first week of the month was scheduled for reactor improvement and calibration. The present series of k_{∞} measurements was completed on the 3% enriched $UO_3.H_2O$ system. The reactor was operated two shifts per day.

The reproducibility of period measurements following rod drops was checked during the month. Sixteen period measurements were made by two operators. The maximum variation from the average was $^{+\ 0.023}_{-\ 0.018}$ cents with a standard deviation of 0.012 cents. The results obtained by rod drops compares favorably with the results obtained by shutting the reactor down by use of the manually controlled rod (standard deviation of 0.013 cents). The values of rods 1 and 5 were measured from 0 to 4.166. Rod 1 was worth 52.3¢ and rod 5, 48.8¢, in the reactor loading used.

Experiments for the Lattice Neutron Temperature Study were conducted for two days in the TTR. Critical mass experiments were conducted during the remainder of the month.

There was one unscheduled scram during the month due to electronic failure in the log level amplifier (Ch. 3). Repairs have been completed.

A device to detect a cooling water failure was built and installed on the temperature controlled thermal column of the TTR. This instrument is a relay actuated by the current generated by a thermocouple. Water flow insufficient to remove the heat escaping from the thermal column is indicated by the ringing of a bell.

Automatic Counter - Design work on 5 of the 9 major circuits for the automatic counter has been completed. Four of these are ready for construction.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

A special study of the forecasting of conditions favorable for the dispersion experiments scheduled for this summer was accelerated during the past month. The most advanced statistical techniques available for objective forecast methods have been utilized in an attempt to set up a 12-hour forecast system which will be used as the primary tool in scheduling the experiments. This work, which is being done under AF and Biology and Medicine funds, constitutes a radical innovation in forecasting methods used at this site, and will provide a definitive test of these methods for this as well as other applications to local forecasting problems.

Research and Development efforts were again expended largely in preparations for the enlarged dispersion program scheduled for this summer. Equipment necessary for these experiments continued to arrive in large lots. The major item received during the month was fifteen towers on loan from the U. S. Army Signal Corps. These towers are to be erected on three symmetrical arcs within two miles of the Metecrology Tower. Facilities Engineering was given an Engineering Request to arrange for a lump-sum contract for the erection of these towers and five 100-foot poles.

Development of the automatic fluorescent pigment counters was continued by Instrument R and D, and the necessary work orders for fabrication of these counters on-site were issued. Bids for the disposable filter holders, of which 30,000 will be required, were received.

The needs of the Operation for additional space were partially fulfilled by occupancy of Building 622-F near 200-E, as a field service center, and by occupancy of Room 11, 2704-W Building, 200-W, as the Manager-Secretary offices.

Acquisition of personnel, vehicles, and radio equipment continued on schedule. FCC authorization to use radio frequency 36.5 mc for field communications was received.

DOSIMETRY

The supporting structure for the large NaI crystal used in the Shielded Personnel Monitoring Station was completed and has been very satisfactory. The resolution obtained with this large crystal and a 14" photomultiplier was 13%. With three 5" photomultipliers the resolution was slightly better and the K^{40} background peak was about one-half that with the 14". An array of seven 3" photomultipliers is now being tested. Resolution of 9.8% has been obtained. This is close to the best that is obtainable from NaI scintillation counters.

During background tests with one of the large crystal arrangements a spectrum characteristic of fallout was observed inside the iron door. Considerable dust was found inside the room. The dust apparently leaked around the filter system. When the room was thoroughly vacuumed, the background dropped to 1/3 to 1/2 of its original value. The addition of absolute filters to the main air conditioning system is planned and should eliminate most of the dust. The filters for the iron room will also be sealed better.

A plutonium-wound subject was re-examined after the appearance of two black specks in the wound. X-ray measurements indicated less than 0.8 mμc of plutonium left in the wound. The specks were removed and measured by alpha counting; 0.55 mμc was found.

A subject exposed to inhalation of mixed fission products was examined. No unusual activity was observed.

The positive ion Van de Graaff operated satisfactorily during the month. Semi-annual maintenance is now being performed. It was found that at least some of instability observed in recent months was due to sparking through pinholes in the belt and at points in the accelerator terminal. A new type of belt, one filled with metal staples, was installed.

A technique for detecting Na^{24} with equipment available in the Van de Graaff laboratory was worked out for possible use in the event of a nuclear accident. As an indication of sensitivity, 0.02 μc of Na^{24} in a gallon jug of reactor effluent water was detectable. For comparison, analysis of individuals exposed during the Oak Ridge incident indicated 48 μc of Na^{24} would be produced in a 70 kg man exposed to 139 rads of fast neutrons.

The neutrons/gm-sec and the average energy of the neutrons emitted from plutonium oxide and plutonium oxalate were measured with the double-moderator system to assist in planning protection measures in separations plants. A PuO_2 source weighing 627 grams gave a neutron yield of 9.9×10^4 neutrons/sec. A $Pu(C_2O_4).6H_2O$ source weighing 350 grams gave 2.8×10^4 neutrons/sec. Last month's data for plutonium chloride were analyzed and indicated that 25-30% of the neutrons came from the $Cl^{37}(\alpha, n)K^{40}$ reaction; the rest are fission neutrons.

The study of PuBe neutron sources indicated that about 25% of the neutrons emitted from the large source belonging to the Calibrations Operation are fission neutrons. The rest come from Be^9 (d,n) C^{12}.

Most of the parts for the precision long counters were fabricated and tested. Reproducibility between similar parts was generally very good. It will be necessary to modify some parts of the design to counteract plastic flow of the polyethylene. It was found that accurately machined polyethylene parts suffered considerable distortion while sitting in the shops for three months.

A rough theory was developed for the fluctuation phenomena to be expected in dosimetry problems. An immediate application was the estimation of the fluctuations to be expected in ion chambers, the size of pencils, exposed to 1 mrad total dose. For gamma rays the root-mean-square fluctuation was estimated to be about 1/3%; for neutrons, about 3%. These estimates are pertinent

in our development of low-dose measuring techniques.

INSTRUMENTATION

Investigation of cross-correlation techniques as applied to low-energy level detection has been renewed, and work is progressing along the lines of improved circuitry and improved detection of low-energy radiations.

The investigation of determining the efficiencies of various light-pipes continued with emphasis on beta-gamma detection. Beta-gamma probes will be evaluated for possible use in the Biology Operation.

The data for the pyrheliometer report were reviewed and analyzed carefully by use of a planimeter to compare actual values of sunlight averages with those obtained with the pyrheliometer integrator. Photographs of sections of the pyrheliometer record were obtained for inclusion in the report.

Eighteen of twenty-one radiotelemetering stations were calibrated and given final adjustments. Twelve stations have been installed in the field. The central station equipment is undergoing final check out. The repeater equipment appears to be faulty. The radio maintenance group will be asked to make repairs and adjustments.

Fabrication and assembly work is completed on the Scintillation Transistorized Alpha-Beta-Gamma Hand and Shoe Counter. Both the hand probes and shoe probes successfully passed the sensitivity and calibration tests. The alpha probes will indicate approximately twice background level for a 500 d/m Pu^{239} alpha source distributed over a four-inch by eight-inch area. The beta-gamma probes will indicate four to five times normal background level for a 15-millimicrocurie Ra D-E-F source distributed over a four-inch by eight-inch area. Both types of radiation are counted simultaneously for a 15-second period. The resultant sensitivities represent a 2:1 to 3:1 improvement over the present four-fold and five-fold counters. Further testing will be undertaken before the instrument is deemed ready for general use and demonstration.

A portable, battery-operated, radiation alarm was built using a GM-type instrument. The device is now being field tested. The instrument was demonstrated to a plantwide meeting of supervisors concerned with radiation monitoring.

The alpha scintillation transistorized a-c-operated poppy circuitry was modified to permit operation of air proportional-type alpha detecting probes for specific use at 234-5 Building. The modification included a higher voltage supply and a two-transistor impedance matching circuit. The proposed model will permit use of either a scintillation probe or an air proportional probe as desired by operating personnel. The air proportional probes are easier and less expensive to repair than are the scintillation probes; however, the scintillation probes have a better geometry and are not affected by temperature or humidity changes.

The Experimental Portable Dose-Rate Integrator was sent to the field for evaluation and the unit operated satisfactorily. The comments received were mostly about the size and weight of the instrument. These two factors will be reduced when a second model is fabricated. An internal report was issued on this instrument.

[redacted]

WASHINGTON DESIGNATED PROGRAM

Mass Spectrometer

The electron multiplier part of an RCA 6810 photomultiplier tube was installed as the ion detector in the mass spectrometer for this program. Further study of the pulse height distribution and the over-all efficiency of ion detection is needed; however, the basic soundness of ion counting detection instrumentation has been established.

The transistorized magnetic sweep current amplifier was fabricated, and a 112-turn sweep coil was installed on the mass spectrometer analyzer tube in the magnet gap. These parts of the magnetic sweep system were tested and found to operate satisfactorily. Circuits providing two-voltage functions, a special square wave and a triangular wave form, to drive the sweep amplifier were developed and are ready for final fabrication.

CUSTOMER WORK

Analog Computing

A single region xenon poisoning study has been made for the PRTR and a report issued, HW-59288.

A circuit has been designed and the necessary passive components ordered to do a six-region xenon poisoning study.

The Non-Destructive Testing Problem has been completed and a report on the solution is being prepared.

An effort was made to establish the general basic equation for the nitric acid recovery process. This consisted of matching the curves of the experimental data. Although the curves could be duplicated, the parameters were not consistent enough to make any valid predictions at this time.

The tape punch-reader unit on the DDA was out of order for a short period this month. A shaft bearing on the reader motor jammed, and, in addition, the punch unit began inserting unwanted zero's frequently. The machine shop replaced the bearing and the punch difficulty was isolated and corrected. At this time, both punch and reader seem to be operating satisfactorily.

An attempt was made to utilize the DDA to produce a direct phase plot of the real versus imaginary components of the ratio of output voltage to input voltage when the input voltage is operated upon by some specific transfer function. It was determined that this is possible, although it is somewhat impractical due to the excessive machine running time required.

A one-group, multi-region neutron diffusion problem was also attempted. This problem was successfully completed, and the DDA seems to provide a very satisfactory method of approach and solution.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	84	83.2
24-Hour General	56	80.4
Special	105	90.5

Precipitation, mostly in the form of snow, totaled 1.17 inches, which was nearly twice the normal amount for February. Temperatures averaged 35.5. This was exactly normal and broke a sequence of nine consecutive months of above normal temperatures.

Instrumentation

The probe design for a dual beta-gamma probe has been turned over to Technical Shops for fabrication and should be ready by the middle of April.

The fabrication of the Alpha Air Filter Monitor Detector was completed. The electronics portion will be tested here by field personnel before moving it to the field. It is expected that the 6655 phototube used in this unit will be less affected by neutrons than the previous model.

The Hog Thyroid Counter, of the Biology Operation, used for measuring I^{131} uptake in vivo, was again modified and tested to provide a more stable drift-free instrument. Complete temperature and input a-c voltage variation tests were made after the modifications were completed. The instrument was found to perform to an accuracy of approximately ± 2% (when adjusted to the I^{131} 364-Kev photopeak) for input a-c voltages from 95 VAC to 130 VAC and was found to have approximately the same error for a temperature range from + 40°F to + 110°F. These limits exceed the known voltage and temperature ranges by at least two to one. After testing, the equipment has been used two weeks with no drift and no troubles as far as is known.

The large shielded Dog Counter of the Biology Operation was recalibrated so that in vivo Pu^{239} counting of dogs can proceed. The added 30-ton low-level talc shield reduced the background counting rate by a factor of about five to one from its previous background level.

[redacted]

circuit was revised and has been tested with good results.

The routine Optical Shop work included the fabrication of 24 glass bearings, light-pipe and multiplier photocell units, a tool for the Jorgan Grinder for fabricating glass bearings, and seven other smaller jobs; the modification of the 105-C Fuel Inspection Facility Slit Camera, and a three-power periscope head; and the servicing of a large Lenox Borescope.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
A. Sheldon J. E. McCloskey	2/19	Electronics Associates, Inc. Los Angeles, Calif.	Consult on analog computer.	HH Burley WD Cameron PF Gast GR Taylor	No	300: 326

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
B. R. Leonard, Jr.	2/2-3	Brookhaven National Lab. Upton, N. Y.	Discuss neutron cross sections.	V. L. Sailor	No
J. T. Russell	2/12-13	University of Calif. Radiation Laboratory Berkeley, Calif.	Attend Symposium on Advances in Fast Pulse Techniques for Nuclear Counting.	Dick Mack	No

Chemical Research and Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Reactor Components

Testing of formulas and procedures for removing uranium dioxide and fission product contamination from scaled carbon and stainless steel coupons was continued during the month. These generally confirm the need for an oxidizing agent and strong complexing agents in the cleaning formulas. Modifications of the APACE process (hot alkaline potassium permanganate followed by hot ammonium citrate-versene) remain the most promising of the formulas studied. Over-all decontamination factors of 5000 and 1000 were obtained for stainless and carbon steel, respectively, after two hours of contact at 95 C with each solution. Low corrosion rates, less than 0.01 mil per cleaning cycle, have been obtained for both carbon and stainless steel. Reversing the order of use of the two solutions reduces the over-all decontamination obtained markedly.

In studies on the removal of UO_2 from scaled carbon and stainless steel coupons, carbonate-peroxide solutions were more effective than carbonate-permanganate which, in turn, was more effective than carbonate only.

Recovery of Scrap from Uranium-Zirconium Coextrusion Operations

A study of chemical problems associated with the recovery of scrap which will be produced in the uranium-zirconium coextrusion pilot plant has been started. Nitric acid dissolution of uranium from material representing fines produced in cutting operations produced no sensitized surfaces on the residues which could be exploded by mechanical shock or electrical sparking. Similarly, dissolution of the zirconium from the fines by NH_4F-NH_4NO_3 solutions followed by dissolution of the residue in nitric acid produced no explosive surfaces. Uranium loss to the NH_4F-NH_4NO_3 during zirconium dissolution is dependent on surface area of the uranium exposed, free fluoride concentration and exposure time. In six, three, and two molar ammonium fluoride containing 0.5 M ammonium nitrate, uranium dissolution rates over a 20 minute exposure period were 0.42, 0.11, and 0.009 $g/in^2/hr$, respectively. Further work will concern the amount of fluoride present following zirconium dissolution and corrosion problems during the subsequent uranium dissolution.

Uranium Oxidation and Fission Product Volatilization

Furnace configurations were studied to obtain optimum design for the forthcoming higher level uranium melting experiments. An insulating refractory, Norblack, proved to be the best insulation of several tried. Furnace designs permitting crucible enclosure in an airtight steel shell of small dimensions were successful, although it presently appears that the steel shell will require external cooling.

Experimental work on fission product release from low level irradiated uranium heated in air was continued. In these experiments, all of which were made at a furnace temperature of 1200 C and an air velocity of 500 cm/min, the fractions of several fission product isotopes released from the oxidizing metal were measured as a function of time. The efficiencies of various filter media to retain radioactive material were also determined. Iodine and tellurium volatilized at about a constant rate until the specimen was completely oxidized, at which time 80 per cent of the iodine and 75 per cent of the tellurium had escaped from the metal. Continued heating did not release more of these isotopes. Strontium, barium, cesium and ruthenium were emitted in about the same amounts regardless of time of heating; the average percentages released for these elements were 0.09, 0.07, 0.80 and 0.75 per cent, respectively. Filters removed about 75 per cent of the iodine, 95 per cent of the tellurium, 99 per cent of the ruthenium and 50 per cent of the strontium, barium and cesium.

300 Area Waste

Recommendations were made to Facilities Engineering Operation, HLO, that it will not be necessary to provide mechanical agitators on the new 340 waste system receiving tanks. The quite low dissolved salts and undissolved solids content of this stream should not result in appreciable sludge accumulation in these tanks.

Decontamination of Reactor Effluent

Cooperative engineering and chemical research studies to be conducted on the use of aluminum turnings to decontaminate reactor effluent were established or initiated. The studies, scheduled to be completed about May 1, 1959, will provide the necessary data to design, install and operate either a prototype or scaled-up facility in one of the reactor areas.

Analytical Services

Beginning next month, Ce^{144} and La^{140} concentrations in river and sanitary water will be reported regularly. Those isotopes are calculated from gamma energy spectra. Separation from interferences is achieved by fluoride precipitation, HCl dissolution, and TTA extraction prior to plating and counting.

Ba-La^{140} values are now being reported in support of the uranium oxidation - fission product volatilization study. Calculations from gamma spectra serve quantitatively to identify those isotopes. The data will be used along with Sr results as a measure of particle transfers should any occur during heating of irradiated uranium. Other isotopes being regularly reported are I^{131}, I^{133}, Te-I^{132}, Xe^{133}, Xe^{135}, Ru, and Cs.

Pu/U ratios were determined for four wafers of depleted, irradiated uranium. Coulometric titration was used to give an error of less than two per cent. Incidentally, daily uranium standardization of coulometer titrations showed a 0.6 precision at the 95 per cent confidence level over a two week period.

SEPARATION PROCESSES

Anion Exchange Processing of Recuplex Feed

The chemical feasibility of processing slag and crucible (Recuplex) feed by anion exchange was demonstrated in a test run with a laboratory-scale Permutit SK (20 - 50 mesh) column at 60 C. At a flow rate of 10 mg Pu/min,cm^2 average column loadings were, respectively, 35, 45, and 54 g Pu/l resin bed at breakthroughs of 0.1, 1, and 10 per cent, respectively. Data are not yet available on the product purity, but previous experience would indicate no difficulty in attaining acceptable purity by the anion exchange process.

The feed rate of 10 mg Pu/min,cm^2 in the 3-foot long column used in this run indicates that a loading rate in excess of 200 g Pu/hr should be attainable in a 6-inch diameter column 6-feet long. With the 20 to 50 mesh Permutit SK resin, pressure drop even with the high salt slag and crucible feed is nominal and a column length greater than 6-feet would be quite feasible.

Tritium Processes

A new technique has been devised for preparing the palladium absorption beds. Tetrachloropalladate ion is scrbed on an anion exchange resin which is then thermally decomposed to yield tiny spheres of carbon containing dispersed palladium.

Reduction of Plutonium Oxide

Because of the obvious advantages entailed, a program has been started to investigate the direct reduction of plutonium oxide to the metal. Since past studies of the direct bomb reduction of plutonium oxide with calcium have not been fruitful, this approach will not be used. Instead, an approach suggested by the demonstrated reduction of $PuCl_3$ by magnesium in the KCl-$AlCl_3$-Al system was first examined. When PuO_2 was added to a molten system comprising Mg, Zn, $MgCl_2$, NaCl, and KCl and heated at 800 C for two hours, the resulting metal button contained 54 per cent of the initial plutonium. Of the remainder, 0.3 per cent was recovered as soluble chloride and 45 per cent as unreacted oxide (by difference). This result was very encouraging since the scale of operation was small, some oxide was observed on the walls of the tube after reaction and the oxide was prepared in a manner expected to leave it in a very refractory condition. Further experiments are needed to determine whether kinetics or thermodynamics limit the extent of reaction.

Analytical Services

Dowex-1 anion exchange resin was utilized to separate Zr + Nb from other interfering fission products for multichannel gamma counting. Quantitative recovery and adequate decontamination of the Zr + Nb was shown for Zr + Nb/FP activity ratios of 1:1000. The method consists of a hydroxide precipitation, dissolution of Zr + Nb in 1 M HF, loading upon the resin, and gamma counting the resin with the multichannel instrument.

Several new counting equipment calibrations were made as follows:

1. Radiochemical Analysis' three-inch well crystal was calibrated for Zr^{95}-Nb^{95}, Cs^{137}, Ru^{106}-Rh^{106}, and Ce^{144}-Pr^{144} to reduce the number of low-level samples requiring chemical separation. The sensitivity of the well crystal is about 50 times that of the present two-inch crystal and its associated mounting.

2. Pa^{233} values are being reported on an absolute basis for tracer studies. Calibration of the two-inch and three-inch crystals was made by standardizing the $Np^{237} \longrightarrow Pa^{233}$ equilibrium solution by alpha counting.

3. Counting efficiencies for 14 isotopes counted on the proportional beta counter have been summarized from data gathered during the past several months. A total of 22 tables has been issued, including efficiencies for isotopes counted in more than one sample configuration. These data have permitted counting several more RCAO sample types on the proportional beta counters.

Alpha and uranium measurements on soil (some 40 samples per month) will be based only on recovery of spiked uranium. Thus, the cost of plutonium spiking can be eliminated. Uranium spiking will serve to adjust both alpha values and uranium values themselves. Basing alpha adjustments on uranium recovery seems technically correct since uranium represents a minor part of the total alpha activity.

WASTE TREATMENT

Fluid Bed Waste Calcination

Argonne National Laboratory is presently performing scouting calcination studies on synthetic Purex 1WW in a six-inch fluid-bed waste calciner. To date, several runs each of approximately six hours duration at calcination temperatures of 350 and 400 C and a feed rate of about six liters/hour have been completed. The amount of fines formation has been comparable to that obtained with other feeds and has not constituted a problem in their equipment. The main problem encountered thus far is the formation of 1/8- to 1/4-inch diameter, frangible agglomerates. The agglomerates are suspected to be calcined particles bound together by incomplete calcination products, possibly sulfates or sodium nitrate. Decreasing the calcination temperature from 400 to 350 C magnified the problem. In an attempt to alleviate this problem, future runs will employ (1) higher calcination temperatures and (2) the possible use of a high-velocity air stream introduced at the calciner wall to break up the agglomerates.

Preliminary design for a pilot-scale fluid-bed calcination facility for treatment of Purex and/or Redox solvent extraction wastes has been completed. The calciner will be nominally eight-inches in diameter by about four-feet high surmounted by a twelve-inch diameter de-entrainment section. Electrical resistance heating will be used initially, with a total heat capacity of about 50 kilowatts at lower calcination temperatures. Off-gas auxiliaries will include a cyclone separator, a surface condenser, a packed scrubber, a packed glass fiber filter, and a jet exhauster.

Solid Waste Heat Generation Studies

Some of the "ultimate" waste storage schemes presently being considered involve the storage of calcined waste powders. To provide information on the heat transfer characteristics of such a self-heating system, studies have been initiated in experimental equipment installed in the 321 Building. Initial studies have been made using a four-inch diameter, 2-foot long cylindrical container packed with alumina powder. Heat is generated uniformly within the powder using 60 equally spaced Nichrome V wires installed parallel to the container axis. During the initial studies the effective thermal conductivity of the powder was calculated for various heat generation rates expected in a waste container. Values ranged from 0.23 to 0.30 Btu/hr/ft^2/°F/ft. Additional studies are planned on powders which might be produced from separations plant wastes.

Fixation of Purex Waste

The study of the melting point and solubility of a series of postulated 1WW compositions as a function of glass forming additives was extended to include borate-silicate (both ortho and meta) and phosphate-borate-silicate systems. The results to date indicate that phosphate alone is the additive of choice. Work is accordingly continuing on the determination of the detailed phase diagram and solubility behavior of the sodium-aluminum-iron phosphate system.

Observation Wells

Samples from monitoring wells in the BY crib area, two months after the wells were reperforated, reveal a definite two- to twenty-fold decrease in concentration of radioactive material. The observed ground water concentration in these wells is now correlative with gamma scintillation probe readings. Before reperforation this correlation was not evident. It is felt that these findings indicate unreliable monitoring performance by these wells prior to reperforation, probably as a result of corroded and plugged casing slots.

No significant change in the extent of ground water contamination was evident from current monitoring samples. (Gross contamination was found in mud samples from the Z-Plant ditch (up to 1.0 μc plutonium/gram) and from the Redox swamp (up to 0.1 μc gross beta emitters/gram).

The most probable paths of movement of ground water from the 200 Area waste disposal sites to the river were plotted on the basis of current water table contours. The permeabilities of sediments traversed by these paths were inferred from recent aquifer evaluation tests and stratigraphic data. The average travel time for ground water moving along this path was calculated to be about 150 years. This estimate should be interpreted with caution because actual movement in some strata may be much faster than this. Radioactive cations would be expected to move much slower than the water because of adsorption on soil surfaces.

Disposal to the Ground

Routing of about one thousand gallons per month of a slurried solution of filter-aid and sludge from the uranium oxide plant to the 216-U cribs via a settling tank was studied. It was concluded that this disposal method would be satisfactory providing infiltration capacity of the facility is not greatly reduced by the solids in the waste. Routine sampling of the waste was recommended along with periodic measurement of liquid levels in the facilities.

Plutonium Recovery from Recuplex Waste

The viscosity of CAW (Recuplex) waste was measured and compared to that of water at two temperatures. At 28 C the viscosity of waste is 1.23 centistokes (water, 0.85 centistokes), and at 60 C the viscosity of the waste is 0.73 centistokes (water, 0.54 centistokes).

The efficiency of various resins for removing plutonium from CAW waste was determined by equilibrium measurements at 60 C and compared with the efficiency measured at 28 C. The decreasing order of efficiency for the resins tested at 60 C was found to be: Dowex $1X^4$, Amberlite IRA 400 and 401, and Permutit SK, the same order as that at 28 C. In every case the higher temperature resulted in a more rapid attainment of equilibrium and a lower equilibrium distribution ratio than that found at the lower temperature.

An Amberlite IRA 400 column flowing at 0.5 $ml/cm^2/min$ received about 775 column volumes of CAW waste before reaching a 5 per cent breakthrough. At 11 $ml/cm^2/min$ a 5 per cent breakthrough was reached in about 40 column volumes. At similar flow rates, columns of Permutit SK, IRA 401 and Dowex $1X^4$ resin required, 7, 44, and 245 column volumes, respectively, to achieve a 5 per cent breakthrough. Batch elution experiments were performed with these resins by timing the desorption of plutonium from weighed samples. These experiments indicate the following ranking of the resins in decreasing order of relative speed of desorption: Permutit SK (fastest) Dowex $1X^4$, Amberlite IRA 401 and IRA 400 (slowest). An over-all evaluation of the resins tested on the basis of presently available data would indicate Dowex $1X^4$ to be the most suitable for recovery of Pu from CAW wastes.

Special Geological Studies

The need for a realistic appraisal of the damage potential of earthquakes at Hanford has culminated in a combined study by several Departments and the Hanford Laboratories. Frank Neumann, CPD seismologist-consultant of the University of Washington, recommended in addition to short-term studies a long-term instrumental data collecting period, the results from which will be closely coordinated to geologic data.

The Midland Drilling Company, pioneering in the use of a drive barrel for well drilling, has in their current drilling program consistently procured better and more representative samples of typical Hanford sediments than can be normally obtained by use of hard rock bits and bailers, routinely used in the past at

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Hanford. Procurement of the unbroken samples uncontaminated by added drilling water permits significantly better data to be obtained from the samples than from those obtained by normal procedures, hence routine use of the method appears desirable.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Multicurie Cell Investigations

Analyses have been completed on the recent multicurie cell anion exchange run which tested simultaneous recovery of neptunium and plutonium from Purex 1WW on a one liter scale. One-hundred-thirty column volumes of filtered 1WW were acidified to 7.5 M nitric acid, treated with 0.1 M sodium nitrite, loaded onto a Permutit SK 30-50 mesh resin at 15 ml/min/cm^2, washed with 20 column volumes of 8 M nitric acid at the same flow rate, and eluted with 20 column volumes of 0.6 M nitric acid at 2 ml/min/cm^2. About 25 per cent each of the neptunium and plutonium were not adsorbed (due to a too high flow rate) and three per cent was lost in the wash for a recovery of 70 to 75 per cent. The product was decontaminated from zirconium-niobium and cesium by a factor of over 1000 and from ruthenium and cerium by a factor of about 500. The recovery obtained in this experiment, although quite satisfactory, could doubtless be increased by loading and washing at slower rates. These results, and the lack of excessive degradation of the resin, lend confidence that similar results can be obtained in the plant.

Following the ion exchange run, the solution was partially neutralized to pH 1 and cerium recovery attempted by the sulfate process. Recovery was only 30 per cent, probably due to a too low pH or to insufficient digestion. The supernate was subsequently further neutralized to pH 2.1, digested for two hours at 90 C, and allowed to stand for three days at room temperature. Thirty milliliters of additional white crystalline precipitate was obtained. This is believed to contain the balance of the cerium and rare earths. The precipitate is being processed further for cerium isolation and for study of the separation of promethium from the other rare earths.

Recovery of Neptunium in Purex

Miniature mixer-settler runs were made to test a flowsheet, jointly developed with personnel of the Purex Technology Operation, CPD, and aimed at reducing the time cycle and costs for reworking Purex 3WB to recover the neptunium content. This flowsheet employs only the 2A and 2B columns. Oxidation with dichromate is employed to effect extraction of uranium, plutonium and neptunium(VI) in the 2A column. Hydrazine is introduced into the aqueous feed to the 2B column to enable reduction to neptunium(V) which can then be stripped away from the uranium and plutonium in the 2B column. The uranium and plutonium-bearing organic stream from the 2B column is recycled to the IBXF tank while the neptunium-bearing aqueous stream is recycled to the 2A column feed. As in earlier plant runs, continuous "spinning" of neptunium in the 2A and 2B columns on a total reflux flowsheet concludes the operation and provides additional fission product decontamination.

This flowsheet performed generally according to expectations in the room temperature Mini run, yielding a neptunium loss of about 0.5 per cent to the 2AW and about 3.5 per cent to the 2BW (organic waste from the 2B column). The observed loss to the 2BW was somewhat higher than expected and on the basis of exhaustive batch stripping contacts appears to be due at least in part to an irreversibly extracted "non-strippable" species of neptunium. For example, when the organic product from the 2A Mini unit was subjected to three successive batch stripping operations with a hydrazine-containing aqueous solution simulating the aqueous phase in the 2B system, the neptunium distribution coefficient (organic/aqueous) increased from 0.023 in the first contact to 0.07 in the second and 0.3 in the third contact. However, only 0.5 per cent of the initial neptunium remained in the organic after the third batch strip.

It is possible that this "non-strippable" neptunium is responsible for the otherwise inexplicable loss of neptunium which has been noted in the 2D column during normal plant operation, and which gives rise to the loss of neptunium to the 2EU.

IBN Contactor Studies

The "IBN Contactor" was given further attention during the month. In this approach the bulk of the Purex Plant neptunium inventory would be accumulated in a confined aqueous phase in a single-stage contactor which would be interposed between IBX and IC columns and would process the IBU continuously. Success in establishing such an internal "sink" for neptunium would reduce the inventory of neptunium elsewhere in the plant and would, therefore, reduce the probability of major losses through temporary upsets in the HA or 2D columns.

As in earlier studies, iron(III) was used to effect oxidation of the neptunium(IV) present in synthetic IBU to inextractable neptunium(V). It was found that the prospects for a successful "IBN contactor" are more favorable if the acidity of the IBU is reduced. Neptunium distribution coefficients were 0.009, 0.0045, and 0.0027 at aqueous phase acidities of, respectively, 0.5, 0.25, and 0.05 M HNO_3. A distribution coefficient of 0.001 would enable about one kilogram of neptunium to be held in 2000 gallons of aqueous phase in a IBN contactor without allowing neptunium concentrations in the remainder of the plant to rise above the "once-through" level.

Behavior of Nitrous Acid in Purex Systems

In the December, 1958, Progress Report, some preliminary data were given on the production of nitrous acid by radiolysis, rates of disappearance in aqueous solutions and on reactions with the organic phase. General studies of the nitrite-nitrate system have been continued. The more pertinent findings can be summarized as follows:

Nitrite determination by diazotization is a sensitive and sufficiently precise method for studies at low nitrite concentration. However, many procedures appearing in the project literature present pitfalls for the unwary. Concentration, reaction sequence and times, and the acidities must be considered.

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The distribution coefficient of nitrous acid between aqueous nitric acid and 30 per cent TBP in "Amsco 125" is in the range 25 to 30 at concentrations up to about 0.5 M HNO_3. At concentrations of HNO_3 greater than one molar the E_a^o value drops rapidly. Approximate values at 25 C are 20, 10, 6.5, and 3 for one, two, three, and five molar nitric acid, respectively. These values agree reasonably well with those previously determined at ORNL and by Buckingham at HAPO. Distribution coefficients at 50 C were about ten per cent lower than at 25 C. The distribution is not dependent on HNO_2 concentration in the range of 10^{-3} to 10^{-5} M.

The distribution was also studied as a function of TBP concentration in iso-octane. Six concentrations between 2 and 50 per cent TBP were used. The aqueous phase contained 0.1 M HNO_3 and 2.5×10^{-3} M HNO_2. The distribution followed the relation $\ln E_a^o = n \ln M_{TBP} + C$ with a value of $n = 1.08 \pm .06$, supporting the assumed 1:1 complex which hydrogen bonding would produce.

To verify the nature of the complex, infrared absorption was employed. Nitrous acid solutions in pure TBP were compared with TBP solutions of HNO_3, NO_2, N_2O_4, $UO_2(NO_3)_2$, and HCl. The shifts of the phosphoryl stretching frequency were $UO_2(NO_3)_2 > HNO_3 > HCl > HNO_2$. This shift is probably a direct measure of the strength of the hydrogen bond formed.

The high extraction of nitrous acid probably results from (1) favorable solubility parameters of the 1:1 complex in hydrocarbons and (2) the low ionization of nitrous acid and hence the high concentration of HNO_2 species in the aqueous phase. (The distribution coefficient of unionized nitric acid from 1 M nitric acid solution is calculated to be about ten, half that of HNO_2.)

High concentrations of nitrous acid in TBP do react slowly. Repeated stripping with 0.01 M NaOH solutions of the TBP solutions used for infrared studies gave a residue showing a spectrum identical to that of pure TBP except that a strong absorption at 6.1 microns remained. A similar absorption band appears in HNO_3, HNO_2, and in NO_2 and is due to the unsymmetric ON stretching vibration. At the present time it is not possible to say whether this material which is slowly washed out with caustic treatment is a compound containing the -O-N-O group or is TBP degraded in some other manner. The extent of the reaction is probably small, and a relatively concentrated solution of nitrous acid in TBP can be used as a "spike" to introduce nitrous acid into the solvent phase.

Distribution coefficients for nitrous acid in the Purex HA column were measured in a batch countercurrent run at 45 C. The measured coefficients were 3.0 in the scrub section, 2.3 at the feed stage, 3.2 in the first extraction stage below the feed stage, 4.8 in the next extraction stage, and 6.8 in the final (lower acid) extraction stage.

Fixed-Bed Ion Exchange Column Studies

Analysis of the experimental data from the annular column studies using sodium as a tracer indicates an increase of 30 per cent in the "holdback" as a result of the presence of the sulfamate-generated gas in the resin bed. (The term

"holdback", as used in describing flow through a packed, granular bed may be defined as a measure of the departure from ideal piston flow; e.g., H = 0 for piston flow and approaches unity for cases of extreme channeling or dead water.) These findings agree quite closely with the results of the 6-inch column studies using uranium as a tracer. The six-inch column data indicated the H.E.T.P. values to be increased by the presence of gas in the resin bed, from 5.5 to 7.2-inches; i.e., a 30 per cent increase.

Visual observation of the columns indicated the gassing to be considerably more severe in the six-inch column than in the annular column. This was attributed partly to wall effects and partly to the higher flow rate used in the six-inch column (ca. twice as great).

Fission Product Isolation and Packaging Prototype

The shop fabrication of the fission product packaging prototype is about 85 per cent complete. Process piping to the vessels installed in the 321-A Building is nearly complete. The calibration and preliminary testing of these vessels is planned to start early in March.

A report, HW-59265, "Fabrication of a Hastelloy B Steam Coil," was issued. This report summarizes the experimental work done in the fabrication of a steam coil for the Crystallizer Tank.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Spectrographic Analysis of General Samples

A spectrographic laboratory is called upon to analyze a large variety of samples for which it is prohibitively expensive to prepare the required calibrations generally needed for each type of sample. The samples may be oxides, salts, siliceous matter, carbonaceous matter, or mixtures of these. Because the sample composition markedly affects the spectral intensity for the elements, a so-called "general" procedure is often used for these miscellaneous samples. If the sample is mixed into a large, constant amount of a matrix material (oxide or salt) and subjected to the spectrographic arc, the emissivity of most elements will be, as a first approximation, characteristic of the matrix rather than the sample composition. Therefore, only one set of calibration standards will be required for a large variety of samples. The selection of the matrix, the mixture ratio, and the arcing conditions are all significant. Such a "general" spectrographic method has been set up in the 325 Building spectrographic laboratory. The basic parameters were selected after a literature search and scouting experimental work. The detailed method has been developed using a 1 to 3 mixture of germanium oxide and graphite as the matrix with a fixed amount of gallium oxide added for an internal standard. A stepped neutral filter (10 and 100 per cent) is used to split the spectrum, permitting an extension of the concentration ranges available on one exposure. Calibrations have been completed for 18 elements and the method gives a standard deviation of ± 15 per cent with an average error of about ± 20 per cent.

Determination of Plutonium and Neptunium in Process Wastes

A method based upon a mercury cathode electrolytic separation of interferences followed by a voltage scanning coulometric titration (derivative titration) has been developed and successfully applied to the determination of plutonium and neptunium in synthetic Purex HAW solutions. The detection limits are 2×10^{-6} molar for plutonium and 5×10^{-7} molar for neptunium, based upon titration of a 2.5 milliliter sample. The method is probably less attractive than the present radiochemical methods for normal laboratory use, but it is more adaptable for remote and automatic analyses. The method may be applicable to in-line analysis if further development leads to greater reliability.

EQUIPMENT AND MATERIALS

Evaluation of Curtisol (Curtiss-Wright Titanium Solder)

Lap joints of A-55 titanium soldered with Curtisol were exposed to synthetic solutions corresponding to Redox oxidizer, Redox waste concentrator, and Darex dissolver conditions. The solder showed very poor corrosion resistance to all of these solutions.

Canned Motor Pump

The titanium canned motor pump fabricated by Gaylord-Rives using the five horsepower General Engineering Laboratory design failed after 2000 hours water service. Pump examination revealed that the thrust faces of the carbon bearings had worn approximately 1/4-inch. Boron carbide is currently being evaluated as a replacement bearing material for the pump.

"Remote" Equipment for Plutonium Processing

A conceptual design was developed of an electrically operated mechanism which could be used in a "hot button" prototype for the transfer of crucibles from station-to-station in the reduction hoods.

A conceptual design was developed for a system which could be used for handling powder from the plutonium chloride reactor of a 234-5 hot button prototype. With the system developed, powder first passes through a powder seal into an inspection chamber where it is cooled. Good powder is then transferred through a second powder lock to further processing. Off-standard powder is pneumatically (CO_2) transferred back to the chloride reactor for reprocessing. Although the entire system has not been tested, preliminary studies have been completed to determine the CO_2 flow required for transfer of powder back to the chlorinator.

Plutonium Oxide Chlorinator

Another series of metals was exposed to a phosgene-air-water vapor mixture at 600 C simulating the atmosphere expected in a plutonium oxide chlorinator. The materials tested were Duralloy, A-55 titanium, zirconium, phosphor bronze, Tantalum, 312 stainless, Monel, 316 stainless, Hastelloy F, Chlorimet-2, and Nionel. Corrosion rates ranged from 700 to 2 mils/mo penetration in the order

given. Only Nionel showed better corrosion resistance to this environment than Hastelloy B or C which were recommended as a result of previous tests. Further evaluation of Nionel for this service will be made.

Corrosion of 304-L by Plutonium(III) Chloride

Samples of 304-L stainless steel were exposed, in contact with plutonium chloride powder, to air at dew points ranging from -20 C to +15 C. Corrosion rates based on preliminary examination of these samples were given in the December report (HW-58661-C). Further examination of the samples was made after better corrosion film removal. No measurable attack occurred at dew point -20 C. At dew points of -13 and -5 C, pitting attack of 0.2 to 0.3 mil/mo occurred. At dew point +5 C, intergranular attack at about 0.5 mil/mo occurred while at +15 C dew point, pitting and intergranular attack at two to three mils per month occurred.

Plutonium Oxalate Calciner Off-Gas Filter

A sintered stainless steel wire pencil-type filter was tested for possible use in filtering particles from the plutonium oxalate calciner off-gases. The filtration efficiency and backflushing characteristics of this filter element are considered adequate for 234-5 use.

The operating characteristics of the Selas ceramic pencil filter previously tested are presented in HW-59381, "Prototype Button Line Powder Traps," currently being issued.

PROCESS CONTROL DEVELOPMENT

Assistance to Chemical Processing Department

The Purex 2BP sampling system is being used to recirculate the 2BP stream to the 2AF tank (J-5) during Palm recovery operations. This eliminates changing canyon jumpers between normal and Palm recovery runs. However, inadequate flow rates are experienced when using this sample system as a process transfer line. The exact cause of the low flow rate is not known, but the jet used (S-3666 - BPF 7924) in the 2BP sampler appears to be limiting based on tests just completed in the 321 Building. A larger capacity jet will be tested in an attempt to obtain the desired flow rate.

Testing of the revised prototype dual jet sampling system for the Redox 1AFS stream is complete. The revised system delivers sufficient flow of gas-free solution (Sp.G. 1.6) for a continuous analyzer. Carry-over of uranium (or plutonium) into the vessel vent system from a continuously operating jet was observed during these tests. The amount is not significant in terms of loss, but may lead to plugging or radiation problems in the vent system. Details of the test results were forwarded to CPD-FEO in a letter to N. T. Hildreth dated February 11, 1959.

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Both the linear polyethylene and Teflon tubing cells failed to maintain a low background activity reading in the Redox HCP stream after approximately one week of service. Unplasticized fluorothene cells are now on order for testing on this stream.

An ultrasonic level detector designed by FPD-Testing Methods Operation was tested and found satisfactory for resin level measurement. The instrument operates at a frequency of 1 megacycle and delivers approximately 45 watts peak power to the crystal. It provides adequate signal return for distances ranging from 0 to 10 feet between resin and transducer. A plant prototype is scheduled for construction and evaluation.

IC Column Studies

A filter photometer was designed and is being developed to indicate the uranium concentration and the phase distribution profiles of the column cartridge. The instrument is designed to clamp around the column, and to travel slowly up the glass sections, scanning the liquids trapped in the cartridge under static conditions. The instrument has a usable range of 0 to 100 g/l (uranium) in either the aqueous or organic phase.

Computer and Simulation Work

A one-second Brown recorder and a Foxboro Consotrol recorder with high chart speeds have been connected to the X-section furnace and powder temperature probes of G-calciner in order to determine the response of the furnace during start-up and shut-down of the calciner. These data along with theoretical studies will lead to an approximate transfer function of the furnace which is necessary for the design of a stable control loop.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End Studies

Fuel element hardware removal studies are to be renewed in the near future. The friction saw (hotsaw) is being modified to permit friction-cutting studies on sodium-filled capsules, compression spring capsules, and Zircaloy metal. In addition to the basic saw studies, equipment is being installed in the saw system which will permit particulate matter and air filtration studies. Particulate removal equipment to be tested includes an American Air Filter Type D Rotoclone and a Cambridge Absolute Filter.

Arrangements have been made to make preliminary "cold saw" (low speed milling cutter type) studies in the 200-West shops. These preliminary studies should determine the basic feasibility of the cold saw system. Hollow tube bundles and compression spring capsules will be cut with the saw.

Feed Preparation

Darex. A series of chloride removal runs were made in the Darex pilot plant unit on solutions containing uranium and stainless steel. Pertinent findings are:

1. The continuous addition of nitric acid through a submerged feed point offered no advantage over a top feed point.

2. A greater difficulty in removing chloride from a solution high in stainless steel content, as reported last month, was again demonstrated with both concentrated and dilute Darex solutions.

3. The addition of water through a submerged feed point for nitric acid removal is superior to a top feed point.

The data secured in these and prior experiments are being analyzed by analog computer techniques in an attempt to delineate the relative contributions of the chloride oxidation reaction and hydrochloric acid volatility to the chloride removal attained.

Niflex. Six additional runs were completed. General observations with a 2 M HNO_3 - 1 M NH_4HF_2 solutions were:

1. The terminal solution consistently contained 23 - 26 grams of stainless steel per liter after four hours of operation.

2. The charge was at least 85 per cent dissolved after one hour of boiling with a fluoride to stainless steel mole charge ratio of five.

3. Off-gas analysis after one hour of dissolution averaged one per cent oxides of nitrogen and one per cent hydrogen with an air flow of 0.34 standard cubic foot of air per minute per square foot of stainless steel surface.

4. Dissolution was 91 to 99 per cent complete after four hours of boiling with a fluoride to stainless steel mole charge ratio of five. Incomplete dissolution consistently occurred near the bottom of the dissolver (liquid depth of eight feet) and along the Hastelloy F contact regions.

Sulfex Studies

Sulfex studies were extended to irradiated uranium metal (irradiated to 2100 MWD/T and cooled about six months). The irradiated metal reacted with boiling four molar sulfuric acid at a rate (1.2 mg/hr,cm^2) identical within experimental error with the rate of reaction of unirradiated uranium (1.1 mg/hr,cm^2). This rate would correspond to a uranium loss (in per cent per hour) of 0.1 times the specific surface of the element in cm^2 per gram.

The presence of dissolving stainless steel had no effect on the rate at which the irradiated uranium reacted with boiling four molar sulfuric acid.

[redacted]

Other experiments showed the rate of dissolution of unirradiated uranium - 9 w/o molybdenum to be lower by a factor of at least ten than that of unalloyed uranium.

Experiments performed this month confirmed that atmospheric oxidation is largely responsible for the previously observed rate (1.8×10^{-4} moles/liter,hr) of formation of iron(III) when a four molar sulfuric acid solution containing 0.2 "molar" stainless steel was boiled with no attempt made to exclude oxygen. A rate of only 1.2×10^{-5} moles/liter, hour was obtained when a 0.3 molar solution of iron(II) in four molar sulfuric acid was boiled under a nitrogen atmosphere. Since iron(III) has been shown to be capable of oxidizing and dissolving uranium or uranium dioxide, provision of a non-oxidizing gas atmosphere will be necessary to obtain minimum core losses in a Sulfex decladding operation.

During Sulfex studies, several specimens of 304-L stainless steel of unknown history have been found which are passive to boiling 3.5 M H_2SO_4. Several techniques involving etching and subsequent exposure to HNO_3 or air (long term) have been found which will produce 304-L specimens passive to 3.5 M H_2SO_4. In all cases, the samples were made active by contact with mild steel or active stainless steel when immersed in dilute sulfuric acid.

Uranium and Urarium Dicxide Dissolution. Dissolution rates for ingot uranium and sintered uranium dicxide in proposed-core dissolvent solutions (HNO_3-HF-$Al(NO_3)_3$) were determined. The tests were made in boiling solutions; constituent concentration ranges studied were HNO_3 from acid deficient to 3 M, HF from 0.1 to 1.0 M, $Al(NO_3)_3$ from 0 to 1.0 M, and $UO_2(NO_3)_2$ from 0 to 0.6 M. Dissolution rates for ingot uranium were in the range from one to five $g/cm^2/hr$ in the absence of aluminum or in the presence of aluminum if the Al/F mole ratio was less than one. At an Al/F mole ratio of one the dissolution rates ranged from 0.2 to 0.5 $g/cm^2/hr$. Dissolution rates for sintered UO_2 were appreciably less than those for metallic uranium. They ranged from 0.1 to about one $g/cm^2/hr$. Addition of ferric nitrate to the dissolvents increased the dissolution rate appreciably.

Dissolution of Uranium-Molybdenum Alloy. Further studies on the dissolution of uranium - 3 per cent molybdenum alloy in HNO_3-NH_4F-$Al(NO_3)_3$ systems generally confirm previously reported limitations on terminal uranium and nitric acid concentrations as well as F/Mo and Al/F mole ratios if gross solid formation is to be avoided. Current studies on the dissolution of this alloy in nitric acid alone indicate that approximately the same terminal uranium and nitric acid concentrations can be attained as are possible in the presence of fluoride and aluminum. Dissolution in nitric acid only would have the advantage of involving a much less corrosive environment and the disadvantage of lower dissolution rates. Stability of solutions during plutonium oxidation and the behavior of molybdenum during solvent extraction have not yet been studied in the absence of fluoride.

A survey of dissolution rates of uranium - 3 per cent molybdenum in the HNO_3-NH_4F-$Al(NO_3)_3$ systems proposed for dissolution of this alloy was made. At Al/F mole ratios of 0.5 or less the average dissolution rate at boiling

was well above one gm/cm^2/hr. At 80 C, the average dissolution rate was about one gm/cm^2/hr. When the Al/F mole ratio was one, the dissolution rates were less than one gm/cm^2/hr even in boiling solutions.

Materials of Construction. Hastelloy F weldments fabricated from vacuum-melted Hastelloy F base metal and a filler wire similar to Hastelloy F but containing nine per cent molybdenum instead of the usual six per cent, and containing no niobium show appreciably less (estimated at a factor of ten) preferential weld metal attack in HNO_3-HF solutions than weldments containing standard Hastelloy F as filler material. Four additional heats of Hastelloy F with varying molybdenum content are in preparation for evaluation as filler materials. Hastelloy F welded with No. 65 Nionel filler wire showed no preferential weld metal attack after exposure for ten days to simulated Sulfex, Zirflex, and core dissolvent solutions. Similar welds prepared with standard Nionel as filler material showed preferential attack in areas adjacent to the weld on exposure to core dissolvent solution (3 M HNO_3, 1 M HF, 0.5 M $Al(NO_3)_3$).

The presence of dissolving stainless steel reduces appreciably the corrosion of Hastelloy F and Nionel by Sulfex decladding solutions (dilute sulfuric acid).

Boron Monitor. A laboratory model of a boron monitor was designed, constructed, and is now under test, to determine the optimum geometry for measuring boron in the 0.1 to 2 grams/liter range. The sensing unit is a thermal neutron absorptiometer utilizing a single BF_3 tube as the detector.

Solvent Extraction

Solution stability tests, batch contact studies, and mini-mixer-settler runs were made to establish satisfactory conditions for Redox solvent extraction of feeds prepared by dissolution of uranium- 3 per cent molybdenum alloy in HNO_3-NH_4F-$Al(NO_3)_3$ solutions. From the standpoint of uranium and plutonium recovery and solution stability, the most satisfactory conditions so far found are as follows. The dissolver solution (containing 0.4 M uranium) should be one molar or more in free acid. Aluminum nitrate was added to give an Al/F mole ratio of at least 1.5 and total nitrate at least 5 M. When the solution was 0.05 M in $Na_2Cr_2O_7$, heating for at least one-half hour at 85-90 C was required for adequate plutonium oxidation. At higher oxidation temperatures, solids were generally formed. Under these feed preparation conditions, uranium and plutonium waste losses ranging from 0.05 to 0.2 per cent were obtained in mini-mixer-settler runs. Fission product behavior under these conditions will be studied in future runs.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

PRTR Fuels Processing

Present plans in developing optimum reactor parameters for the use of recycled plutonium in thermal reactors include the reprocessing of PRTR spent fuels in the Redox plant and/or the proposed reprocessing complex for Non-Production Fuels.

[redacted]

This approach is not considered to be optimum as the chemical reprocessing steps to the over-all plutonium recycle, but is intended as a service during the interim period until such time that a more optimum fuel reprocessing-fuel reconstitution cycle has been developed. In this concept the interim reprocessing is, therefore, a special case of reprocessing a non-production fuel. Accordingly, development in support of this reprocessing has been carried out and reported under the Non-Production Fuels Reprocessing Development Program. Unique features of the PRTR fuels have been considered in that development program, as well as the provision of any necessary technology to make it possible to process spent PRTR spike fuel elements in the Redox plant with a minimum of modifications, prior to the completion of the Non-Production Fuels Reprocessing complex as a whole. As presently envisioned it will not be necessary to provide any facilities in these minimum modifications which are not also necessary in the longer-range portion of providing facilities for processing of Non-Production Fuels.

Combustible Gas Analyzer

Calibration of the new combustible gas analyzer, for use at Redox, is in progress. Data are being evaluated in order to interpret the effects of two combustible gases (hydrogen and ammonia) in air. Preliminary results indicate that with an ammonia to hydrogen mole ratio of ten or greater, the instrument output signal is the same as if ammonia only were present. At lower ratios both gases contribute to the output signal.

Plutonium Oxalate Disk Filter

Tests have continued on the plutonium oxalate disk filter using cerium oxalate as a stand-in for plutonium oxalate. Both filtration media tested (an aluminum oxide disc and a sintered stainless steel wire mesh) have proven adequate in filtering cerium oxalate. Exploratory studies were performed in an effort to devise cake removal methods which would minimize filter media blinding while maintaining uniform filter discharge rates. "Blowing back" a small sector of the filter at a time effectively removed the cake but resulted in large pressure drop variations across the filter and an eneven build-up of cake on the filter disc. A second method investigated involves the use of a traveling "scalpel" mounted below the normal cut-off knife. With rotation of the disc the scalpel makes a 3/16-inch incision in the 1/4-inch thick filter cake. Subsequent filtration takes place largely in the groove produced by the scalpel. With this method the pressure drop across the filter does not fluctuate and filter discharge rates are quite uniform.

Potassium-Aluminum Chloride System

A sample of short exposure, long cooled, irradiated uranium dioxide was converted to U_3O_8 by heating in air to 725 C and was dissolved in $KCl-AlCl_3$ to yield a salt phase 18 weight per cent in uranium. After contacting with aluminum at 725 C for 40 minutes, the salt phase was found to contain over 99 per cent of the strontium, cesium and cerium. The ruthenium (surprisingly enough) was found distributed between the salt and metal phases, ranging in three experiments from 40 to 80 per cent in the salt phase. It is not known whether this is a kinetic phenomenon or is due to an unknown reaction of the ruthenium with the substrate material.

Scouting experiments were performed to determine the effect on uranium distribution of substituting bromide for all or part of the chloride of the KCl-$AlCl_3$ system. Thorium-234 (UX_1) was used to simulate plutonium in the system since these two elements have similar distribution coefficients in the $AlCl_3$-KCl system. Preliminary experiments show minimum ten-fold increase in the separation factor for uranium and UX_1 if the potassium chloride is replaced with potassium bromide. This effect is due to an apparent increase in the uranium distribution coupled with a decrease in the UX_1 distribution. Replacement of the $AlCl_3$ with $AlBr_3$, as well, results in separation factors about the same as those of the chloride system. Distribution coefficients, however, are lowered for both uranium and thorium.

If confirmed, the distribution data quoted above, should mean an improvement in the salt fluxing process demonstrated for the purification of aluminum-uranium-233 alloys from thorium-228.

Fuel Materials

A set of six plutonium impregnated graphite samples was completed and sent to Plutonium Metallurgy Operation for canning and irradiation.

Analytical Services

Uranium down to 1 ppm in Zircaloy-2 was measured with some 60 per cent error. The fluorimetric method was applied directly to HNO_3-HF solution of the metal. The analysis is expected to be used regularly to note whether purchased Zircaloy-2 meets impurity uranium specifications.

Magnesium at the 0.02 to 10 per cent level in aluminum-uranium and aluminum-plutonium buttons was determined with an error of less than three per cent, relative. Main interference was aluminum. Magnesium was carried from a caustic solution on ferric hydroxide. It was washed with ammonia and dissolved in 10 M HCl. The HCl solution was passed through Dowex-1 which retained the iron. A flame photometer measured magnesium in the effluent.

WASTE TREATMENT

Radiant Heat Spray Calcination

Twelve runs were made during the month in the eight-inch spray calciner. These were aimed at optimizing operating conditions and at producing a high grade product similar to that previously obtained in the three-inch unit. The feed was formaldehyde killed synthetic 1WW from the Chemical Development pilot plant. Air was used as atomizing media in the first two runs, saturated steam in two, and superheated steam in the rest. The use of steam is preferred because it is condensable and hence reduces the off-gas volume. Superheat was required because of the high water content of the building steam supply.

The quality of product was generally fair, either with or without phosphate addition, and with either air or superheated steam atomization, but dustiness

was a problem in some cases. Adherence of powder to the cold top flange and to other parts of the column was also troublesome, and several changes were made in an attempt to eliminate this difficulty. Spargers were installed to collimate the spray and reduce the effect but were effective in a limited region only and require further development. It was also found desirable to replace the "disk and donut" baffle system with a cone and frustrum and to eliminate the cyclone associated with the product receiver. The off-gas system is also being modified in preparation for tracer level runs.

Supporting studies in the three-inch column were aimed at relating product density to operating variables such as air to feed ratio in the atomizing nozzle, air pressure at the nozzle, and residence time in the column. The effect of these variables was not clear cut; however, maximum product density occurred when air to feed ratio was in the range 0.4 to 0.7 liters of air per milliliter of feed and decreased with increased pressure. With sugar addition, tap densities ranged from 1.04 to 1.84 gm/cc, and perfect spheres of glass-like material were obtained in all cases.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

Specific retention measurements were made on samples of soil taken from wells drilled near the BC cribs. These measurements were performed by centrifuging the saturated samples for one hour at 1000 gravities. The moisture content of the samples after centrifugation averaged about 2 per cent by volume. The moisture content of special drive samples of soil from deep within these formations was found to average under 4 per cent by volume. Recent drive samples from a similar formation in 200 West Area averaged just under 2 per cent by volume moisture. These drive samples provide realistic moisture-content data because they are obtained from wells constructed without the use of drilling water. The low moisture content obtained with these field samples in the centrifuge test compares with about 14 per cent obtained previously with fine Touchet soil. This fine soil is not representative of the actual material beneath the cribs. The acceptable agreement between the moisture content resulting from these tests and that measured in actual samples may indicate a verification of the value of the centrifuge test for specific retention measurements.

Two techniques for constructing laboratory unsaturated flow models were tested. It was found that the use of porous glass membranes for maintaining moisture tension was satisfactory for tensions up to 24 cm of water. The second technique tested involved the removal of water from the bottom of the model by means of a vacuum pump to provide unsaturated flow. This device permitted model operation under moisture tensions as great as 50 cm of water. The moisture content of soils was measured with two experimental instruments based on the determination of electrical conductivity. These instruments require significant equilibration time before measurements can be made, limiting the usefulness of the technique. Design improvements are sought to increase the rate of response.

Soil Chemistry and Geochemistry

The capacity of clinoptilolite for removing cesium from solution was determined to be 166 meq./100g. to reach a C/C_o value of 0.5 from a 0.01 M cesium solution. With addition of 1.0 M sodium to this influent the cesium capacity is reduced to 72 meq. Cs/100g. The large concentration of sodium ion needed to cause an appreciable depression in Cs removal emphasizes the pronounced selectivity of clinoptilolite for cesium. Comparable tests with synthetic resins indicated a higher capacity for cesium from pure solutions but their cesium capacity is depressed to a much greater extent by the presence of sodium ion than is that of clinoptilolite.

Completion of experiments providing cation exchange data confirms the previous indication that no appreciable change in cation exchange capacity results from acid pre-leaching of the soil. The soil prepared for laboratory investigations was composited from samples taken from a 200-foot zone during construction of a well near 200 West Area. A mechanical analysis of the composite showed 26 per cent in the >2.0 mm fraction, 20 per cent in the 0.35 to 2.0 mm fraction, and the rest to be fine sand, silt, and clay in the <0.25 mm fraction. This fine fraction has a natural cation exchange capacity of 12.6 meq./100g., indicating a calculated exchange capacity for the whole soil of 6.8 meq./100g.

Ground Waste Investigations

A technique was designed and demonstrated for performing soil column experiments with controlled unsaturated flow. The test solution flows through a short soil bed retained between two porous glass membranes. Unsaturated flow is attained by maintaining tension on the membranes. A linear relationship was found between the per cent saturation of the soil bed and the tension on the influent over the experimental range studied.

Laboratory soil column experiments were completed to study the effect of variations in packing on the resulting breakthrough curve. Only qualitative variations in packing are possible, being determined by the column packing technique employed. It was found that slightly steeper breakthrough curves are obtained with loosely packed columns than with those prepared by maximum compaction with a vibrator. Thus failure to duplicate field packing in laboratory experiments will result in high estimates of crib capacity. The effect is not pronounced amounting to a maximum column volume error of about 10 per cent at 0.1 per cent breakthrough.

Pre-leaching of two 47-foot soil columns was completed and influent spiked with Sr^{90} is being fed.

Field Apparatus Development

Closed circuit television was used for the first time locally to examine well casing integrity and the condition of perforations. Good resolution was obtained in the well above the water level but in some wells turbidity made the viewing less defined upon immersion of the camera. The camera was prepared near month's end to assist CPD in the internal examination of a dissolver vessel.

[redacted]

A crystal-controlled chronometer circuit for use in exploratory geophysical work was developed.

A laboratory device was developed for applying a known controllable tension to soil column, yet permitting continuous undisturbed flow of liquid through the column.

Equipment and procedures were developed and tested for rapidly placing well points for use in forthcoming field tests. Driving the well point to 20 feet is accomplished in 30 minutes.

Micromeritics

Capsule filters for removing uranium particles from cut-off operations were prepared from (1) long asbestos fibers, (2) various wool felts. Efficiencies of 99.5 per cent were achieved for each of the filters for removing very fine iron oxide particles. Either of the materials will be more effective than the glass wool pads presently used in high level radiometallurgy cells. Further tests with commercial filters are planned.

Two methods were used to determine the particle size distribution of uranium oxide particles produced in an autoclave rupture of a uranium element. Although both methods showed that all particles were smaller than 210 microns, the distribution of sizes was not in agreement by the two methods. Direct sedimentation weight vs. time showed 49 per cent of the material to be less than 70 microns diameter.

Sampling of effluent air from the 234 Building stack was investigated as part of a study recently initiated to characterize plutonium particulates present in this stream.

Rupture Monitoring

An analysis of three sources of information accumulated over several years relating to rupture debris released to the Columbia River led to the conclusion that on the average between 20 and 50 curies of fission product per rupture are released. The long-term average concentration of Sr^{89} in the Columbia River at Pasco is five times that predicted from an average taken of 30 curies per rupture. These data support the conclusion that ruptures contribute even less to the total fission product "burden" of the Columbia River than previously estimated, the principal source apparently being fission of uranium in the cooling water, or in reactor uranium contamination with access to cooling water.

Radioisotopes in Reactor Cooling Water

Reactor effluent radioisotope ratio measurement of $Sb^{122}:Sb^{124}$ indicate that the antimony parent material which holds up temporarily in the slug and tube film has an average residence time on the film from the time of entering until the activated products are released of about 40 hours. The $Ce^{143}:Ce^{141}$ and $Zr^{97}:Zr^{95}$ measurements give values of 25 and 40 hours, respectively, if these

materials arise by $n\gamma$ reactions. If they result from fission, the times are 360 and 130 hours. Thus, the average residence time values for these systems as well as for the zinc reported last month fall between 10 hours and about 12 days. Together with other data these results show that a relatively small percentage of the parent material is responsible for the radioisotopes observed in reactor effluent water because of the long residence time in the reactor.

Demonstration of and instruction in the procedure for determining As^{76} in river water samples was given RCAO personnel on a small area electrodeposition technique for determining plutonium in small volume urine samples.

Facilities have been obtained and apparatus constructed at H and F Areas to continue studies of the decontamination of reactor effluent water on aluminum turnings. The effect of temperature, flow rate and column length will be studied.

L P Bupp

Manager,
Chemical Research & Development

LP Bupp:bp

[redacted]

ORGANIZATION AND PERSONNEL

A. E. Reisenauer, Chemical Effluents Technology Operation, was promoted from Technician R&D to Chemist II-L.

T. F. Evans, Chemical Development Operation, transferred to San Jose, California.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
G. W. Watt	2/2-6/	University of Texas Austin, Texas	Technical Consultations.	LP Bupp WH Reas OF Hill RE Burns	Yes
R. Merritt	2/4/	Arva Corporation Seattle, Washington	Demonstrate vacuum pump.	RJ Brouns	No
L. Malter		Varian Associates Palo Alto, California			
D. Verhagen	2/2/	Van Water & Rogers, Inc. Seattle, Washington	Technical Consultations.	RL Moore GB Barton LL Burger	No
W. D. Claus F. Western V. Beard W. Lotz J. E. Turner	2/10-11/	AEC Division of Biology & Medicine Washington, D.C.	Research programs discussions.	DW Pearce LC Schwendiman JF Honstead RE Brown JL Nelson WH Bierschenck	Yes
F. Neumann	2/4/	University of Washington Seattle, Washington	Review Biophysics Program. Discuss earthquake and damage potential at Hanford.	JM Nielsen RE Brown	Yes No
W. T. Donaldson	2/18-20/	Savannah River Laboratory Aiken, South Carolina	Discuss analytical chemistry of mutual interest.	EW Christopherson DL Reid HJ Anderson	Yes

VISITS TO HANFORD WORKS - Continued

Name	Dates of Visits	Company or Organization Represented and Addres	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
F. Tober W. T. Donaldson	2/18-20/	Savannah River Plant Aiken, South Carolina	Discuss ion exchange technology.	WH Reas MT Walling JL Ryan EE Voiland RL Moore WE Keder	Yes
H. T. Hahn K. J. Rohde	2/24-25/	Phillips Petroleum Co. Idaho Falls, Idaho	Discuss development work on Zr-containing fuels, and Non-Production Fuels Reprocessing.	RE Burns AM Platt LP Bupp MT Walling JL Swanson RL Moore EE Voiland	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. W. Pearce	2/2-3/	Subcommittee on Radiation Washington, D.C.	Attend public hearings on waste disposal.		No
R. L. Moore	2/3/	Curtiss-Wright Corporation Phillipsburgh, Pennsylvania	Discuss fission product recovery.	C Clayton	No
	2/4-6/	Pittsburgh, Pennsylvania	Attend ASTM Meeting. Committee #10.	---	No
	2/6/	Westinghouse Electric Corp. Pittsburgh, Pennsylvania	Discuss hot cells.	RC Westphal	No
L. P. Bupp	2/17-19/	Vallecitos Atomic Laboratory Pleasanton, California	Technical Conference.	RD Bennett	No

VISITS TO OTHER INSTALLATIONS - Continued

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. M. Robertson	2/18-20/	Oak Ridge National Lab. Oak Ridge, Tennessee	Meeting with Advisory Committee for analytical chemistry; discuss analytical instrumentation.	E. Blase	Yes
A. S. Wilson	2/25/	Portland, Oregon	Present speech on "Use of Atomic Energy for Peace Time Purposes"	Eastside Commercial Club & Professional Engineers Of Oregon	No
V. P. Kelly	2/23-25/	ANP-GE Idaho Falls, Idaho	Discussion of equipment & process technology for processing large fuel assemblies.	RL Dexler	Yes
		ICPT-Phillips Petroleum Idaho Falls, Idaho	Process discussions including separations processes, rare gas handling, waste disposal, calcination operation, mechanical engineering.	CE Stevenson	Yes
		Westinghouse Idaho Falls, Idaho	Inspect expended core facility.	D. Grey	Yes

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

No significant changes occurred during the month.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

The concentrations of I^{131} in thyroid glands of jack rabbits were slightly higher than those of one year ago. Values follow:

Collection Site	μc/g wet thyroid Average	Maximum	Trend Factor
Prosser Barricade	3×10^{-3}	5×10^{-3}	-
4 Miles SW of Redox	2×10^{-3}	3×10^{-3}	+ 2
Wahluke Slope	7×10^{-4}	9×10^{-4}	-

Columbia River Contamination

Concentration of gross beta emitters in Columbia River organisms decreased from values observed last month. Values follow:

Sample Type	Location	μc/g wet wt. Average	Maximum	Trend Factor
Minnows (entire)	Hanford	2×10^{-3}	2×10^{-3}	-
Whitefish flesh	Priest Rapids	2×10^{-4}	5×10^{-4}	
Whitefish flesh	F-1	1×10^{-4}	1×10^{-4}	
Goose flesh	Hanford Res.	2×10^{-5}	2×10^{-5}	
Diving duck flesh	Hanford Res.	1×10^{-3}	3×10^{-3}	- 3
River duck flesh	Hanford Res.	4×10^{-5}	6×10^{-5}	- 3
Grebe flesh	Hanford Res.	3×10^{-4}	3×10^{-4}	
Gull flesh	Hanford Res.	7×10^{-5}	1×10^{-4}	

Virulent and nonvirulent of C. columnaris, obtained from Dr. Ordal of the University of Washington, were tested for their ability to kill fish. Tests were by intraperitoneal injections. There seems to be only little more killing

effect from the virulent strains than from the nonvirulent strains. To test the effects of toxins, some of the injections were pasteurized. The rate of fish death from these heat treated cells seemed to be appreciably greater than from cells not heat treated. Tests of these pasteurized cultures showed that not all cells had been completely inactivated so that death might have resulted from either toxins or from virulent organisms produced by the heat treatment.

Preliminary work to develop a synthetic medium indicates that vitamins are not required but as yet, good growth has not been obtained from a mixture of amino acids. Tryptone fortified with asparagine gives good growth. It has also been possible to obtain abundant microcysts which will be tested both for their effects in killing fish and for their apparent chromosome number as determined by viability response to radiation.

221-U Swamp Contamination

Concentrations of mixed fission products in tissues of waterfowl increased as a result of longer exposure of the birds to contaminated food items. Values follow:

Sample Type	μc/g wet wt. Average	Maximum	Trend Factor
Waterfowl (game species)			
Bone	2×10^{-3}	5×10^{-3}	+ 5 *
Soft Tissues	1×10^{-3}	4×10^{-3}	+ 2 *

* Compared to December

Measurable amounts of plutonium were found in aquatic plants and tissues of waterfowl from the 221-U swamp.

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}	+ 2
Bone	5×10^{-5}	-
Liver	1×10^{-5}	-
Muscle	7×10^{-6}	-

Effect of Reactor Effluent on Aquatic Organisms

Routine monitoring of effluent from the 100-KE reactor was not carried out as planned because of continued mechanical failures with the effluent

pump. Effluent from a single process tube was used at a strength of 2-1/2 per cent on young salmon. There is continued evidence of a slight toxic effect with this water, however.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Zinc

Data are being interpreted on the 24-hour absorption and retention of Zn^{65} administered orally to rats at ages 6, 14, 19, 26, 36, and 94 days. The per cent of Zn^{65} fed which is retained for 24 hours falls from approximately 90 per cent in the 6-day animals to approximately 12% in the 36 and 94-day animals. The major change in absorption occurs between the 19th and 26th day, or approximately at the time of weaning. Significant changes with age were also observed in the distribution of the zinc among the various organs.

Strontium

A technique was developed for repetitive sampling of the blood from a single large fish. This is a major advance in our technology since it will substantially reduce the numbers of fish required for metabolism studies and it also provides a practical means for intravenous injections in fish.

Preparations were virtually completed for a test on the toxicity of orally administered Sr^{90} to trout. It is expected that this test will be initiated early in March and run for approximately three months.

The results of hematological studies made during the last 100 days of the 200-day Sr^{90}-Ca^{45} chronic feeding study with weanling rats indicate a lowering of the neutrophil and lymphocyte counts in animals on the 0.1 and 0.5 per cent calcium diets. This is probably attributable to radiation which was received in largest amounts by the animals on these diets. There is no other clear evidence of damaging effects from the radiation received.

The initial drop in OR values observed during the first few weeks of the Sr^{90}-Ca^{45} chronic feeding experiment in mature animals was found to be in close agreement with predictions based on the observed effects of dietary calcium level on retention of a single dose of Sr^{90} and Ca^{45}. This agreement between two different types of experiments strengthens our contention that the OR, as frequently measured in short-term experiments, cannot be relied upon as a constant, even for a singular dietary calcium level.

Bean plants were grown in nutrient solution containing Ca^{45} and Sr^{85} in addition to normal nutrients with calcium adjusted from 0.12 up to 2 mM. The greatest effect on the observed ratio was in roots and least in leaves. With increasing calcium, the OR decreased in roots from 5 to 2.

Iodine

The Q/D (ratio of radioiodine in the thyroid to the quantity fed daily) of sheep decreased slightly, reflecting warmer weather. The Q/D of the group of 16-month-old swine exposed to 5 μc/day for their lifetime continued at a level of one-half that of swine fed 1 μc/day.

Cesium

Bean plants grown in nutrient solution showed an increased OR $\left(\frac{Cs^{137}}{K}\right)$ as potassium increased. The OR was also greater in plants grown in the presence of carrier cesium as compared with those grown in the absence of carrier cesium. The least change in OR was in roots, the greatest in leaves. It is interesting that almost without exception the effects observed with Cs-K are essentially the reverse of those observed with Sr-Ca. Possibly this is the consequence of contrasting mobile and non-mobile ions and mono-valent and di-valent ions.

Plutonium

The relative organ concentrations in miniature pigs 30 and 600 days after administration of Pu^{239}-IV citrate or nitrate intravenously, intratracheally and intragastrically are shown in Table 1.

Table 1

Relative Tissue Activity per Gram

	Intravenous		Intratracheal		Intragastric	
	30 days	600 days	30 days	600 days	30 days	600 days
1	Liver	Liver	Spleen	Adrenal	Liver	Liver
2	Spleen	Bone	Liver	Liver	Bone	Bone
3	Bone	Kidney	Bone	Bone	Adrenal	Adrenal
4	Kidney	Adrenal	Kidney	Kidney	Spleen	Kidney
5	Adrenal	Spleen	Adrenal	Spleen	Kidney	Spleen

In previous experiments testing the effectiveness of orally administered DTPA for removal of internally deposited plutonium, the DTPA was administered as the neutral penta-sodium salt along with calcium gluconate. In the hope of increasing the tolerated dose, experiments were performed in which the DTPA was administered orally as the calcium tri-sodium salt. The effectiveness of this treatment in removing plutonium has not yet been determined, however, toxicity was comparable to that observed with the penta-sodium salt. The maximum tolerated oral dose appears to be of the order of 6 mM/kg which is roughly equivalent to the minimum effective dose as determined previously with the penta-sodium salt. Oral dosage with DTPA does not, therefore, appear too promising unless means can be found to increase its absorption from the intestinal tract.

Radioactive Particles

Deposition of 50 μc Pu^{239} in lungs of dogs during a ten-minute exposure was accomplished using an air pistol to fire gelatin capsules containing $Pu^{239}O_2$ into an inhalation chamber. This and other techniques are being used to study the deposition of $Pu^{239}O_2$ as a function of concentration in the air and particle size.

The daily excretion of Pu in dogs has been studied for four months after inhalation of $Pu^{239}O_2$. Day to day variability in total quantity excreted in urine and feces was often more than tenfold. The excretion does not appear to follow a simple exponential or logarithmic function with time.

The biological half-life of I^{131} accumulated in thyroid of sheep after inhalation of I^{131} vapor and AgI^{131} particles varied from four and one-half to six and one-half days. These values were comparable to those obtained in the same animals after intragastric, subcutaneous, and intraperitoneal administration.

Gastrointestinal Radiation Injury

The experiment involving daily administration of Y^{90} to rats has progressed through six weeks of the projected eight-week feeding period. Only one death has occurred among the 100 rats involved. However, the weight loss and debilitated state of the animals receiving 0.5 mc/day is indicative of the sub-acute effects of such a radiation dosage.

Radiation Protective Agents

The radiation protective effect of erioglaucine, previously indicated in limited studies with mice, has been confirmed in a second experiment employing rats. The X-ray dose employed was 917 r. The erioglaucine dose was 950 mg/kg administered 10 minutes prior to X-radiation. Six out of 10 treated animals have survived for 20 days post irradiation. One out of 10 unprotected control animals has survived for the same period.

Microbiological Studies

A comparative study has been completed to evaluate the relative rates of potassium and phosphorus leakage from yeast cells. The dose required to double the rate of leakage as compared with unirradiated cells is 12 Kr for potassium leakage and 62 Kr for phosphorus leakage. These doses compare with an LD_{50} value of 4.5 Kr in this same strain of haploid yeast. The relationships of the leakage curves for the two elements indicate that they are not dependent on each other. It was also noticed that the packed cell volume of irradiated cells is greater than corresponding non-irradiated cells. Comparison of dry and wet weight indicate that the increase in volume is due to water uptake.

In comparing sensitivity to radiation and cytochrome with catalase content of yeast cells, it appeared that catalase rather than cytochrome was responsible for increased sensitivity in high sensitivity strains. When catalase was added to

the medium in which yeast cells were irradiated, there was no effect on killing. When cytochrome c was added to a similar cell suspension, 20% fewer cells were killed than in cultures to which no cytochrome had been added. This effect of cytochrome in the external environment was quite unexpected and will have to be retested before complete confidence can be placed in the results.

Ecology

Amounts of fission products in flesh of deer that were sampled from different environmental habitats last fall appeared to be related to rainfall. Examples of values are as follow:

Station	Inches Average Annual Rainfall	μc/g dry wt. $Zr\text{-}Nb^{95}$	Cs^{137}	Ce^{141} $Ce\text{-}Pr^{144}$
Snowgrass Flats	80	8×10^{-7}	3×10^{-6}	1×10^{-4}
Bear Prairie	50	7×10^{-7}	3×10^{-6}	9×10^{-5}
Sequim	20	6×10^{-7}	6×10^{-7}	
Rock Lake	15	6×10^{-7}	2×10^{-7}	

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. Wm. Lotz	2/9-11	AEC, Wash. D.C.	Discuss research.	Kornberg & staff	No	100-F-Biol.
Col. Hanson	2/9	US Army, AFSWP	Tour facilities	" "	No	"
Leonard Dworski	2/9	CRAG, Seattle	Tour facilities	Davis, Clarke	No	100-F,Biol.
Dr. Konzak, Om Komra, SA Qureshi, Miss Sardella	2/10	WSC, Pullman	Present seminar, tour facilities	Kornberg & staff	No	" "
Edison Day students	2/11	Area Schools	Tour	Biology staff	No	" "
WD Claus, J. Turner	2/11	AEC, Wash. DC	Tour	Foster, Bustad	No	" "
Dr. S. Laskin	2/17	New York Univ. - Bellevue Med. Center	Discuss research.	Bair	No	" "
3 WSC and 6 Prosser Station	2/24	Pullman, Prosser	Tour facilities	Hungate	No	" "
VISITS TO OTHER INSTALLATIONS						
RF Foster	2/5-6	Robert A. Taft Sanitary Engineering Center, Cleveland, Ohio	Attend informal mtg. concerned with radionuclide disposal to the hydrosphere	A.G. Friend	No	-
WJ.Clarke	2/25-26	U of Oregon Med. School, Portland, Ore.	Address MD. Journal Club	EE Osgood	No	-

D. Lectures

a. Papers presented at meetings

None . . .

b. Off-site Seminars (other than Biology)

W. J. Bair, "Inhalation of Radioactive Particles," 2/2/59 (AFSWP lecture)

F. P. Hungate, "Effects of Radiation on Genetic Systems: Genes", 2/2/59 (AFSWP).

W. J. Bair, Introduction and outline at the Science Fair Panel in Richland (2/16/59) - Panel composed of NL Dockum, RL Uhler, RH Schiffman, GD Smith.

L. A. Temple, "The Biology Program at Hanford," Biology Students at Pasco High School - 2/18/59.

V. G. Horstman, "Radiation Biology at Hanford," Franklin County Livestock Association, Pasco, Washington - 2/20/59.

W. J. Clarke, "Treatment of Radiation Injuries with Bone Marrow Transplantation," Medical Journal Club of Univ. of Oregon Medical School, Portland, Oregon, 2-26-59.

c. Biology Seminars

L. A. Temple, 2/17/59, "Induction of lung tumors by radioactive particles"

D. H. Willard, 2/17/59, "Behavior of Iodine^{131} after inhalation as a gas and as a particle"

V. G. Horstman, 2/24-59, "Pitman-Moore Swine for Research"

L. A. George, 2/24/59, "The Mammalian Cell"

E. PUBLICATIONS

a. HW Publications

Bair, W. J. and F. P. Hungate, "Chemical toxicity of plutonium in y ast," Document HW-58334 (UNCLASSIFIED) December 3, 1958.

b. Open Literature

Schiffman, R. H. and P. O. Fromm, "Measurement of Some Physiological Parameters in Rainbow Trout (Salmo Gairdnerii), Can. J. Zool. 37(10): 25-32 (1959) (work performed elsewhere).

Temple, L.A., D.H. Willard, S. Marks and W. J. Bair, "Induction of lung tumors by radioactive particles," Nature 183, No. 4658 (1959) p. 408-409.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

February, 1959

ORGANIZATION AND PERSONNEL

There were no changes in personnel during the month.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

A highly aggregated model of HAPO and its interdependencies with the AEC, the defense establishment, and the national economy was formulated during February. Data have been gathered for the variables considered over a ten-year time period, and a testing program formulated. This model along with two others is now awaiting completion of the IBM 709 program for handling systems of this type.

A series of lectures to plant personnel describing the use of recently developed multivariant analysis techniques in the investigation of causal interrelationships was continued.

Business Descriptions

The study of methods for the description of a business was continued.

OPERATIONS ANALYSIS STUDIES

Z Plant Information Study

In order to proceed with the test program discussed last month using APR equipment, a portion of the information system structure was selected which it was felt would approximate the capacity of the equipment available and still provide sufficient data for test purposes. Operating procedures necessary to permit the test were then defined and presented to CPD management for tentative approval. Following this approval IBM customer engineers were contacted with respect to this specific application of the equipment. It was found that the portion of the structure selected would require approximately twice the amount of equipment available. However, the program presented can be subdivided and it is still felt that it will be possible to perform a satisfactory test within the limitations involved. A detailed proposal for CPD consideration will be available early in April.

FPD Process Control and Experimentation

In connection with the determination of the optimum combination of preheat and submerge times in the canning cycle, several sets of data, resulting

from designed experiments, were collected. Yield variables included total bond count, residual can wall thickness, non-wetting (measured in two different ways), and various reject rates. An optimum region has been found on the basis of these experiments, and it has been recommended that the nature of the response surface in this region be further investigated in the pilot plant using a 3^2 factorial design. Firm recommendations for changing process specifications will follow this final investigation. A report on findings to date will be issued during March.

Data were analyzed from an experiment designed to evaluate the effect of metal additions to the canning bath on the depletion rate of silicon. The experiment was conducted in order to determine how much metal to add, and when, in order to maintain silicon content above a given value. Along the same line, process data were analyzed to determine if replenishment during canning as opposed to during a shift break significantly affects the quality of the canned fuel element.

Evaluation of Fuel Element Quality

Two experiments were run in connection with the measurement of pre-irradiated fuel element quality. In one of these, an evaluation was made of an optical measuring device to measure can wall loss. This has the advantage of being a non-destructive measurement, and would also permit a more rapid feedback of information for process control applications. Results of optical measurements were compared with results from the caustic stripping method in current use. The other concerned the measurement of the extent of non-wetting, and was designed to compare the effectiveness of physically measuring non-wet areas with the existing ranking method of evaluation.

Fuel Element Failures

Uneven surface conditions for I and E fuel elements during irradiation have been monitored by means of thermocouples designed to measure outlet water temperature for a given tube at different positions around the circumference and in the center. These data are of interest in connection with rupture studies because of the apparent strong dependence of rupture rates on such surface conditions. Data of this type have been submitted for analysis in order to determine the relationship of "rupture indices" computed from the surface conditions with the corrosion index of the tube, a measure of tube condition. The behavior of such rupture indices with time is also being investigated.

Work is continuing in an effort to relate the aluminum corrosion curves to the side failure curves. The hypothesis has been suggested that "hot spot" ruptures are the result of uniform corrosion observed under more severe conditions due to a combination of circumstances. If this is true, a reconciliation of the curves should be possible. However, several explanations as to the extent and/or severity of localized

[redacted]

heating can be offered to reconcile the curves, and supplementary data will be required to firm up any explanation. In this general problem area, the corrosion equation has been revised slightly by eliminating some of the data which do not appear to be described adequately by the existing model.

Production Tests

Data for I and E fuel elements from the old reactors are being analyzed in order to estimate a regression equation for dimensional changes versus fuel element power and exposure. This is necessitated by the fact that tube powers in the various production tests differ little, so that the effects cannot be determined on a tube basis. Within a tube, the range in powers is wide enough to permit this determination.

CPD Control

Some preliminary work was started in reviewing material control measurements in Z plant. Problems associated with different inventory estimates of the amount of nitrate in the new feed tanks are being considered.

A review of Process Technology and SS Accountability data is being made to evaluate material control potentialities in the Product Recovery Operation. This is prompted by the process improvements recently instigated in this operation.

Radiation Protection Precision and Accuracy Study

Continued emphasis was placed upon gaining understanding of the many variables associated with the film badge program. Basic information has been collected in report form covering such areas as beta, gamma, and x-ray calibration of film, the film badge, film characteristics, the developing process, densitometer and dose interpretation from calibration curves. Based on this information, a list of the important variables is being prepared so as to determine what types of data and experiments will be needed in order to estimate the associated precision and accuracies. Basic information and understanding is yet to be obtained for the neutron dosimetry program and some parts of the regular film badge dosimetry program.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Reactor

A cooperative program has been started for the investigation of heat transfer and thermal stress effects in fuel columns which have become non-concentric with their tubular containers.

Work has been started to develop a mathematical model of the ion exchange and coating phenomenon which occurs in reactor process tubes.

4000 Program - PRP

A series of mathematical analyses was started to study the heat transfer properties of several types of fuel elements under the non-linear assumption that the thermal conductivity of the fuel material is temperature dependent.

A non-linear least squares analysis was suggested to evaluate experimental data concerning the separation of spent fuel elements. The mechanics of programming the mathematical calculations for IBM 709 computation were also considered. Data are currently being processed.

Statistical analysis was initiated to determine the precision with which certain properties of microstructures can be estimated from random photographs of cermets. Properties estimable from such metallography data include average cross-sections, average linear intercepts, surface to volume ratio, and mean free paths of particles of a given phase in the cermet.

4000 Program - Swelling Studies

Work continued on methods of estimating the distribution of diameters and centers of gas bubbles in irradiated uranium. Two methods for the resolution of bubble diameters are currently under investigation. The first utilizes measurements of the escape rate of gas from a molten irradiated uranium sample. A non-linear differential equation, to date not solved, expresses the functional dependency of bubble rising velocity on the parameters of the system. The second is based on analysis of radiographic cross-sections of irradiated uranium samples. Its validity depends upon ability to anneal irradiated uranium samples sufficiently to sphericalize internal gas bubbles without boiling off appreciable amounts of the gas. If this can be accomplished valid estimates of the total void volume, the distribution of bubble radii, and the distribution of centers can be obtained from radiographic data.

6000 Program - Biology

A meeting was held with Plant Nutrition and Microbiology Operation concerning statistical analysis of data from an experiment yielding values of the observed ratio (O. R.) in plants. Consultation continued with Biology Operation personnel in an effort to provide a theoretical basis for experimentally observed changes in such observed ratios in plants and animals.

[redacted]

Continuing effort is being made to fit a mathematical model to data on bone concentrations of radioisotopes from a chronic feeding experiment with mice.

Work was completed on a Metabolism Operation study of linear regression curves relating blood concentration of radioactive isotopes in test animals to time following a single intravenous injection.

A meeting was held with personnel of the Experimental Animal Farm Operation to consider the allocation of animals to the various feeding levels in a proposed large animal experiment to investigate Sr-90 toxicity in swine.

Further discussions were held with Radioecology Operation concerning analysis of data from an experiment involving the passage of Cs-137 throughout an aquatic community following an acute administration. Discussion centered on methods of summarizing the large quantities of data obtained from the study in preparation for statistical analysis.

6000 Program - Atmospheric Physics

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

General

Two problems are currently being considered in connection with the application of statistical and mathematical techniques to the resolution of multi-channel analyzer spectrum data. The first is the quantitative resolution of the total spectrum among a known set of isotopes by mathematical techniques, including standard error estimates for each isotope, and the second is the estimation of proportional and zero shift instrument drift from a scan of a standard material. Current efforts are directed toward the solution of the first of these two problems, and data are being processed to investigate the efficiency of several statistical techniques.

Further discussions were held with Bioassay Operation concerning the estimation of relative sensitivity of a spot sampling program in comparison to the current routine one based on a 24-hour collection period. The type of information necessary for such a comparison was indicated to interested persons.

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

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Further mathematical analyses were made in connection with the continuing program of the Testing Methods Operation. These analyses were for the purpose of predicting and interpreting the types of signals received by electrical eddy-current and ultrasonic fuel element testers. Several experiments set up by this group have confirmed the predictions of the mathematical theory.

Reactivity data for K, O, and C size I and E fuel elements were analyzed in order to estimate the reactivity of bare fuel elements currently being received at HAPO.

Irradiation Processing Department

The regression analysis study relating prediction errors associated with reactor start-ups to nine independent reactor variables was completed. The analysis demonstrated that three of these variables need not be included in the model.

A report was issued in connection with the reliability study for a proposed nuclear monitoring system. The report also contained a discussion of the general method of analyzing reliability data.

Chemical Processing Department

Estimates of the process average and the dilution and titration variances for final parts were made based on recently collected data. These estimates are used for control purposes in addition to indicating whether or not conformity to specifications is being maintained.

A review has been made of the control method used by the Analytical Quality Control Laboratory in connection with spectographic analyses.

Relations and Utilities

A supplementary report has been issued in connection with the procedures for estimating inventories and book-physical inventory differences.

Calibration tables for the E-12 and C-1 vessels were prepared using the IBM-650 program. These tables differed from previous ones primarily in that they include a temperature correction to a base of 40C. The calculation and use of these estimates are given in HW-59439. A detailed description of the IBM 650 program was also prepared.

Statistical analysis of age- and sex- specific mortality data in Richland and in the United States was completed and the results reported to interested persons.

C. a Bennett jbk

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 Watt	2/3/59	University of Texas Austin, Texas	Consultation	C. A. Bennett	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
John L. Jaech	2/10/59-2/14/59	Iowa State College Ames, Iowa	Recruitment	G. B. Coover	No
Warren R. Lewis	2/23/59-2/27/59	Operations Research and Synthesis Conference, General Electric Company, Philadelphia, Pa.	Business Planning Conference	W. H. Bloodworth	No
Robert C. Burke	2/17/59	Lawrence Rad. Lab., Livermore, California	Consult. on Computer Use of IBM 709	Max Harris	Yes
Robert C. Burke	2/18/59	IBM, San Francisco, California	"	E. Hill	No

PROGRAMMING OPERATION
FEBRUARY 1959

A. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

High Exposure Plutonium for the PRP

Approval was granted by the AEC Division of Reactor Development to re-irradiate in the MTR and ETR 20 of the Pu-Al fuel elements that were originally fabricated for MTR use by HLO Plutonium Metallurgy. The re-irradiation of four in the MTR has already begun. Upon completion of the irradiation the 20 elements will contain about 2 Kg of plutonium, some with 20 w/o and some with 40 w/O Pu-240 + 241 + 242. This plutonium will be used in the PCTR to determine physics parameters for the Plutonium Recycle Program. It will then be refabricated into PRTR fuel elements.

Negotiations were started with the local AEC concerning release to the PRP of the irradiated depleted uranium now being stored in the 100-C Storage Area. This material, totaling 6.7 tons of uranium, is estimated to contain 9.3 Kg of plutonium averaging 14 w/o Pu-240. In addition there are some 3 to 4 tons of similar material still being irradiated that are also requested for the PRP.

Trans-Plutonium Elements

In support of current AEC interest in the utilization of high exposure plutonium from the PRTR program for the recovery and production of trans-plutonium elements, calculations were made to show the content of certain elements in fuels at various exposures. In addition, the higher plutonium isotope contents of fuels were developed. Of special interest are the plutonium-242, americium-243, and curium-244 isotopes which may be used ultimately for the production of elements such as californium-252.

Schedule and Inventory for PRTR Fuels

Incorporation of most recent cross section data for plutonium isotopes into the calculation of time for 50 percent burn-out has established 6.4 days as the discharge interval for spike elements in the PRTR. This is a shorter time than earlier calculations showed and will have significant effects on the charge and discharge schedule and on the inventory.

Cycle Analysis

A rough draft of a report entitled "A Calculation of the Reactivity Worth of Plutonium and Uranium-235 as Enrichment in Thermal Reactors", was essentially completed. Results subject to qualifications noted in the report show that (1) the value of a gram of fissile material (Pu-239 +

Pu-241) in extending the exposure life of uranium-238 as fuel in efficient reactors is greatest if the fissile material is contained in highly-exposed plutonium with pure Pu-239 and pure U-235 following in that order. This result reflects the fertility of Pu-240, which when properly used is a valuable material. (2) In reactors of medium efficiency, the difference between the three fuel compositions is rather small. (3) In a reactor of poor neutron economy, the difference is large and in a reverse order. The reason for this is that to take advantage of the properties of Pu-240 as a fertile material it is necessary to invest excess neutrons in non-fission absorption in the plutonium isotopes Pu-239 and Pu-240 for re-generation of the fissile material Pu-241, rather than spend them in producing more fissions immediately. In a reactor with low neutron economy this investment is a losing proposition because of the associated leakage and parasitic absorption losses, while in the reactors with good neutron economy the investment is ultimately recovered "with interest" from the Pu-241.

A single-pass fuel cycle code (MELEAGER A) for the IBM-709 computer was developed and written. The code, which is an enlarged and improved version of the WESSEX A and B codes for the IBM-650, will handle up to 140 different materials subject to burnup and radioactive decay, and will be useful for fission-product and trans-plutonium studies as well as the basic uranium-plutonium and thorium reactor fuel cycles. Input tape prep-aration permits the running of extensive surveys without time-consuming clerical labor. Provision is made for treatment of spectrum and flux-level shifts in batch irradiation cycles, which can now be analyzed with as much accuracy and convenience as graded discharge cycles.

Analytical work was completed on IBM-650 computer analysis of two aspects of plutonium fuel utilization. The first examined plutonium feed of various compositions in specific reactors under construction or in operation as part of an AEC requested effort, jointly with ANL and ORNL, bearing on evaluation of plutonium pricing policies. The second examined the special characteristics associated with stainless-steel cladding (as an alternate to cladding with a lower cross-section) of plutonium fuels.

A paper entitled "Selected Economic Aspects of Plutonium Fuels Utilization in D_2O Moderated Reactors" was written for an AEC sponsored symposium on Heavy Water Moderated Reactors to be held in Washington, D.C. on March 3 and 4.

B. 6000 PROGRAM

Radiological Consultation

A quarterly report for the Radiological Evaluation Task Force was written. Meetings of the Task Force have concentrated on the need for a Radiological Evaluation group and its organization.

Consultation was rendered concerning radiation protection legislation, extrapolation to humans of biological data secured from small animals, NPR confinement, application of autoradiography to the study of fallout, and controlled background radiation measuring facilities.

A Bio-Medical Program Director's meeting was attended and a review prepared for those involved in the Biology and Medicine Program.

Arrangements were made for presentations and discussions of HLO programs sponsored by the AEC Division of Biology and Medicine for W. D. Claus, F. Western, G. V. Beard, W. Lotz, and J. Turner during their visit to Hanford on February 9 and 10.

D. OTHER ACTIVITIES

Arrangements are under study by which it is hoped to certify a qualified person from the Hanford Laboratories to teach advanced electrical engineering courses at the University of Washington Graduate Center at Hanford. Necessary arrangements were made to bring a qualified instructor to Richland from the University this summer to teach a Graduate Course in Business Administration.

In accordance with requests from Washington AEC personnel, alternate proposals involving revisions to the content of the 1959 SINE Program at HLO were developed. Selected lecture topics to be delivered by off-site personnel were integrated into proposed alternates. In addition, the possibility of including a trip to the NRTS facilities was considered.

Arrangements were made for a display and a laboratory tour for C. W. LaPierre, L. R. Fink, F. E. Crever, and E. J. Schmidt during their visit to Hanford on February 10 and 11.

Manager, Programming

LH McEwen:dl

VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
Dr. F. Western Dr. G.V. Beard Dr. J. Turner Dr. W. Lotz	2/11-12	AEC - Division of Biology & Medicine Washington, D.C.	Reviewed the Biophysics program.	J.W. Healy L.H. McEwen	Yes	300 Area - 3760,329,325 100-F Area 146-FR & 141-M 200-W Area 622 & 222-U

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. W. Healy	2/2-2	Joint Committee on Atomic Energy, Washington, D.C.	Attended Waste Disposal Hearings.	C. Holifield	No
J. W. Healy	2/17-19	AEC Headquarters Germantown, Md.	Attended Bio-Med Directors Meeting.	C.L. Dunham	Yes
C. A. Rohrmann	2/24-25	Phillips Petroleum Co. Idaho Falls, Idaho	Information exchange in fields of separations processing, rare gas handling, and waste disposal.	C.E. Stevenson	Yes
	2/26	General Electric - ANP Idaho Falls, Idaho	Discuss equipment and process technology for processing large fuel assemblies.	R.L. Drexler	Yes

RADIATION PROTECTION OPERATION MONTHLY REPORT - FEBRUARY 1959

A. ORGANIZATION AND PERSONNEL

Luese W. Powers was reactived on February 9, 1959. Barbara H. Ryan was granted a leave of absence effective February 27, 1959.

B. ACTIVITIES

Four minor cases of plutonium deposition were confirmed during the month. Two cases were associated with rupture of plastic bags or hood gloves. One case was detected through the routine sampling program and is probably a result of chronic exposure of several years. One additional case apparently occurred offsite at the Nevada Test Site to an employee in ROF status. Preliminary estimates place the deposition in all cases at less than 10% of the MPL. This brings the total number of plutonium deposition cases which have occurred at Hanford to 228. There are 163 employees currently employed who have a measurable deposition of plutonium.

Incomplete information from the manufacturer contributed to incorrect installation of the accelerating belt on the Van de Graaff positive ion accelerator. The subsequent temporary acceleration of negative ions resulted in generation of X-rays and some unexpected exposure of three employees. The maximum whole body dose received was estimated to be about 0.6 r to the employee who was not wearing his film badge at the time of the incident. This estimate was based on measurements taken during restaging of the incident. The whole body doses received by the other two employees including three weeks of nominal prior exposure were 0.045 r and 0.035 r.

Two FPD employees received hand and forearm exposures of 2.0 and 2.5 r. The unplanned exposure was received when the safety device of the radiographic X-ray testing unit failed. A third employee received about 1 r to the hands and forearms. Whole body exposure to all three employees were less than 60 mr.

A contamination spread at the 183-KE Coolant Systems Development laboratory resulted in hand and protective clothing contamination to one employee. Nasal irrigation was performed on the involved employee. Skin decontamination was successful and external exposure was estimated to be less than 150 mrads. Measurements in the Shielded Personnel Monitoring Station were scheduled.

Discharge of I^{131} from separations plants to the atmosphere totaled 4.9 curies during February.

The technique for electrodeposition of plutonium on a reduced area of a stainless steel disc was tested under operating conditions at the bioassay laboratory by Analytical Chemistry Operation personnel. Mechanical difficulties of premature drying of the electrodeposition sample were resolved. Further testing is in progress.

Equipping the Shielded Personnel Monitoring Station continued. The reception room furniture including sofas, chairs, and end tables was ordered. Tentative plans were made for landscaping the entrance to this facility.

The X-ray spectrometer to be used for evaluation of gamma doses up to 2000 r was received and assembled. Periodic tests are planned for use of this equipment in estimating the doses on badge film exposed in the near-lethal to lethal range.

Surface dose rates to be expected in the PRTR recycled plutonium were estimated for metal at the completion of each cycle through the fourth cycle.

The individual Exposure Record Cards for CY 1958 were distributed to all employees with area clearances.

Revisions to the Radiation Protection Standards Manual continued. Approximately one-half of the revisions to this entire manual have been completed.

The new Chairman of the Columbia River Advisory Group, Leonard B. Dworsky, of the U. S. Public Health Service toured Hanford on February 9. He visited the Regional Monitoring facilities, Biology facilities, toured the 100-K Area, and visited the Atmospheric Physics facilities and the Shielded Personnel Monitoring Station.

Eight members of the Technical Defense Organization attended the second in a series of fallout plotting exercises at the 703 Plotting Room.

Solicited comments were offered to the ASA N2.1 Subcommittee on the Radiation Symbol. Comments were offered on a booklet entitled "A Guide to the Safe Handling and Use of Radioisotope Sources" which was issued by the Public and Employee Relations Servic

C. EMPLOYEE RELATIONS

There were three medical treatment injuries for a frequency of 1.44. No security violations occurred during the month.

Nine suggestions were received for evaluation. Six of these were completed and none were adopted. Five suggestions are pending in RPO for evaluation. No awards were made.

G. A. Little attended the course, "Understanding People".

G. D. Brown presented a talk on Bioassay at a Purex Radiation Monitoring information meeting.

D. SIGNIFICANT REPORTS

HW-59116 - Hanford Semiannual Report to Columbia River Advisory Group - Through December 1958, by M. W. McConiga and H. V. Clukey.

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

HW-59454 - Regional Monitoring Activities, February 1959, by B. V. Andersen.

HW-59455 - Waste Disposal Monitoring Activities Summary, February 1959, by K. F. Baldridge.

HW-59405 - Monthly Report - February 1959, Radiation Monitoring Operation by A. J. Stevens.

Report of Invention - An Ionization Type Finger Ring Dosimeter by C. M. Unruh.

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. D. Claus Forrest Western Dr. G. V. Beard J. Turner W. Lutz	2-10-59	U.S. Atomic Energy Commission, Washington 25, D. C.	Obtain information on radiation protection methods and programs	AR Keene RL Junkins	No	325:300
L. B. Dworsky	2- 9-59	U. S. Public Health Service, Portland, Oregon	Tour Hanford as Columbia River Advisory Group Chairman	HV Clukey BV Andersen MW McConiga	No	329:300

VISITS TO OTHER INSTALLATIONS

B. V. Andersen H. V. Clukey	2-10-59	Washington State Pollution Control Commission, Olympia, Washington	Columbia River water quality meeting	W. W. Saxton	No
W. V. Baumgartner	2-4 thru 2-6-59	AEC - Idaho Falls, Idaho	Observe automatic densitometer	M. Wilhemlsen	No
T. C. Mehas	2-25-59 thru 3- 1-59	Eberline Instrument Company, Santa Fe, New Mexico	Observe and discuss automatic densitometer	H. O. Wilcoxon	No

REGIONAL MONITORING - RESULTS (January 26, 1959 - February 22, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	1.3	% MPC_{GI}	-2
Separations Areas	Total Beta	4.1×10^{-6}	µc/cc	--
Pasco	Isotopic	0.4	% MPC_{GI}	--
Kennewick	Isotopic	0.2	% MPC_{GI}	-2
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	6.2	% MPC_{GI}	--
Hanford Ferry	Total Beta	7.7×10^{-5}	µc/cc	--
Pasco	Isotopic	1.3	% MPC_{GI}	-2
McNary Dam	Total Beta	7.6×10^{-7}	µc/cc	-2
Vancouver, Washington	Total Beta	6.8×10^{-7}	µc/cc	-2
Waste Water				
Outlying Test Wells	Total Beta	2.7×10^{-6} (Max)	µc/cc	+2
Reactor Effluent Retention Basins to River	Total Beta	24,000	curies/day	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	0.7	mrad/day	--
Environs	Gamma	0.5	mrad/day	--
I-131 Separations Areas	I-131	3.2×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	4.9	curies/week	--
Active Particles - Project	--	15	ptle/100 m^3	--
Active Particles - Environs	--	28	ptle/100 m^3	--
Vegetation				
Separations	I-131	7.1×10^{-6}	µc/gm	--
Residential	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	5.0×10^{-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
February	0	1
1959 to Date	0	2

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
February	33,683	39	3	1
1959 to Date	65,846	94	7	2

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	Average Dose Per Film Packet mr(s)
February	9,988	949	168	22	80	3.19	24.37
1959 to Date	20,730	1,845	253	22	138	2.95	21.17

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
February	867	11	1	0	0
1959 to Date	2,320	11	1	0	8
Fast Neutron					
February	20	0	1	0	0
1959 to Date	75	0	1	0	9

Bioassay

	February	1959 to Date
Plutonium: Samples Assayed	791	1,638
Results above 2.2×10^{-8} µc/sample	24	48
Fission Products: Samples Assayed	834	1,608
Results Above 3.1×10^{-5} µc FP/sample	7	10
Uranium: Samples Assayed	292	612
Confirmed Plutonium Deposition Cases	4	4*

* This brings the total number of plutonium deposition cases which have occurred at Hanford to 228.

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	17	3.5	46	5.8	2.2	36
Hanford Laboratories	84	10	17	12	3.0	18
Chemical Processing	12	2.9	39	17	2.8	64
Chemical Processing*	37	21	5	11	8.3	2
Special Incidents	0	0	0	0	0	0
Random	2.1	0.7	65	0	0	0

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

Thyroid Checks	February	1959 to Date
Checks Taken	0	0
Checks Above Detection Limit	0	0

Hand Checks		
Checks Taken - Alpha	29,187	57,700
- Beta-Gamma	18,683	37,339

Skin Contamination		
Plutonium	12	31
Fission Products	47	105
Uranium	23	26

CALIBRATIONS

Portable Instruments	Number of Units Calibrated February	1959 to Date
CP Meter	932	1,886
Juno	300	610
GM	1,343	2,700
Other	227	413
Total	2,802	5,609

Personnel Meters		
Badge Film	1,274	1,832
Pencils	1,314	1,314
Other	492	874
Total	3,080	4,020
Miscellaneous Special Services	431	627
Total Number of Calibrations	6,313	10,256

AR Keene

Manager
Radiation Protection

1240779

AR Keene:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - FEBRUARY, 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 3.08, which is considered about average experience.

The absenteeism rate was 3.39 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 13,043 hours. The total shop work backlog is 21,385 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 5.5% (902 hours) of the total available hours.

Distribution of time was as follows:	Man Hours	% of Total
Fuels Preparation Department	1412	10.9
Irradiation Processing Department	785	6.0
Chemical Processing Department	447	3.4
Hanford Laboratories Operation	10209	78.3
Construction Engineering Operation	--	--
Miscellaneous	190	1.4

The number of requests from customers for emergency service decreased from the previous month resulting in a lower overtime ratio. However, the February ratio (5.5%) of overtime hours to available hours is about double the desired annual control ratio. Other project shops were utilized to capacity in providing assistance to the Technical Shops.

A total of 13 requisitions for craft personnel are on file with the Employee Relations Operation. These consist of requisitions for 10 journeyman machinists, one for a journeyman welder, one for an instrument specialist, and one for an instrument technician. One instrument specialist and one instrument technician were transferred to the St. Petersburg, Florida, plant.

The final draft of an assistance type contract was completed and forwarded to off-site shops for bids. In response, two firm bids were received offering to do the work at what is considered a reasonable cost per hour. Two bids were received after the closing acceptance date and could not be considered. The acceptable bids are now being analyzed and approval to accept the successful bidder's offer will be sought in the near future.

Quotations for a planer type machine were received and analyzed. The successful bidder offered a Rockford Hydraulic machine which met all important specifications. The order was placed on March 2, and delivery is expected in April.

Notice was received from the Construction Engineering Operation concerning the return of machine tools loaned to the Technical Shops in 1955. The equipment was formerly located in the 2101 Bldg. (graphite machining) and was being utilized by the Technical Shops for machining graphite and for regular shop work. Because this equipment will be used in machining graphite for the NPR, its return to the 2101 Bldg. is felt to be mandatory. The impact on the Technical Shops Operation by the loss of this equipment is being studied and preliminary plans for replacement are in process.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with 10 medical treatment injuries and no major injuries. Absenteeism due to illness was believed to be normal for this period.

RADIOGRAPHIC TESTING OPERATION

Activity for the Radiographic Testing Operation was above normal for this month reflecting increased activity on the tubular product program. A total of 9,026 tests were made, of which 1,463 were radiographic (including x-ray and gamma ray) and 7,563 were supplementary tests. In man hours out of a total of 1,141, 657 (57.6%) were employed in connection with radiographic tests, and 484 (42.4%) were employed on supplementary tests. The supplementary test work included dimensional measurements (micrometric), eddy current, leak detection, penetrant, and ultrasonic (thickness measurements and flaw detection) tests.

The number of pieces handled this month was comparable to that of previous months totaling some 3,268 items. The feet of material represented by this total however was considerably larger than in any previous month, amounting to almost 20,000 feet. This large increase is indicative of successful automation of some tests on tubular products. Work was done for 20 different organizational components representing most of the operating departments and service organizations. A total of 37 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 17 different requests for advice and information regarding general testing theory for other than jobs tabulated in Part II.

Relocation of the Radiographic Testing Operation's facilities to the White Bluffs area is progressing. The Informal Request issued to effect the move is awaiting momentary AEC approval. Building layouts have been completed to incorporate the tubular product testing equipment and it would appear that all of the work can be done in the east end of the building. Money has been authorized from PRTR funds for construction of pickling and autoclaving facility to do the PRTR process tubes. Work orders have been issued for fabrication of the work tanks and conveyor sections.

Radiographic Testing Operation was called upon for service work in a new field to it's generally accepted activities as part of a strontium 90 uptake. Biology Operation will periodically examine a selected group of animals. To aid in the study it is desirable that radiographs of the skeleton be available for analysis.

Testing Statistics

Component	No.of Tests	Ft. of Weld or Material	No.of Pieces	Description
CPD	133	111 1/2	55	Purex silver reactor welds; 54" and 10" O.D. x .375" wall pipe; 2" sch. 40 pipe; 1 1/2" Sch. 80 pipe. Re-boiler tube bundle.
CEO	949	1327	77	Weld seams on PRTR containment vessel.
FPD	13	18	2	Repair welds on 313 Bldg. autoclave.
HLO	7289	16589 1/2	2015	Animal farm (biology); 8" SS flanges; Zr clad UO_2 samples and fuel rods; Al can with Zr clad UO_2 in NaK sol.; 505" I.D. x .030" wall Zr-2 tubing; .680" I.D. x .035" wall Zr-2 tubing; Pu-Al fuel Plates; 5% Pu-Al billets; 20% Pu-Al Zr clad capsules; Co-extruded Al-U core. Zr clad Al fuel rods; 15% U-85% Pu alloy; 14, 20, 30% U-Al, 1" diam. extruded rods; KER ribless process tubes.
IPD	547	1307 1/2	1050	Helium leak tests 105 C and 105 D; NPR, high pressure pipe; 12" & 18" sch 80 discharge headers, 190 B; boiler mud drum blowdown lines.
R&UO	95	216	69	Longitudinal welds 3" sch 10 SS pipe, Power pole rot survey.
TOTALS	9026	19569 1/2	3268	

FACILITIES ENGINEERING OPERATION

Projects

There were 14 authorized projects at month end with total authorized funds of $6,484,078. The total estimated cost of these projects is $7,589,400. One project was completed during the month. Two new projects are awaiting AEC approval. Project Proposals for eight new projects are in preparation.

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

Engineering Services

Title	Status
Reroofing of 146-FR and 222-U Bldgs.	146-FR Building is essentially complete. 222-U Building work will start in March with completion estimated in April.
Removable Grating - 3745-B Bldg.	Design complete. Work initiated for procurement and installation.
Traveling Crane Improvements 314 Bldg.	Installation work is proceeding.
Noise Attenuation 3760 Bldg.	After the Q-duct installation in the Conference Room an octave band analysis shows that 5 to 7 decibels attenuation were obtained in all octave bands.
Correct Ventilation 326 Building Mezzanine	Installation work underway.
Provide Additional Hoods, Room 7-2A, 325 Building	Installation work underway and essentially complete.
Decontamination of the Interior of 314 Building	Work is progressing. Areas above crane complete.
Erection of Towers for Atmospheric Physics	Eight truck loads of components for ten aluminum rectangular towers. 204 feet tall and five steel triangular towers 141 feet tall have been received from the Air Force. In addition to these, five wood poles 100 feet long will be erected. Specifications and general conditions for erection have been given the Commission with a request that they prepare and process a lump sum contract. The bid opening is planned for 2:00 o'clock on March 12, 1959, awarding of the contract March 16, 1959, and completion of erection May 1, 1959. The installations will be on 200, 800, 1600 and 3200 meter arcs with the focal point in the vicinity of the meteorological tower near 200 West Area.
Renovate Room 30-C - 326 Building	New equipment is being procured for installation.
Improve Lighting - Rooms 11-1A & B - 325 Building	Work is progressing.

Title	Status
Alterations to 40' x 80' Army Mess Hall Building (Atmospheric Physics)	Work complete. Building occupied.
306 Building Water Filter	Vendor is proposing different equipment for this job.
Design & Install Fire Alarm System - 314 Building	Design work essentially complete.
Air Balance - 108-F Building	Engineering work in progress.
Building Modifications 146-FR Building	Work is underway to convert storage space into office rooms.
Gamma Irradiation Facility 3730 Bldg.	Construction work has started. Steel caisson has been ordered and foundation work was started.
Kitchenette Facility In 326 Building	A work order for this work is being issued.
Locker Room Modifications 321 Bldg.	Initial design has been checked and approved. A work order has been issued to Construction Forces to perform work.
Heating & Ventilating Study 306 Bldg.	Study work is in progress.

Design and Drafting Services

Title	Status
Draw Bench Chain Support	Work complete.
Equilibrium Chamber	A device to measure thermal conductivity of dense ceramics. Detail work approximately 80% 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 95% complete.
Wet Storage Basin Manipulators and Cleaner - 325-A Building	Work in progress at 25% complete.

In addition to the above about 7 miscellaneous job items are being worked on in the Drafting Operation.

Maintenance and Building Engineering - Landlord Functions

Costs - January - $ 112,907
December - 128,790

FYTD Total: $ 678,737 - 55% of Budget. The predicted expenditure forecast cost over the same period was estimated to be approximately the same.

Analysis for Month of January: Steam costs were $4000 below predicted because of mild weather. Unusual Maintenance costs were $18,000 below forecast. This slacking of activity accommodated other work commitments, and controlled the total monthly expenditure. The first six months costs were 100.8% of forecast. Now the seven months costs are 99% of forecast.

TECHNICAL INFORMATION OPERATION

There were three personnel changes during the month. The Library's projectionist transferred to an engineering assistant job with Materials Development Operation. A File's messenger, whose driver's license had been revoked for reckless driving, was dropped. A new technical editor was added to the staff, replacing J. J. Hauth who transferred to Fuels Development some months ago.

Three memoranda containing classification instructions were issued during the month.

They are:

HW-59206 "Classification:. . . . . Program"
HW-59334 "Classification: Demonstration Loading"
HW-58275 SUP1 "Classification: New Production Reactor"

A fourth memorandum on classifying plutonium-240 production, quantities of depleted uranium and several miscellaneous items is being prepared.

Section 700 of the Hanford Classification Guide was completely revised. The Civilian Application Program Classification Guide was incorporated in Section 700 to replace the old Guide to Unclassified Fields of Research. The CAP Guide has only recently been authorized for Hanford use in this manner. Several other revisions to the Guide were prepared during February.

The proposal to downgrade production rates is still in the hands of the Military Liaison Committee. Information on its status has not been made available to the AEC.

There has been no further action on the declassification of the NPR. The AEC staff paper containing the proposal is still undergoing review.

A title listing of Research and Development reports published in 1958 was prepared for inclusion in HW-60000, "1958 at Hanford". An additional 200 copies of this listing were supplied to the Professional Personnel Placement Operation for use in technical recruitment.

In the future all Hanford prepared translations of foreign reports will be assigned on HW-TR number. Sixty copies of each translation will be submitted to TISE, Oak Ridge. These HW-TR reports will be given limited project distribution, microcarded and placed on deposit in USAEC foreign and domestic depository libraries and with the Office of Technical Services, U. S. Department of Commerce, Washington, D. C.

The National Aeronautics and Space Administration has placed General Electric Company, Richland on their distribution list to automatically receive copies of CONFIDENTIAL and UNCLASSIFIED NASA publications in the following subject categories:

Hydrodynamics	Compressors
Fluid Mechanics	Turbines
Internal Flow	Lubrication and Wear
Aircraft Structures	Engine Materials
Airframe Materials	

Three members of the Technical Information staff met with personnel from the Engineering and Reports Branch, AEC-HOO, on February 20 to discuss the categorization of classified research and development reports. It was agreed that the primary need was for an analysis of the types of data from which operating levels, operating rates, unit costs or other production related information could be calculated. The AEC agreed to prepare such an analysis. It will be placed on trial for about six months in a draft form. If the criteria prove to be satisfactory, the document will be submitted to the AEC Division of Production for review and approval.

The 1959 inventory of classified documents was started February 23. Arrangements had previously been made with Data Processing to reduce the length of the monthly inventory listings to fit a reduced document inventory staff. The 1959 listings will contain about 30,000 entries per month rather than the 60,000 used when the inventory staff was larger. Under the present schedule, the inventory will be completed in seven months.

Tentative plans have been completed for handling the classified documents to be used at the Eighth Annual AEC Corrosion Symposium to be held in Richland in May. Offsite participants have been instructed to mail their papers to General Electric, Richland, attention the Symposium. Central Mail will forward all material so addressed to the 700 Files. Procedures for checking out and returning the material will be worked out with Security. The meeting is to be held in the Village Theater where Patrol will provide temporary storage for classified material during the day.

The "Approval for Offsite Transmittal of Documents" form has been revised to include a classification review of all unclassified documents before release. The intent of the review is to prevent the inadvertent disclosure of classified information in a document which the author believes to be unclassified.

The Manager, Technical Information attended a meeting in Washington, D. C. of the Steering Committee of the Technical Information Panel. Present Commission plans are to have the Panel take an increasingly active role in planning and evaluating the AEC Technical Information program. Purpose of the meeting was to discuss the new role of the Panel and to delineate a long-range plan of action.

Three members of the Technical Publications staff, General Electric Company, Aircraft Nuclear Propulsion Department visited the Technical Information Operation on February 12, 1959. Mutual problems concerning writing, editing and publication of technical reports were discussed.

Work Volume Statistics	January	February
Document Distribution and Files		
Documents routed and discharged (copies)	15,746	19,219
Documents issued (copies)	10,578	10,354
Documents sent offsite (copies)	3,453	3,893
Document reserves filled (copies)	886	987
Documents picked up and delivered	22,149	25,790
Document Accountability		
Holders of classified documents whose files were inventoried	577	310
Documents inventoried in Files (copies)	105	28,705
Documents destroyed or retired (copies)	4,675	5,274
Documents revised (copies)	2,061	2,835
Documents pulled and documents filed (copies)	11,359	12,815
Documents reclassified	582	561
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	204,878	202,961
Reference and Publication		
Books cataloged (new titles)	111	2
Books added to the collection (volumes)	252	227
Ready reference questions answered by professional staff	168	185
Literature searches by professional staff	119	107
Reports abstracted (titles)	205	214
Formal reports prepared (titles)	6	12
Offsite requests for HAPO reports (copies)	179	208
Reports released to CAP (titles)	29	20
Library Acquisitions and Circulation		
Books ordered (volumes)	342	415
Periodicals ordered	30	122
Books circulated (volumes)	1,524	1,601
Periodicals circulated (issues)	2,520	2,549
Inter-Library loans	81	66
Films borrowed or rented	21	31
Industrial film showings	44	44
Bound periodicals added to the collection	153	28

Library collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Totals
No. of books	25,413	8,153	1,383	1,925	36,874
No. of bound periodicals	11,559	1	1,431	96	13,087
	36,972	8,154	2,814	2,021	49,961

Classification and Declassification	January	February
Documents, including drawings and photographs reviewed for downgrading or declassification	89	128
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	27	24
Documents submitted to Declassification Branch, Oak Ridge	30	21

LABORATORIES ADMINISTRATION

Timely revisions were issued on two Organization and Policy Guides.

The following contracts were processed for approval:

SA-54, The Swedish Hospital, for exchange of clinical data.
DDR-54, Aeroprojects, Inc. for welding of fuel elements.
SA-61, State College of Washington, for acquisition of swine and exchange of information.

The following contracts are being negotiated:

DDR-29, Nuclear Metals, Inc., a modification providing for additional research and development work.
CA-212, Dr. Frankling I. Badgley, for consulting services.
CA-213, Dr. P. E. Church, for consulting services.
DDR-62, Battelle Memorial Institute, for graphite studies.
A contract for machine shop work.
A new contract replacing CA-185 with Dr. Sidney Marks for pathological services.
A new contract replacing CA-181 with Prof. J. L. Powell, for consulting services in physics.

Assistance to Hanford, No. ATH-HLO-3-59, for corrosion testing of aluminum cladding, and No. ATH-HLO-4-59, for research on processing of aluminum cermets, were approved February 4, 1959. No. ATH-HLO-5-59 for investigation of friction welding of nuclear fuel rods was approved February 20, 1959. No. ATH-HLO-6-59 for the design and construction of an electron welding gun, has been prepared for approval. An Assistance to Hanford project for the fusion of uranium dioxide is being considered.

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 - 59463
MONTH February, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN SCHED.	CONST. 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:

Work remaining on the exceptions for the Lump Sum Contractor includes; paving, and general clean-up. Completion is dependent on weather conditions.

Work remaining on the exceptions for the CPFF Contractor includes; hood installation, oil pans under the hydraulic unit, safety chain around the elevator and rain gutter over the outside elevator door. Completion of these items is expected by March 6, 1959.

* Actual dates.

CGH-809	Electrical Modifications - 328 Building		$40,000	100	100	7-30-58	- - -	12-15-58*
		$31,000	6-30-58	100	100**	1-9-59	3-1-59	2-27-59**

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: R. C. Ingersoll

REMARKS:

This project is essentially complete. Approximately 20 man days will be required to complete the redistribution of lighting and receptacle circuits in the first floor area. It is expected that the remaining work will be complete by March 13, 1959.

* Actual date.
** The project is considered physically complete with exceptions as noted.

General Plant Projects FY 1959								
CAH-827	Automatic Columbia River Monitoring Station		None	0	0	5-1-59	- - -	8-1-59*
		$27,000	None	0	0	10-1-59	- - -	3-1-60

USING COMPONENT: Radiation Protection

FEO ENGINEER: D. S. Jackson

REMARKS:

The new project proposal was transmitted to Project Budgets Operation on February 26, 1959. Funds in the amount of $27,000 are requested to construct a single river monitoring station at the PRTR river pump house site.

* GE portion only.

AM-7286-630 (9-58)

BUDGET CLASSIFICATION: General Plant Projects FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59463
MONTH February, 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. N.S.	N.S. N.S.	3-18-59 6-18-59	4-3-59* 12-31-59	4-3-59 12-31-59

USING COMPONENT: Property Accounting

FEO ENGINEER: R. C. Ingersoll

REMARKS:

Directive No. AEC-148 was issued February 18, 1959. Work Authority CAH-828(1) was issued February 24, 1959. The funds were reduced $1,100 by the Commission and the variance was accepted by HLO. Work on the design criteria has been initiated.

*Project proposal date.

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-829	Building 325 Basement Improvements	$70,000	$70,000 2-13-59	N.S. 50	N.S. 0	2-13-59 3-2-59	5-13-59 9-30-59	5-13-59 9-30-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. C. Ingersoll

REMARKS:

AEC Directive No. HW-481, dated February 13, 1959, was received on February 17, 1959. HLO Work Release Authorization No. 39, dated February 17, 1959, was issued to CEO. Relocation work on vacuum lines and electrical outlets to make room for the partition will start on March 2, 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-837	Animal Pens, Isolation and Examination Facilities	$80,000	None None	0 0	0 0	- - -* - - -*	- - - - - -	- - -* - - -*

USING COMPONENT: Biology

FEO ENGINEER: J. T. Lloyd

REMARKS:

The project proposal was transmitted to AEC-HOO February 27, 1959.

* Schedule to be determined at a later date

AM-7300-819 (5-58)

BUDGET CLASSIFICATION: General Plant Projects FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - HW-59463

MONTH: February, 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	5 5	2-17-59 2-23-59*	... 4-28-59	2-20-59** 4-10-59

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. E. Ralph

REMARKS:

Informal Approval IR-242, dated February 17, 1959, was received on February 19, 1959. Field work started on February 23, 1959. Ninety-five per cent (95%) of the equipment in the 314 Building has been dismantled and removed to the 303-J Building.

* Plant Forces and Construction Forces started work on February 23, 1959 (Equipment work by Plant Forces - Building modifications and utilities by CPFF Contractor Forces).

** Design is complete, consisted only of field sketches.

IR-243	Relocation of 200-E Testing Equipment	$18,000	None None	0 0	0 0	.5 * 1 *	... ...	1 * 6 *

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: H. Radow

REMARKS:

The Informal Request has been submitted to AEC HOO for approval.

* Weeks after authorization.

New Construction FY 1960

CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None None	0 0	0 0	... ...	... ...	... ...

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

A preliminary project proposal requesting funds for preliminary design was submitted to the General Manager for approval on January 23, 1959, to date it has not been signed and submitted to the Commission.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59463
MONTH February, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory (Stage I)	$1,000,000	$175,000 5-12-58	100 100	0 0	5-22-58 12-1-59	--- ---	2-24-59 2-1-61 *

USING COMPONENT: Physics & Instruments R & D

PEO ENGINEER: D. S. Jackson

REMARKS: Due to previous committments made to the Commission and to the Advisory Committee on Reactor Safeguards, the revised estimated cost of $6,000,000 for CGI-791, "Reactor Confinements" must be funded from Budget Item 58-b-4. To provide the necessary funds the project proposals requesting $825,000 for Stage I of the "Critical Mass Laboratory" and $250,000 for "Remotely Operated Cap Remover", which were in AEC Washington awaiting approval, were approved and are to be funded from Budget Item 60-(1). This means that funds will not be available to initiate procurement of engineered items or a construction contract until about September or October, 1959. This will delay completion of the project about six or seven months. Design of Stage I was completed on February 24, 1959. Design review is now in progress.

* Revised date assuming funds are available September 1, 1959.

CA-744	Metallurgical Development Facilities	$2,623,000	$2,685,000 11-5-58	93 96	0 0	6-30-58 N.S.	--- 9-1-60	9-1-59 9-1-60

USING COMPONENT: Reactor & Fuels R & D

PEO ENGINEER: J. T. Lloyd

REMARKS: The invitation to bid on the structure (Invitation Number AT(45-1)-1440) has been sent out to prospective bidders. Bids will be opened on March 26, 1959. Requisitions for equipment are being prepared according to priority and delivery schedule.

CA-749	High Level Radiochemistry Facility	$960,000	$960,000 10-31-58	100 100	38 39.5	6-15-58 8-14-58	--- 6-30-59	11-21-58 8-1-59

USING COMPONENT: Chemical Research & Development

PEO ENGINEER: R. W. Dascenzo

REMARKS: The following construction work was performed during this period: (1) Formed ground floor slab for cell structures and installed cell liner supports. (2) Building was closed in February 4, 1959. (3) Finishing of concrete walls continued. (4) Pipework in basement continued; wet storage pump installed. (5) Electrical conduit installed from existing panels in the basement of the 325 Building to 325-A Building. (6) Stainless steel liners for Cells B and C Hausermann Partitions, liquid transfer hood and leaded stainless steel tanks received on-site; the two liners were set in place. (7) Ventilation supply duct partially insulated. (8) Electrical transformers were installed. (9) Miscellaneous lead shielding was received. (10) Compacted backfill around building continued. The proposal for the General Mills Crane was received from the AEC on 2-11-59, approved and returned to them on 2-12-59. To date this order has not been placed; 5 months required for delivery.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58 b 4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59463
MONTH February, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$338,000	$325,000 / 6-25-58	100 / 100	23 / 28	6-23-58 / 10-9-58	- - - / 2-1-60	12-31-58* / 2-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: A. W. Hervin		

REMARKS:

The CPFF Construction Contractor is working on installation of piping, electrical, re-steel, and building exhaust ductwork for the last major concrete pour. The last major concrete pour is scheduled for the first week in March. The special conditions for the lump sum portion of the work have been forwarded to the Commission. The advance notice to prospective bidders has been issued. A letter has been written to the Commission advising them that as a result of the waste line leaks, there is a possibility that this project may overrun the authorized funds.

* Actual date.

CGH-819	Increased Laboratory Waste Facilities - 300 Area	$300,000	$30,000 / 11-24-58	0 / 0	0 / 0	3-31-59 / 11-1-59	- - - / - - -	9-1-59 / 9-1-60
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: A. W. Hervin		

REMARKS:

Work is continuing on the particulate problem. Design is now expected to start by the end of March.

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	40 / 38	12-6-56 / 12-3-58	- - - / 8-31-59	10-15-58* / 8-31-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: A. W. Hervin		

REMARKS:

The major portion of the concrete has been poured. The contractor has installed DC bus and cable trays in the 185 portion of the building. It is anticipated that the contractor will start work about March 15, 1959 on the piping and loop system in the 189-D Building. The contractor has started moving some of the equipment into the building.

* Actual date.

AM-7300-011 -58)

BUDGET C SIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MO. ALY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59463
MONTH February, 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.	ESTIM. COMP.: DESI / CONS
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,200,000 / 8-1-[illegible]	100 / 100	98 / 95	9-17-56 / 9-7-58	/ 12-15-58	9-2-5[illegible] / 5-1-5[illegible]

USING COMPONENT: Reactor & Fuels R & D

PED ENGINEER: H. Radow

REMARKS:

The in reactor 6 x 9 loop fabrication is on hand, however, approval of the Hazards Survey Group has not yet been received, therefore the installation is still being held up. The damaged 3 x 3 loop has been replaced. Examination of the "failed" section indicated a defective weld in the aluminum piping.

Revision 3 of the project proposal has been prepared and submitted to the General Manager, to date it has not been transmitted to the Commission.

* Forecast completion dates and revised estimated total project cost are shown in the revised project proposal.

** Some design to cover startup items is now underway on a work order basis.

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.	ESTIM. COMP.: DESI / CONS
CG-682	High Level Cut-Off and Examination Cell - 327 Building	$415,225*	$430,000 / 8-20-5[illegible]	100 / 100	100 / 100	7-18-56 / 3-27-58	/ 10-1-58	6-28-5[illegible] / 9-30-5[illegible]

USING COMPONENT: Reactor & Fuels R & D

PED ENGINEER: A. W. Hervin

REMARKS:

Status of exceptions: The drive assembly on the cut-off saw has been changed from a V-belt to a direct drive. Preliminary cutting tests have been run and it was found that baffling of the wafer will be needed to prevent splashing from the saw wheel; more extensive tests will be run during March. The sample storage racks are being fabricated. The micrometer for the length measurer has been ordered. In-cell hood lifting mechanism is complete and work has been started on the exterior mechanism. One manipulator has been installed. The second manipulator has been reworked and is awaiting gears for the wrist action. The third manipulator is being reworked.

* Actual.

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.	ESTIM. COMP.: DESI / CONS
CA-695	Radio Telemetering Network	$109,078	$109,078 / 5-23-58	100 / 100	100 / 99	2-22-57 / 7-25-57	4-15-57 / 2-1-59	5-27-57 / 2-27-59

USING COMPONENT: Physics & Instruments R & D

PED ENGINEER: J. T. Lloyd

REMARKS:

The station that was located on Richland School property on Thayer Drive has been eliminated. The project will be closed out with only 19 stations installed. The one station which was not installed is a trickle charger type and some time in the future a wind charger will be purchased and the unit will be installed in a remote area; until this time there will be two spares. The AEC has indicated they will not revise and extend the project completion date, but will close out the project in its present state. All stations have been checked-out by Instrument Labs; their personnel have left the area. Activation of the network is scheduled for the first week of March, 1959.

*Project complete with minor exceptions.

AM-7300-019 (3-58)

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59463
MONTH February, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT	DESIGN SCHED.	CONST. SCHED.	DESIGN	DESIGN	DESIGN
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000	3	0	1-5-59	- - -	12-8-59
			12-8-58	3	0	N.S.	12-31-60	12-31-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The first Comment Drawings have been issued and preliminary specifications for instrumentation procurement have been prepared. A meeting was held to resolve the basic requirements and scope of the capsule removal equipment; mechanical design activity on this has begun.

CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$10,000	N.S.	0	6-10-58	- - -	7-1-59
			6-7-58	40	0	N. S.	- - -	2-1-60

USING COMPONENT: Reactor & Fuels R & D

FEO 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	$150,000	N. S.	0	8-26-58	- - -	5-30-59
			2-25-59	42	0	N. S.	3-31-60	3-31-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

Directive No. HW-468, Modification No. 1, dated February 25, 1959 was issued authorizing total project funds of $150,000. The project proposal requested 13 months for completion of the project, but only 12 months were allowed.

AM-7300-019 (8-58)

BUDGET CLASSIFICATION: Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 59463

MONTH February, 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.
	Dynamic Test Facilities	$150,000	None / None	0 / 0	0 / 0	1* / 5*	- - - / - - -	4.5* / 12*

USING COMPONENT: Reactor & Fuels R & D

PED ENGINEER: D. S. Jackson

REMARKS:

The project proposal is currently under review by members of Reactor & Fuels R & D management.

* Months after authorization.

CGH-834	Modifications and Additions to High Pressure Heat Apparatus - 189-D Bldg.	$700,000	None / None	0 / 0	0 / 0	* / 3 **	- - - / - - -	10 ** / 18 **

USING COMPONENT: Reactor & Fuels R & D

PED ENGINEER: H. Radow

REMARKS:

The project proposal has been submitted to the General Manager for approval.

* Immediately upon authorization.
** Months after authorization.

	Fission Product Volatilization Studies Test Facility - 292-T Building	$75,000	None / None	0 / 0	0 / 0	0.5 * / 3 *	- - - / - - -	3.5 * / 8 *

USING COMPONENT: Chemical Research & Development

PED ENGINEER: D. D. Wodrich

REMARKS:

The project proposal has been revised and is being circulated for final HLO approvals.

* Months after authorization.

AM-7000-000 (8-58)

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
Paul Berner	2-4-59	Star Machinery Co.	To inspect equipment	L.J. Lucas	No	300, 328
K. H. James	2-5-59	Metco Co. Seattle, Wash.	To discuss problems on metal spraying	J.H. Kelly	No	300, 328
Paul Berner	2-10-59	Star Machinery Co. Seattle, Wash.	To discuss jig borer	L.J. Lucas	No	300, 328
Cleo Gray Ed Hill Charles Horner	2-12-59	Aircraft Nuclear Propulsion Dept. Cincinnati, Ohio	Discuss operation of Tech.Info. and Tech. Pub.	C.G. Stevenson S.P. Gydesen	No	300, 3760

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R.B. Socky	2-15-59	ASTM Committee meetings, Pittsburgh,Pa.	HAPO representative on E-7 & E-10 Committees		No
"	2-18-59	Puget Sound Naval Shipyard, Bremerton, Wash.	Confer on installation of 1 Mev Van de Graaff X-ray Generator	W.H. Hannah	No
C.G. Stevenson	2-18 - 2-27-59	GE USAEC Washington 25, DC	Attend Steering Committee meeting.	M.S. Day	No
		Eli Lilly Co. Indianapolis, Ind.	Work out details of talk to Spec.Libraries Assoc.	Helen Loftus	
" "		General Electric Schenectady, N.Y.	Discuss of utilization of GE Tech. Infor.	Clifford Fick	No
R.W. Dascenzo	2-28-59	B.D. Bohna & Co. Vancouver, B.C.	Observe the application of guniting provess	B.D. Bohna	No

EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

GENERAL

At month's end, the staff of the Hanford Laboratories Operation totalled 1210 employees, including 575 exempt and 635 nonexempt employees. There were 489 exempt employees possessing technical degrees, including 278 B.S., 107 M.S. and 104 Ph.D.

TRAINING

The Armed Forces Special Weapons Project training program for medical officers was completed February 13. Feedback from the participants was extremely favorable insofar as course presentation and course content were concerned.

Plans for the HLO Information and Orientation Series for Nonexempt Employees were completed for final approval. The preliminary schedule provides for the first session of this program to be presented on March 13.

UNION RELATIONS

The arbitration hearing on the Wonacott case has been postponed until security clearances have been granted for non-employees appearing in the hearing.

Three oral complaints pertaining to assignment of work were discussed with bargaining unit representatives during the month. Progress is being made toward a mutual understanding of the work assignments involved.

Four grievances pertaining to work assignments were submitted during February. Two were settled at Step I and two are being processed at Step II. For the calendar year to date there have been five grievances within the Laboratories.

COMMUNICATIONS

The Nuclear Physics Research Open House was held on February 14 with approximately half of the organization attending.

Hanford Laboratories participated extensively in a tour program sponsored by the A.E.C. for Edison Day and provided a technical display for the visit of the Division and Group General Managers.

Plans for HLO participation in A.E.C. sponsored tours during the spring months were completed and provided an average of three tours per month during this period.

EMPLOYEE COMPENSATION

The HOO-AEC approved a suggestion award in the amount of $1175 to D. W. Latta of the Reactor & Fuels Research & Development Operation. Five additional suggestions were approved for awards totalling $410 at the February meeting of the HLO Suggestion Board.

HEALTH & SAFETY

Laboratories personnel worked a total of 197,828 manhours during the month with no disabling injuries. Since September 1, 1956 a total of 5,672,868 manhours have been completed with no disabling injuries. The medical treatment frequency for February was 1.67 as compared with 1.13 during January.

1240799

There were three security violations during the month of February.

PROFESSIONAL PERSONNEL PLACEMENT

Recruiting of Ph.D. physicists continues to cause concern and extensive effort is being made to secure the necessary numbers of such personnel and to develop previously unrewarded sources of qualified candidates. To date, eight physicists have visited for interviews and 25 are scheduled to visit Richland during coming months. Recruiting of Ph.D. candidates in other disciplines appears to be favorable with seven acceptances for the year to date.

Recruiting of Technical Graduates and experienced BS/MS candidates is progressing very satisfactorily although some difficulty is being encountered in employing the necessary numbers of BS/MS candidates in physics. It is anticipated that other requirements will be met.

At month's end there were 25 Technical Graduates on the program. It is now impossible to fill available assignments for permanent placement and this situation will not be improved until June graduates report on the roll.

Recruiting for summer programs of temporary employment has resulted in acceptances from eight professors, nine graduate students and seven juniors. It is expected that requirements for graduate students and juniors will be met; however, difficulty is being encountered in obtaining the necessary number of acceptances from faculty members primarily as a result of the extensive opportunities available for such people and the salary schedules that are currently in effect for them in other companies.

EMPLOYMENT

Twenty-seven requisitions were received during the month. Fifteen openings were filled and currently there are 50 openings. There are 16 candidates in process and nine transfers pending, leaving 25 candidates to be procured.

T G Marshall

Manager,
Employee Relations

TG Marshall:tr

VISITORS TO HAPO

Name	Date of Visit	Company Represented	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
Arthur Werner Robert Ashworth	2/3	Radiation Lab. Univ. of Calif.	Organization of Labs. function to best utilize technicians	H.A.Paulsen W.E.Foust A.P.Hudspeth R.S.Himmelright	None	300-3760
K. M. Haws	2/27	Engineering Services	Engineering Services Western Circuit Program and Advanced Engineering Programs	T.G.Marshall E.P.Galbraith	None	700-705

TABLE II. NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	Jan.	Feb.
Requisitions		
At end of month	45	50
Cancelled	0	1
Received during month	26	27
Filled during month	9	15
Candidates Considered		
Total applications	41	35
Total transfer requests from other at HAPO	0	0

Nonexempt Transfer Requests	Jan.	Feb.
Transfer Requests		
Active cases at end of mo.	73	74
Cancelled	2	2
New	10	6
Transfers effected	1	1

TABLE III. UNION RELATIONS

Grievances Processed - January 1, 1959 to date

Total Processed	5
Step I	
Answered satisfactorily*	2
Step II	
Pending Step II answer	1
Answered	
Satisfactorily**	0
Pending time limit	1
Applied for arbitration	1
Pending arbitration decision	1

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

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

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.	526	174	39	67	22	7	6	7
Ex. BS/MS	298	53	35	7	50	32	9	32
Program BS/MS	260	-	-	-	146	34	82	8

*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.	526	174	39	67	15	4	5	4
Exp. BS/MS	258	41	24	6	24	15	4	14
Program BS/MS	(Off Program Placement)				*** 13	*** 13	-	-

**Offer totals include offers open on 9/1/58

Ph.D.	2
Exp. BS/MS	2

***Last month's figures in error

In addition to the above activity, 17 exempt employees have transferred into HLO from other HAPO departments to date.

C - Technical Graduate and Technician Training Program
Month ending February 28, 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	11	5
CEO	0	0
R&UO	0	0
FPD	2	0
IPD	12	5
CPD	0	0
Distribution of assignments by functions		
R&D or Engineering	20	10
Other	5	0

FINANCIAL OPERATION MONTHLY REPORT
FEBRUARY 1959

Personnel

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

Activities

GENERAL ACCOUNTING OPERATION

A report of results was issued for the physical inventory of uninstalled cataloged equipment in the custody of Physics and Instrument Research and Development Operation. One thousand, two hundred twenty-seven items were physically counted, valued at $952,517. No missing equipment was reported during the inventory as compared to 10 missing items valued at $3,155 in the FY 1957 inventory. In the current FY inventory 4 items valued at $1,252 were added to record as compared to 124 items valued at $35,334 in the FY 1957 inventory. Inventory results indicate good control over equipment and the use of proper procedures in transferring or retirement of equipment.

All field work in connection with the physical inventory of uninstalled cataloged equipment in the custody of Reactor and Fuels Research and Development Operation and equipment purchased under Project Whitney is complete and the reconciliation is in progress. Considerable effort was expended by Financial personnel in searching for missing Project Whitney equipment, which was reduced to 5 items valued at $451. Acquisition prices were obtained for 321 items valued at $574,846 which will be added to record in March 1959.

Approval was obtained from the Commission to transfer equipment purchased for the MTR Fuel Pilot Fabrication to HLO by use of the Non-Fund Adjustment Account. This equipment valued at $13,677 will be added to record in the month of March.

A request was made of Contract Accounting to obtain Commission approval to change the classification of zirconium from special reactor materials to that of essential material. The classification of zirconium and its fabricated alloy as reactor materials results in unnecessarily costly, burdensome and restrictive procedures in the every-day operational movement of this material.

In response to a request of SS Accountability, material custodians were requested to submit outside quota material forecasts to this office. Upon receipt, the information will be consolidated and forwarded to SS Accountability.

Separated Plutonium valued at $1,041,791 applicable to Project Whitney was returned to CPD during the month of February. It was necessary to change the Consumed In Research account $178,913, the difference between CPD's price and HLO price.

The local Commission was notified by the Pittsburgh Naval Reactors Operation that they will no longer accept zirconium scrap. A study is underway to determine disposition of approximately 12,000 lbs. of scrap located at vendors' plants.

The updating of our property unit records with IBM is 2/3 complete. In the past three months, 7,417 input data sheets have been prepared and submitted to Data Processing to include additional description, purchase order reference, rate of depreciation and reconciliation of all other information. There are approximately 3,500 cards remaining to be processed. The updating and reconciliation of our records with IBM is in connection with our mechanization program of property records.

The budget for Equipment Not Included in Construction Projects was consolidated and submitted to Contract Accounting by the due date. A summary of our submission shown below reflects an overall reduction in equipment requirements as compared to our FY 1959 Expenditure - Commitment Allocation.

			Current Budget	
(Amounts in Thousands)	FY 1959 Allocation	Original FY 1960 Budget	Revised FY 1960 Budget	FY 1961 Budget
2000 Program*	$3 570	$2 860	$2 557	$2 606
3000 Program	150	325	122	210
4000 Program	585	723	988	1 051
6000 Program	106	190	227	201
Totals	$4 411	$4 098	$3 894	$4 068

*Includes Equipment not specifically allocated.

Classification activity included the review of 724 work orders and 688 purchase requisitions for capital-expense determination. Transfers to plant in February totaled $267,822 and included the following:

CG-729	222-U Building Ventilation and Heating Improvements	$79 420
CGH-803	Alterations to Building 231-Z	40 019
Miscellaneous Equipment Items		148 383

Approval was received from the Commission to transfer the expense portion of Project CG-680 ($41,551) to Expense Portion of Construction Projects.

A manual concerning travel is nearly complete in draft form and should be ready for review by March 16, 1959.

COST ACCOUNTING OPERATION

Information received from AEC established the HAPO 4000 Program for FY 1959 at $6,500,000. Maximum amounts established for sub-programs totaled $6,715,000. AEC requested that GE realign the sub-programs to the $6,500,000 level. Following is the allocation established by General Electric Company of the $6,500,000 which will be used as the Control Budget, effective with February reports.

(Dollars in Thousands)

Plutonium Recycle Program	
Reactor & Fuels R&D Operation	$3 710
Chemical R&D Operation	504
Physics & Instrument R&D Operation	280
Programming Operation	316
Total PRP	4 810
Gas Cooled Power Reactor	
Reactor Physics Studies	77
Reactor Graphite Studies	128
Total GCPR	205
Maritime Loop (IPD)	625
Reactor Fuels & Materials	
Swelling Studies	150
Non-Destructive Testing (FPD)	65
Total RF&M	215
Waste Disposal	60
Total 4000 Program	
Operating Funds	5 915
Equipment	585
Total	$6 500

During February, Hanford Laboratories Operation received funds from off-site sources for new jobs and expansion of current work as follows:

Fabrication of Transplutonic Elements	$120 000
Additional Project Whitney Funds (in transit)	69 000
Palm Element Program	30 000
	$219 000

A study of the accounting requirements for the PRTR Operation has been initiated. Tentatively, AEC has agreed that it will not be necessary to follow accounting procedures established for either production reactors or other test reactors. Consequently, effort is being directed toward developing an accounting system which will facilitate to the maximum degree the technical evaluation of the economics of alternate fuel fabrication techniques and fuel cycles.

PERSONNEL ACCOUNTING OPERATION

Statistical reports were prepared for each section manager covering the Salary Review for 1959.

Envelopes containing the January 26, 1959 Salary Owners Quarterly were delivered to all participants in the Savings and Security Program.

The General Electric Savings and Security Program monthly register and recapitulation of employees deductions savings, proportionate Company payment and incentive shares credited to employees were received from Schenectady on March 2, 1959. The recapitulation of employee deductions savings of $38,815.08 agreed with control figures maintained by Personnel Accounting.

This register indicates the average stock price used in crediting employees' accounts for fractional shares of stock as being $78.64 for the month of January.

Seven exhibits were prepared showing some of the activities and all of the expenditures made by Personnel Accounting during the calendar year of 1958. It was interesting to note that the gross earnings plus the employer's cost of the various benefit plans approximated 9 1/2 million dollars.

PROCEDURES

Mechanical accounting needs for Equipment Work in Progress were defined and transmitted to Data Processing Operation with a request for implementation information.

In cooperation with Radiation Protection Operation a study of the disposal schedules for radiation protection records is in progress.

Work is continuing on feasibility of HLO Financial doing their own IBM card punching, obtaining improvements in present information received from Data Processing and further mechanization of accounting records.

MEASUREMENTS

The contribution of Hanford Laboratories to "1958 at HAPO" was completed and forwarded for consolidation with other HAPO contributions on February 10. A summary of Personnel Accounting functions was prepared to assist in comparisons of different Personnel Accounting components throughout the Company.

AUDITING

Reports on the audit of Material and Equipment Furnished AEC Construction Contractors and the audit of Contracting and Procurement were issued. Follow-ups were completed for the audit of Personnel Accounting and the audit of Property Accounting. Field work on the audit of Work Orders is nearing completion.

The HAPO Internal Auditors have agreed on a tentative standard HAPO procedure that would relieve GE Security of all material pass processing except the actual pick-up at the barricades. The procedure calls for the following additions to present HLO procedures:

(1) Property Accounting matching of One Trip Material Pass yellow copies received from the originators to the white copies picked up by Patrol. Property Accounting now receives these yellow copies but forwards them to Security for matching.

(2) Property Accounting control of Extended Material Passes.

(3) Recall of all present One Trip Material Passes and issue of newly designed passes with a number prefix of 7 to designate HLO.

Payroll Statistics

Number of HLO Employee Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 203	570	633
Additions and Transfers In	21	9	12
Removals and Transfers Out	(14)	(4)	(10)
Employees on Payroll at End of Month	1 210	575	635

Overtime Payments During Month	February	January
Exempt	$ 5 172	$ 1 829
Non-Exempt	10 069	8 576
Total	$15 241	$10 405

Gross Payroll Paid During Month		
Exempt	$445 638	$471 812
Non-Exempt	284 685	341 381
Total	$730 323	$813 193

Participation in Employee Benefit Plans at Month End	Feb. Participation Number	Feb. Participation Percent	January Participation Number	January Participation Percent
Pension Plan	1 157	98.9	1 161	98.9
Insurance Plan				
Personal Coverage	1 231	99.8	1 225	99.8
Dependent Coverage	827	-	822	-
U.S. Savings Bonds				
Stock Bonus Plan	75	37.9	78	40.0
Savings Plan	95	7.9	99	8.2
Savings & Security Plan	1 012	94.0	1 008	94.5
Good Neighbor Fund	824	68.1	819	68.1

Insurance Claims	February Number	February Amount	January Number	January Amount
Employee Benefits				
Life Insurance	-	-	-	-
Weekly Sickness & Accident	15	1 678	12	1 253
Comprehensive Medical	55	5 187	94	8 195
Dependent Benefits				
Comprhensive Medical	113	7 457	146	12 134
Total	183	$14 322	252	$21 582

W. Sale/bk

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INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
C. M. Unruh	An Ionization Type Finger Ring Dosimeter
L. E. Mills John Scherger	Insulated Tungsten Electrode for Tungsten Arc Welding
W. E. Roake, E. A. Evans D. W. Brite	Isostatic Fuel Elements for Neutronic Reactors
M. O. Rankin	Portable Dose-Rate Integrator

H M Parker