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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

SEPTEMBER, 1959

OCTOBER 15, 1959

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
SEPTEMBER, 1959

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By Authority of CG-PR-2

Compiled by
Operation Managers

October 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE September 30, 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	127	101	228	137	105	242	0	3	10	7
Reactor & Fuels Research & Development	192	159	351	194	163	357	1	9	3	13
Physics & Instrument Research & Development	62	34	96	68	39	107	2	2	8	7
Biology Operation	36	45	81	38	47	85	0	0	2	2
Operation Res. & Syn.	16	4	20	16	4	20	0	1	0	1
Radiation Protection	33	100	133	34	100	134	0	1	1	1
Laboratory Auxiliaries	48	193	241	47	195	242	2	3	1	5
Financial	12	13	25	12	13	25	0	0	0	0
Prof. Plcmt. & Rel. Pr.	86	18	104	90	27	117	4	3	8	12
Programming	16	4	20	16	5	21	1	0	1	1
General	1	2	3	1	2	3	0	1	0	1
Totals	629	673	1302	653	700	1353	10	23	34	50
Totals excluding internal transfers	629	673	1302	653	700	1353	10	17	34	44

Composite Separation Rate _____ 6.4516
Separation Rate(based on separations leaving G. E.)_____ 1.6897
Controllable Separations Rate _____ .5376

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BUDGETS AND COSTS

Costs for September were $2,009,000, an increase of $199,000 over August. Fiscal year-to-date costs are 25% of the amounts currently authorized to Hanford Laboratories.

Plutonium Recycle Program costs are $1,438,000 (28% of annual authorized funds) for the first fiscal quarter which will require a substantial reduction in level of effort to stay within the authorized cost ceiling.

Adjustment in the level of effort on IPD New Production Reactor will also be required as the cost of this program when annualized indicates a potential overrun of available funds.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Preliminary laboratory studies indicated that an adequate degree of flow mixing is obtained within NPR type, wire wrapped, seven-rod cluster fuel elements.

A survey of the shielding properties of high density concretes indicates that the proper mixture of iron, serpentine, and cement in the density range of 210 lb/ft^3 is a good candidate for biological shield application where the ambient temperature of the shield may reach 300 C.

Contrary to the behavior of ingot metal, bare dingot uranium does not appear to corrode in water by a hydride-controlled reaction at 200 C. This is attributed to the absence of carbide stringers in dingot material. However, when confined in a pre-defected jacket, dingot metal appears to corrode by a hydride-controlled reaction, at this temperature.

Corrosion rates of uranium - 2% Zr metal in water at 200 and 300 C were found to be approximately one-fifth of those observed for unalloyed uranium metal.

The effectiveness of bicarbonate-peroxide reagent for removing UO_2 rupture product from a mixed stainless steel-carbon steel system has been established by three loop tests.

Effective decontaminating agents for an NPR-type mixed stainless steel-carbon steel system have been demonstrated in loop tests, except that the corrosion of the carbon steel surface is approximately one mil per decontamination, or five times the desired maximum corrosion rate.

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A section of 18 percent cold worked NPR Zircaloy-2 process tubing burst at 9000 psig internal pressure when tested at 340 C, indicating greater than a four-fold safety factor over design operating conditions.

Preliminary data for the high temperature irradiation of needle-type Continental Coke graphite indicates a contraction of 0.08 percent after three MTR cycles at approximately 900 C. This is, tentatively, less than half of the contraction rate of TSGBF, and slightly less than the rate of CSF graphite, at this temperature.

Examination of a Zircaloy-2 process tube in KER loop service for 25 months revealed the following: (1) a friable, rust-brown film was generally visible except in those regions where fuel had scored the tube, (2) pits approximately 0.005" deep were observed on the downstream end of the tube, (3) areas of equiaxed grains were observed which in at least one instance extended through the wall, and, (4) small unidentified rod shaped inclusions were observed.

Testing continues to reveal marked differences in the creep behavior of 25% and 45% cold worked Zircaloy-2.

Daily measurements of the strain measuring transducers in the in-reactor (KW) creep capsul indicate no radiation induced zero shift. The Zircaloy-2 specimen will be subjected to a creep test when its exposure reaches 10^{18} nvt.

A KER nine-foot charge of enriched tube-tube elements showed a measured temperature imbalance of 27 C from the central hole to the outer annulus at full power. This imbalance is sufficient to require a redesign of the fuel.

Two tube-rod elements irradiated to 2000 MWD/T in KER currently undergoing radiometallurgy examination at BMI show a diametral increase of about six percent.

Evaluation of ultrasonic welding for attaching self-supports to present reactor fuels indicates a satisfactory product and that this method may be more amenable to mass production than spot welding.

Short lengths of coextruded NPR tubular fuel have been successfully hot headed in a manner analogous to that successfully developed for rod closures. The jacket thickening appears sufficient to permit the satisfactory projection weld of a ring cap to the ends of the tubes for the final closure.

The quenching of an irradiated uranium disk specimen at rates comparable to those to which fuel is subjected in-reactor, produced macrocracks identical in appearance to those observed in some irradiated rod cluster elements.

A second mockup of the rupture mechanism for ETR "push-button" ruptures operated satisfactorily after exposure in ELMO-4 for three days at 300 C. The special fuel for the rupture tests was discharged from the Hanford reactors without damage and has been shipped to Arco.

Laboratory experiments showed that with 50% eccentricity of the inner tube boiling burnout of the PRTR Mark II fuel element occurs at a heat flux about 40% less than for a concentric geometry. However, this is still twice the PRTR design flux.

Continued difficulty was experienced with the Hofer high pressure compresser gas discharge check valves and oil compensating pumps. Redesigned check valves are being tested. Commercially available injection oil pumps are being sought for use with these compressors.

Cadmium was selected as the most practical material for thermal neutron shielding for the large penetrations of the PRTR bottom primary shield.

The PRTR Final Safeguards Report, HW-61236, was issued in rough draft form for comment.

The over-all PRTR contract is 47% completed versus 42% scheduled, based on the official schedule.

The contract for the PRTR stack and stack sample facilities was awarded to Custodus Chimney Company on the basis of a low bid of $40,625.

PFPP Phase II is estimated at 93% complete versus 98% scheduled.

A revised PFPP project proposal, which requests additional authorization of $230,000 to cover the value of plant capital equipment planned to be transferred to the project, is being circulated for approval.

The linear thermal expansion of PuO_2 sintered to 90% of theoretical density has been determined to be $15.2 \times 10^{-6}/^{o}C$ from 122 to 911 C. In comparison the thermal expansion of UO_2 is about $10 \times 10^{-6}/^{o}C$.

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Corrosion tests of aluminum-base plutonium fuel alloys employing aluminum matrix materials of various compositions have disclosed two compositions having markedly superior resistance to 350 C water. Use of one of these alloys will minimize the dispersal of fission products in the event of rupture of an Al-Pu element in PRTR at the cost of a slight reduction in attainable exposure.

A technique has been developed for casting aluminum base fuel alloys directly into aluminum cans, thus eliminating all billet machining, decontamination, welding and outgassing steps in preparing billets for coextrusion.

Experience gained in the first sustained fabrication of PRTR fuel cores indicates that three billets of plutonium-aluminum alloy can be extruded, straightened, cut to length, weighed, gauged and cleaned to produce six fuel rods per man-day. (Each fuel rod contains 18 grams of plutonium.)

Two high density UO_2-PuO_2 cores discharged from the MTR last month showed no dimensional change from irradiation.

A total of 340 fuel rods for PRTR was swaged during the month. The use of tubing which had successfully passed the fluorescent penetrant inspection reduced the rejection rate of swaged rods from 50 percent to seven percent, with most of the rejects being reclaimable.

Swaged UO_2 capsules have attained an estimated maximum exposure of 10,000 MWD/T in the MTR. No failures of these capsules or any other swaged fuel elements have occurred to date.

Operation of a defected, swaged UO_2 rod in the MTR resulted in (1) a much smaller release of fission products than anticipated, with a decrease in activity of the coolant while the element was being irradiated at constant power; and (2) no disintegration of the Zircaloy-2 jacket due to waterlogging or hydriding.

A non-destructive testing of the PRTR Zircaloy-2 process tubes is 80 percent complete, with only one tube detected with a serious defect. Some bowing has occurred on autoclaving requiring straightening operations.

The "Thermatool" high-frequency welding machine for attaching external ribs to thin-wall Zircaloy jacket tubing has been delivered to Hanford from the New Rochelle Tool Corp.

2. Chemical Research and Development

One hundred curies of cerium-144 were recoverd from Purex 1WW in the multicurie cell by the double sulfate process and successfully isolated by oxalate precipitation, thus proving that the intense radiation field does not seriously interfere with the formation or stability of the oxalate precipitate.

A TBP-25 (high aluminum) waste was successfully calcined to a dense vitreous glass by addition of sodium tetra borate. This result is in marked contrast to the calcination of the straight TBP-25 waste, which gives a powdery product of very low bulk density.

Optimum conditions for the peroxy - acetate process (for separation of trivalent rare earths from cerium) were firmed up in preparation for an early Purex plant test. Demonstration of low ruthenium volatilization during cerium precipitation and subsequent cake dissolution was crucial to approval of the test. The amount of ruthenium envolved in both steps was found, as expected, to be entirely negligible, (below analytical detection limit).

Five kilograms of UO_2 have been prepared by the electrolytic reduction of UO_2Cl_2 in fused NaCl-KCl and turned over to Ceramic Fuels Development Operation for evaluation as a fuel material.

Three grams of Olive have been acquired for studies of Palmolive processing concepts.

Careful tests showed precision manometers capable of measuring solution volumes in tanks of several thousand gallon capacity with an error of only 0.3 percent. Results are important for materials accountability on power reactor fuels processing.

3. Physics and Instrument Research and Development

Nuclear safety in the dissolving of fuel elements containing 1% U-235 can be achieved by adding small amounts of boron according to experiments which indicate that 3 gm/liter of boric acid would permit a safe batch size of 100 tons.

Processing of solutions of 3% enriched uranium can be carried out without volume limitations when concentrations of less than 600 gms U per liter of water can be assured according to experiments run in the PCTR.

Meanwhile experiments are in progress to assist in determining safe sizes of equipment when higher concentrations cannot be excluded.

In other activities in this area, design progressed on the criticality vessels and associated piping for the first series of experiments to be run in the Critical Mass Laboratory. A nuclear safety review of the Fuel Cladding Facilities plans was conducted for FPD and some improvements recommended; and assistance was given in preparing nuclear safety specifications for new tasks in 231 and 234-5 Buildings.

HAPO readiness to take necessary action following a criticality accident was improved by calibration work at the Shielded Personnel Monitoring Station which will facilitate determination of neutron doses to individuals by measuring the activity induced in them. In other activities at this facility nearly 100 people were counted during the month to build up our knowledge of the "normal background" to be expected.

Safety of operation of the existing production reactors was materially aided by the completion of analog computer studies which defined limiting combinations of power level and reactivity tied up in coolant for I and E loads. These limits result from the criterion that the fuel should not melt during an excursion following loss of coolant pressure.

In the NPR program, the reactivity of cluster fuel elements of 1% enrichment was determined in the PCTR and comparison experiments with natural uranium were readied. Work progressed on the development of a remote area radiation monitoring system and on the fuel element rupture detector. Design was aided by computer studies on the frequency response of the primary coolant loop and on the primary heat exchanger performance. A study was begun on the required characteristics of an automatic control system for this reactor.

In the Plutonium Recycle Program, improved circuitry for the PRTR rupture monitor was recommended and preparations were made to test the controller by using the Analog Computer as a reactor simulator.

The experimental phase of the AEC-AF program in Atmospheric Physics was completed by two additional experiments and full attention turned to the task of data reduction and analysis.

Improved equipment for gamma and beta monitoring of remote areas

successfully passed experimental testing. This equipment covers three decades of intensity with errors no greater than 20%.

In the basic data field, it was determined that for Pu^{241} fission becomes more probable relative to capture as moderator temperature increases. This behavior is in contrast to that of Pu^{239} and to some extent U^{235} where the opposite holds.

The prosecution of research and development work was assisted by the demonstration of an infrared pyrometer for metallographic work and a simple optical means for underwater measurement of the inside diameter of irradiated fuel elements. Also of note was the development of a technique for forming large metallic crystals for use in the neutron spectrometers.

4. Biology

It appears that the dose to gonads in a ram is less from Zn^{65} in the gonads than from Zn^{65} in the rest of the body.

Phosphate fertilizer added to basic soils (local) can decrease Sr^{90} uptake. In acid soils, this is without effect.

Lambs are being started at 0.5 and 0.15 μc I^{131}/day in additional numbers because of finding tumors in the 1.5 μc/day level.

The tests to remove contamination from plants exposed to fuel element burn vapors showed that, of various wash solutions tested, alcohol, acetone, and Tide were most effective in decontamination.

Five hundred days after a mouse inhaled $Pu^{239}O_2$, a bronchiolar carcinoma was noted. The lung deposition amounted to 0.08 μc. This is the first malignant lung tumor we have observed following inhalation of radioactive particles.

5. Programming

Investigation revealed that Th-228, an intensely active alpha emitter which can be made from the irradiation of ionium (Th-230) recovered from ore mill wastes, may have unusual promise as a neutron source constituent. Milligrams of Th-228 are equivalent to grams of radium, as used in neutron sources in conjunction with beryllium. Grams of

Th-228 used in this manner may be competitive with low flux research reactors as sources of neutrons.

Following some months of revising and improving IBM-650 computer codes used for Cycle Analysis study of plutonium fuel, initial large scale use was made of the new IBM-709 facility. Immediate results were gratifying and indicate a substantial increase in analytical productivity to be associated with use of the new computer.

Examination of alternate methods of irradiation to provide early delivery of high exposure plutonium for the Plutonium Recycle Program indicate that preparation at either Hanford or Sevannah River is feasible.

The Hanford Laboratories University Relations Council hosted a visit by the Hanford Liaison Committee of the University of Washington. Mutually interesting areas of research and development were discussed and plans were laid for an exchange of seminar speakers.

TECHNICAL AND OTHER SERVICES

A rough draft report was issued in connection with the problem of reactor calculations and is being circulated for comment.

Criticisms of the CPD analytical control program were discussed with the AEC-HOO personnel and agreement was reached on the adequacy of the program.

An experimental program to investigate the corrosion of various zirconium alloys as a function of several independent variables was initiated and a pilot study conducted to evaluate the characteristics of experimental apparatus.

Work on 12 operations analysis programs continued during the month. In addition, statistical and mathematical assistance on 14 problems was given within HLO and to other departments and operations.

Three new plutonium deposition cases were confirmed during the month. All were less than five per cent of the maximum permissible body burden. There are 240 cases of plutonium deposition on record. The total number of deposition cases that have occurred at HAPO is 235 and 169 are currently employed.

An explosion occurred in the plutonium oxide hood in cell 5, 231 building. A section of the top of the hood was displaced and rubber hood gloves were

ruptured by the reaction. No injuries occurred to nearby employees. Four people who were in the room at the time received minor amounts of plutonium contamination on their clothing and/or person. Decontamination of these employees was successful. Internal deposition of plutonium in these employees appeared to be unlikely.

There were 22 authorized projects at month's end with total authorized funds of $8,740,000. The total estimated cost of these projects is $9,576,600. (Note: PRTR and PFPP are considered separately.) One new project was authorized and two were completed during the month. Two projects were returned from AEC without action due to lack of funds and one new project is awaiting AEC approval. No new projects were submitted to AEC during the month. Five proposals for new projects are in preparation.

The steel strike continues to affect work progress on almost all jobs and will of course cause more serious delays as steel items become harder to obtain. So far, only two major projects are seriously delayed - Project CGH-790, 327 Building Addition, and Project CG-731, Critical Mass Laboratory.

Total productive time for Technical Shops for the month was 15,444 hours. This includes 12,802 hours performed in the Technical Shops, 995 assigned to Minor Construction, 188 hours to other project shops, and 1,459 hours to off-site vendors. The total shop backlog is 30,568 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 5.6% (1090 hours) of the total available hours.

Radiographic Testing Operation made a total of 3,407 tests, of which 835 were radiographic (including x-ray and gamma-ray) and 2,572 were supplementary tests. Out of a total of 1,885 man-hours, 557 (29.6%) were used in connection with radiographic tests, and 1,328 (70.4%) were used on supplementary tests. The supplementary test work included;autoclave, borescope, dimensional measurements, eddy current, penetrant (O.D. and I.D.), pickling, surface treatment (alkaline cleaning and vapor blasting), and ultrasonic (flaw detection and thickness measurements).

Three major projects are substantially completed. Remaining work consists largely of minor equipment installation, "start-up" inspection and clearance of exceptions. These projects are -

CA-749	High Level Radiochemistry Facility	$ 960,000
CG-661	Additional Heat Generation Equipment - 189-D Building	500,000

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CA-681 Hanford Equipment in the ETR $1,140,000

Effective October 1, 1959, the responsibility for the assignment and direction of work to be performed by the CPFF Construction Service Contractor was assigned to Laboratory Auxiliaries. Procedures have been established and assignments of personnel made to accomplish this work.

SUPPORTING FUNCTIONS

Funds available to Hanford Laboratories for 2000 Program equipment have been increased from $1,555,000 to $2,105,000 for FY 1960. Allocations have been made to HLO Sections based on priority needs.

Washington State Use Tax which will have to be absorbed by HLO programs during FY 1960 is estimated to be $100,000.

Forty-one of 130 eligible employees who were not previously participating in the Savings and Security Program enrolled in the Program effective September 15, 1959.

A manual on Travel and Living Expenses is now ready for issuance.

Necessary financial procedures to effect the assignment of certain management functions to J. A. Jones Construction Company were instituted effective September 28.

As of September 30, 1959, the staff of the Hanford Laboratories totalled 1302 employees, including 629 exempt and 673 nonexempt. There were 546 exempt employees possessing technical degrees, including 335 B. S., 112 M. S., and 99 Ph. D.'s.

The medical treatment frequency for September was 2.05 as compared with 1.63 last month.

There were two security violations during July, bringing the total for the year to date to 33.

Two Government vehicles assigned to Hanford Laboratories were involved in incidents causing $82.00 total damages. No injuries were experienced.

There were two serious accidents during the month, one involving a glove box explosion and resulting in no injuries. The other incident resulted in a smashed finger. The seriousness of this injury will not be known

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immediately. (Note: October report will indicate this is classified as a disabling injury.)

During the month, two acceptances for the Technical Graduate Program were received. In addition, eight offers were accepted by experienced BS/MS candidates. IPD remains active in interviewing experienced engineers in the fields of electronics and mechanical engineering. Other HAPO Departments are only moderately active.

College recruiting plans for the coming year are being made through a series of meetings with Engineering, Manufacturing, and Technical Marketing Services.

Three Technical Graduates were added to Training Program rolls during September. Total force on the Program is now 83 as a result of three permanent placements and the termination of all temporary summer employees.

One Serviceman was removed from HLO payroll due to lack of work. He was later employed by the City of Richland.

H M Parker

Manager,
Hanford Laboratories

HM Parker:vf

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REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Fuel Element Rupture Studies. Additional tests have confirmed the effect of annulus size on rupture behavior of pre-defected tubular fuel elements, as reported last month. If the cladding fractures before the blister contacts the process tubing, the induction period is less than one hour followed by a slowly increasing rupture rate (0.1 to 0.5 gram/min after two hours of rupturing). However, if the cladding blister encounters the process tubing and hence is restrained prior to failure of the cladding, then the blister mushrooms out along the fuel element and continues to grow during a prolonged induction time (up to 7.5 hours). Considerable distortion and damage can occur during this prolonged induction period. By the time the cladding fails there is extensive core damage and the rupture proceeds at a rapidly increasing rate (up to 8 grams/min one hour after the cladding fails). Blisters formed on samples with an initial annulus of 1/16-inch or less, invariably contacted the process tubing, resulting in a long induction time followed by a rapid rupture rate. With an initial annulus of 1/8-inch or larger, some encountered the process tubing and some did not. The probability of the blister encountering the process tubing and causing the more damaging rupture behavior decreases with increasing annular spacing.

A sample was ruptured without a process tube at 1500 psig and 200 C, the temperature at which hydriding rather than uranium oxidation is the controlling reaction. After an induction time of 4.5 hours, it ruptured slowly (about 0.1 gram/min after two hours). As previously observed for rod elements ruptured at 200 C, the distortion of the cladding near the defect was more extensive than at 300 C.

Corrosion of Dingot Uranium Cores. Open-end samples of coextruded rod made from dingot uranium were corroded at 200 and 300 C. Only uniform penetration was observed giving lower over-all rates than observed for ingot material, and no sample distortion. Non-uniform attack of the ingot metal is believed to be caused by the formation of uranium hydride which is promoted by the presence of carbide stringers found in ingot uranium and not in dingot uranium.

A pin-hole defected rod element sample, fabricated from dingot material, was ruptured at 200 C and 1500 psig. In this case, even with dingot metal, it is believed that the hydriding reaction may control at 200 C because of the confinement of the rupture products by the jacket. The experiment appears to confirm this hypothesis, since the induction time, rupture rate, and degree of distortion were comparable to those observed previously with ingot material.

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Corrosion of Uranium - 2% Zirconium Cores. Open-end samples of coextruded U-2% Zr core rod were exposed at 200 and 300 C. Only uniform penetration was observed. The corrosion rates were about a fifth of that observed for uranium core material as shown in the following table.

Uniform Corrosion Rates, Mils/Min

Temperature	U Core	U-2% Zr Core
300 C	2.1	0.43
200 C	0.11	0.016

Radiometallurgy Laboratory Studies

The end cap section of the defective center rod of an enriched (1.6 a/o), Zr-2 jacketed, 7-rod cluster fuel element (IP-214A) was sectioned to reveal a 1/8-inch long, elliptically shaped fissure in the Zr-2 jacket. The examination of a 0.570-inch x 5-inch, ruptured Zr-2 clad, natural uranium rod (which had been immersed in NaK and irradiated to 3500 MWD/T in a stainless steel container according to GEH-3-32) showed that swelling of the uranium had filled the 0.025-inch free spaces originally at each end of the uranium rod. A sample of Zr-2 clad, 1000 MWD/T uranium was rapidly quenched ten times from 600 C to room temperature to produce micro cracks in the uranium.

Two samples of thorium oralloy (GEH-3-12) were removed from their Zircaloy-2 jackets and measured. Both samples had decreased in density 4.5 percent, showing increases in diameter and decreases in length. One thorium tensile specimen from GEH-3-27 was cathodically etched and metallography work was completed. Six other thorium tensile specimens (IP-116-D) were removed from capsules and the flux monitors were recovered.

Samples of high exposure uranium (2600 and 3500 MWD/T) were annealed for 100 hours at temperatures from 600 to 800 C as part of the uranium swelling program. The higher exposure sample suffered more density decrease as a result of the thermal treatment. After annealing, the samples were prepared for electron microscopy studies. Other samples of low irradiation exposure have been subjected to high temperature anneals and are being studied to determine the extent of fission gas bubble formation in unrestrained uranium.

Metallography work was initiated on samples of Zircaloy-2 tubing from sections 4 and 5 of the tube recently removed from KER Loop No. 2.

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

Basic Metallurgy Studies

Radiation Effects in Fissionable Materials. A turbo-mechanism has been developed that will rotate an irradiation capsule so that the enclosed specimens will receive a radially uniform exposure to the neutron flux. Comparative

irradiation tests using both rotating and stationary capsules are being performed. Capsules 14-2 and 14-4, both containing normal uranium, were inadvertently discharged after five of the required twelve cycles. Capsule 14-2 (rotating) reached an exposure of 3568 MWD/T in a flux of 6×10^{13} nvt and capsule 14-1 (stationary) reached an exposure of 4189 MWD/T in a flux of 7×10^{13} nvt. Since reinsertion of the capsules was deemed inadvisable, the capsules will be shipped to Radiometallurgy in the near future.

A Zircaloy-2 tube which has been exposed to neutron radiation over a 25-month period, and a similar unirradiated tube were removed from the KER loop facility. These tubes will be mechanically tested and examined metallographically to determine the effects of high neutron exposures at elevated temperatures on Zircaloy-2 and to establish testing methods for monitoring NPR tubing. Two of the five pieces of the irradiated tube were sectioned and metallographic investigations started during the month. A friable, rust-brown film, which was absent where fuel elements had scored the tube, was observed on the inner surface of the tube pieces. Pits which appear to be approximately 0.005-inch in depth were observed in both pieces, but pitting was more prevalent in the downstream piece. The downstream piece was polished and examined under polarized light. Areas of equiaxed grains were observed in several locations, which in one location extended throughout the tube wall. A moderate concentration of small, rod-shaped inclusions was observed at the inside surface. These gradated inward and were not observed throughout the remainder of the transverse section. The individual inclusions were too small to identify by color as hydrides.

The effects of a neutron exposure of 9×10^{19} nvt at 220 C on the microstructure and properties of zirconium, Zircaloy-2 and Zircaloy-3 are being evaluated by metallographic, x-ray diffraction, and microhardness studies. The materials are in the annealed, cold worked, and beta quenched conditions. Optical metallographic studies to 250X have been completed for irradiated Zircaloy-2 in the beta quenched and 25 and 50 percent cold worked conditions. No changes in the microstructures due to irradiation were observed. Metallographic studies are being continued at higher magnifications with electron microscopy.

Mechanical and Physical Properties of Materials. The creep properties of Zircaloy-2 are considerably improved by small amounts of residual cold work. The extent to which increasing amounts of cold work improve creep properties and the effects of recovery occurring in the test temperature range are not known. These effects are being determined in the range 15 to 45 percent cold work. Flat creep specimen cold worked to 15-25 and 45 percent are being tested in vacuum creep units back-filled with a static pure helium atmosphere. Results of 3000-hour tests on the 25 and 45 percent cold worked material at 400 C (752 F) indicate that third stage creep has not yet occurred at the stress levels of 13,000 and 18,000 psi. One 45 percent specimen at the same temperature but at 21,000 began third stage creep before the test was discontinued due to a faulty extensometer clamp.

The total elongation was 3.8 percent for this 45 percent cold worked specimen, which is the same as for a 25 percent cold worked specimen stressed at 21,000 psi. The initial elongation was more for the 25 percent cold worked

material, but after 2000 hours the 45 percent cold worked specimen overtook it. The assembly removed from the unit with the faulty extensometer was used to calibrate the effective gage length in both the elastic and plastic portions for the flat specimens. Calibration was made with the aid of a Tuckerman extensometer and a Templin calibrator.

A sample identical to the in-reactor creep specimen of annealed Zircaloy-2 was then installed in the unit. It will be given the same temperature and stress program as the in-reactor specimen.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel material is a direct way of detecting radiation damage in these materials. The preparation, irradiation, and subsequent microscopic examination of thin films and foil is continuing.

A thin evaporated film of aluminum supported on a copper grid has been irradiated to 5.2×10^{19} nvt and examined in the electron microscope. The (111), (200), and (311) diffraction lines for copper were identified. These lines were found to appear in a previous irradiation to an exposure of only 8.4×10^{18} nvt. An additional unidentified line with spacing of 1.395 Å has also been reproduced in this second irradiation; however, $CuAl_2$ lines were not observed. Although the temperature during the irradiation is believed to be less than 60 C for which evaporation of copper onto the aluminum should be negligible, neutron spikes may cause such an evaporation. Diffusion of copper on or through the aluminum film may also account for the presence of copper in the aluminum. Additional irradiations are required to resolve this question.

One micron particles of uranium dioxide dispersed on a thin evaporated film of aluminum are being irradiated to various exposures. These irradiations are aimed at determining the extent and nature of fission recoil damage to cladding material.

The preparation of thin films and foils of fissionable and non-fissionable reactor materials by high vacuum evaporation, sputtering, chemical, and electrolytic techniques is in progress. Such thin films or foils are necessary for direct transmission electron microscopy examinations.

Irradiated boron carbide steel balls from KE Reactor showing extensive spalling are being studied to establish the failure mechanism. Non-irradiated control balls have been examined optically and in the electron microscope. Specimen preparation techniques compatible with radiometallurgy facilities have been established.

An invited paper, "The Application of Electron Microscopy to Reactor Fuels-Uranium Dioxide," was presented at the 17th Annual Meeting of the Electron Microscope Society of America.

In-Reactor Measurements. A prototype creep capsule manufactured to Hanford specifications by Technical Industries Corporation has been charged in the KW Reactor. This capsule has been designed to make continuous measurements of the creep deformation of an annealed Zircaloy-2 specimen during irradiation. The capsule was charged with the specimen located at the edge of the graphite

reflector. This extreme position was necessitated because of gamma heating problems anticipated in the active lattice of the reactor. At this point the fast flux is calculated to be of the order of 10^{11} nvt. Prior to loading the specimen, operational checks are being made on the temperature control system and the strain transducers. At the time of loading, it is anticipated the specimen will have received an exposure of 10^{18} nvt. Measurements of the temperature monitor and control system indicated the capsule performance is very near to that calculated prior to insertion in the reactor. Daily measurements of the strain measuring transducers indicate no radiation induced zero shift within their limits of sensitivity. It has further been established that changes in their reading as a function of specimen temperature are the same as those obtained out of the reactor. A delay in test startup has been imposed by the failure of a saturable core reactor component in a magnetic amplifier of the heater power supply. This unit is being replaced, after which the test will be initiated by the application of load to the specimen.

Accurate temperature measurement in-reactor is essential for the evaluation of the effects of neutron irradiation on materials. Thermocouple instability induced by reactor environment is being investigated to establish the conditions under which thermocouples may be relied upon for accurate in-reactor temperature measurement.

The first thermocouple stability capsule, containing an iron-constantan, a chromel-alumel, and a copper-constantan thermocouple, has been irradiated 5960 hours. The inclosed thermocouples have been maintained at temperature of 300 C during irradiation, except during occasional short periods at 335 C. An atmosphere of approximately 25 percent CO_2 - 75 percent He has been maintained in the capsule during the past eleven weeks. During the last month the resistance between the copper-constantan couple and the aluminum thermocouple well in the capsule has varied between 30,000 and 50,000 ohms. This erratic behavior is possibly due to reaction of the thermocouple with CO_2. The copper constantan couple in an identical ex-reactor control capsule has also developed erratic contact resistance.

Metallic Fuel Development

Cluster Fuel Elements. Post-irradiation examination of the 7-rod cluster fuel element irradiated in KER Loop 2 in 200 C coolant to an exposure of 1500 MWD/T was continued. Further examination of a wafer found to have an area reduced can wall thickness showed large numbers of inclusions in the area where the can wall was reduced. The number of inclusions per unit area becomes smaller toward the center of the rod and then increases again toward the edge of the rod. Examination of the can wall of the longitudinal section through the cap just below the cap-to-can weld showed the presence of inclusions, stringers, etc., in the Zircaloy-2. The uranium is 10 mils over the nominal diameter in this region, and this plus a 30-mil reduction in outside diameter have resulted in a very thin can wall. One might guess that poor quality uranium and poor quality Zircaloy-2 met at this point in the extrusion and the uranium was reduced less than the nominal amount and the Zircaloy-2 more than the nominal amount. The reduction in the outside diameter might have been caused by accelerated corrosion of the poor quality Zircaloy-2.

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The three fuel elements for the rupture test in the 3x3 loop at the ETR have been fabricated and shipped. One of the elements has an intentional defect that can be ruptured in the reactor by external signal.

Tubular Fuel Elements. Three enriched uranium tubular elements are now being tested in KER Loop 3. The elements are clad in Zircaloy-2 with a core of 1.47 percent enriched uranium. A thermocouple spacer measures the outlet water temperatures in the cooling channels of the last element. At full power, the temperatures were 243, 257, and 270 C reading from the center hole to outer annulus. This degree of temperature imbalance in nine feet of charge calls for redesign of the element. Power output was 100 kw/ft. Maximum temperature in the fuel then calculates 325 C for the inner tube and 350 C for the outer tube.

During September an additional charge of 36" tube/tube elements were made for KER Loop 4. They are identical to those operating in KER Loop 3.

Two tube-rod elements had been irradiated to 2000 MWD/T in Loop 4. The rods of the elements had diameter increases of about six percent. Radiometallurgy examination of these elements is being done at BMI with the second element shipped to BMI in September.

Four tube-tube coextruded elements were tested in KER Loop 1 for 150-200 MWD/T. They were discharged prematurely on a neutron monitor indication of fission products in the loop. These elements were examined in the KE viewing pit during September. No sign of failure can be seen under eight feet of water or by periscope. The two large grained unalloyed uranium tubes have bumped surfaces, but no apparent cracks or ruptures. The average diameter of the unalloyed tubes has increased 0.005" as a result of irradiation. Two uranium - two percent Zircaloy tubes have no measurable change. The diameter increase in one case is probably due to the bumping which the jaws of the electronic micrometer sense as the effective outer diameter. The general appearance of the alloy elements is excellent; clean black surface, supports intact, very few surface scratches.

A 36" tube and tube natural uranium element of KER size was shipped to the Engineering Test Reactor for high power testing. The high flux in the ETR will give core temperatures exceeding those expected in NPR. The outer tube will have 525 C maximum and the inner tube 650 C maximum uranium temperatures. Surface temperature of the fuel will be about 325 C maximum.

IPD requested that NPR size tube-tube fuel elements be fabricated for use in their charge-discharge studies. The lot consists of four, three-foot long; two, two-foot long; and two, one-foot long elements. They are to meet the following minimum criteria: (1) water-tight Zircaloy-2 cladding (and end closure); (2) conformance with current NPR tube-tube dimensions including supporting diameters; (3) total weight of about 25 lbs/ft; (4) supports capable of withstanding normal handling and charging forces. The tubes (outer from FPD extruded and inner from NMI extruded lots) have been cut to length, counter-bored on the ends, etched, and are ready for closure and support attachment. There will be no heat treating of these elements.

Fuel for Present Reactors. The commonly observed variability in properties of the compound layer on adjacent areas of the same canned fuel element (hot dip process) indicates that uranium surface conditions not associated with visual appearance may influence the properties of the compound layer. Recent experiments with measuring the ionization potential of small areas ($\sim$ 2 mm^2) of a uranium slug surface, using tap water as an electrolytic, have indicated potentials ranging from -0.20 V to +0.60 V. The positive and negative areas bear no relation to the visual appearance of the surface but form a separate pattern of areas up to several square centimeters in extent. A device is being developed for mapping these anodic and cathodic areas, in order that they may be compared on the same slug core before pickling, after pickling, and after canning, to determine whether compound layer quality correlates with these indicated electrical properties.

Irradiation calculations for placing two hot pressed fuel elements in the MTR have been completed. The specific power of these elements was calculated to be 92 kw/ft. The jacket temperature, at a flow rate of 17 gpm, would be 57 C, uranium surface temperature would be 105 C, and the maximum core temperature would be 457 C. This irradiation will indicate the durability of the hot pressed elements to an exposure of 1000 MWD/T (4 MTR cycles) and should provide the necessary information for a run-to-rupture test in the Hanford reactors. The proposal has been written and is awaiting necessary approval.

As the present hot press process has been developed to its limit using standard components, the process specification document has been written. This specification covers all aspects of component design, punch, die and furnace construction, component preparation and cleaning, nickel plating, component assembly and pressing, and the inspection. The document will be issued as a classified report HW-61995.

Component Fabrication. Zircaloy-2 tubing has been used to evaluate the adaptability of rod draw sizing methods to tube draw sizing. The tubes were degreased, vacuum annealed, and vapor blasted. A copper plate was then chemically deposited on the surface. The interior of the tubes was rubbed with "Steelskin" lubricant and plug drawn. The inner surface of the tube improved with each successive draw, and no galling or die pickup was observed. The final diameter of the tubes varied up to 0.0005" per tube. The remaining copper plate should be acceptable for use in the "hot heading" operation. This process appears very promising for sizing and improving the finish of coextruded tubing.

Six extrusions, approximately forty feet of material, are being processed for Hanford irradiation in a zirconium ribless process tube. The material is Zircaloy-2 clad I & E geometry coextruded by NMI. The tubes were extruded by the conventional floating mandrel process at 1155-1160 F at an extrusion ratio of 14.3:1. Extruded dimensions were 1.471 ± 0.004" OD, 0.398 ± 0.003" ID with a nominal 0.021" thick inner and outer Zircaloy-2 cladding. Transverse and longitudinal sections of the front and rear of each extrusion were examined for dimensions, uranium quality, and bond quality. The material was found adequate for irradiation with smooth Zircaloy-2 uranium interface and was well bonded on both the inner and outer clad. A series of heat treatments were performed on nine-inch lengths to evaluate the resulting texture, grain size,

and Zircaloy-2 uranium bond. X-ray examination was made of both the as-extruded and heat treated material. Texture coefficients and growth index were calculated, and inverse pole figures were plotted for transverse sections. The material as extruded has a duplex (110)(100) orientation in the extrusion direction with a growth index of -0.508 calculated by the ten plane area weight method.

The vacuum treatment yielded average uranium grain sizes of 0.210 mm average grain diameter. The Zircaloy-2 uranium bonds were not adversely affected by any of the heat treatments, and all showed the normal uniform diffusion thickening.

A limited quantity of KER outer tube (1.825 OD x 1.450 ID) stock, coextruded with 0.020" inner and outer clad has been used for vertical salt bath heat treatment of 20" long sections. A jig was fabricated that holds the section during treatment and quenching and gives close fitting internal support of four 90° spaced points the full length of the element. Dimensional changes as a result of several treatments have been measured and the degree of warp or bowing determined. Shorter sections, 3" in length, have been given a wider range of heat treatment and are being examined for microstructure and bond effects and x-ray examination for resulting texture.

Closure and Joining. The ultrasonic welding process for attaching supports for the self-supported fuel element concept for present reactors is being evaluated. All ex-reactor tests are completed, and the results are satisfactory. A production test proposal has been written, and a total of nine tube charges to determine the in-reactor behavior of this attachment method have been fabricated.

Short lengths of Zircaloy-2 clad uranium coextruded tubes have been successfully hot headed in the existing 400-ton extrusion press container. The tubes were NPR outer tubes swaged to 2-1/4" OD (1.60" ID) to fit the extrusion container. The method used for hot heading coextruded tubes is basically the same used for hot heading coextruded rods. The heading dies were designed to extrude the uranium core from the end of the tubes at reduction ratio of 6 to 1 while forcing the Zircaloy-2 cladding over the ends of the tube toward the center of the tube wall. The Zircaloy-2 clad which formed over the end of the tube appears sufficiently thick to permit projection welding a ring cap to the ends of the tubes for the final closure.

The tube preparation for hot heading is the same used for rods. This includes a thin copper electroplate or chemical plate on the tube surface to prevent the Zircaloy clad from seizing to the tube container and mandrel, thin graphite lubricant coat, and the 620 C preheat just prior to heading.

Tooling is being fabricated to hot head the inner KER size tubing for a future production test. The tooling consists of a grip for holding the tube and a short container which is slipped over the end of the tube while heading. The end of the tube is induction heated to the desired temperature just prior to hot heading. This method of hot heading proved to be successful for hot heading rods and has the advantage that any length of coextruded tubing can be hot

headed with very little tooling change. However, some slight swelling will occur on the tube end (0.005 to 0.010 inch/inch diameter) which must be corrected by a post heading drawing operation.

The ends of thirty-eight, eight-inch, coextruded, Zircaloy-2 clad, I & E fuel elements (1.470" OD x 0.4" ID x 20-mil wall) were acid machined to provide a recess in which a 100-mil thick Zircaloy-2 washer could be welded to form the end closure. Uniform etching free of undercutting was achieved by the following process. The fuel elements were suspended vertically such that the end to be machined was approximately 1-1/2" below the surface of the etch bath. The initial etch bath was prepared by dissolving 0.3 pound of uranium scrap per liter of reagent grade hydrochloric acid (37-38% HCl). As etching progressed, fresh acid was added to replenish the bath; however, the dissolved uranium to acid ratio was maintained at not less than 0.3 pounds/liter. Bath temperature varied from room temperature (26 C) to 65 C. The average etch rate per end was twenty minutes. Total removal ranged from 100 to 105 mils per end. Undercutting was observed if the dissolved uranium to acid ratio was below 0.3 pound/liter and non-uniform etching was observed if the bath temperature exceeded 65 C. No ill effects except very slow etch rates were observed with dissolved uranium to acid ratio as high as 0.9 pound/liter.

Allied Fuel Studies. Reactor swelling experiments of Zircaloy clad uranium fuel rods with selected uranium temperatures, cladding thickness, and exposure are being conducted. Radiometallurgy examination of GEH-3-58, one of the above rods, which operated at an average central uranium temperature of 580 C to an exposure of 2100 MWD/T, has begun. No externally visible damage can be seen on this fuel rod which was subjected to severe temperature cycling through the $\alpha - \beta$ transformation.

To attempt a statistical analysis of the effect of temperature, exposure, and cladding upon fuel element swelling, 19 aluminum capsules each containing a Zircaloy-2 clad uranium rod surrounded by NaK, have been charged in D Reactor process tubes. These capsules permit irradiation of 0.020" and 0.030" clad uranium rods at selected central uranium and cladding surface temperatures to an exposure of 1500 MWD/T.

Under cyclic temperature operation, polycrystalline uranium should have microstresses due to the anisotropic thermal expansion of the uranium crystals. These microstresses should affect the macroscopic creep rates by orders of magnitude. Equipment for running creep tests of uranium under cyclic temperatures is fabricated and being assembled.

An investigation of macrocracking in irradiated uranium caused by the internal strains due to the anisotropic thermal expansion of uranium crystals has been experimentally demonstrated. A uranium disk irradiated to $\sim$1000 MWD/T was heated to 600 C and quenched at a rate equivalent to that encountered in a reactor fuel element. No macrocracking was observed after one quenching cycle, while many macrocracks were observed after ten quenching cycles. The metallography of the crack specimen looked similar to pictures of cracked irradiated fuel elements.

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Stress rupture tests on Zircaloy-2 fuel element jackets reveals that, for a similar time to fracture, and at similar test temperature, the tangential fracture stress of the jackets is about 15,000 psi greater than the fracture stress of rolled sheet Zircaloy-2. Fracture strains as much as 30 percent are observed. Diffusion of oxygen into the zirconium, bi-axial loading and the crystallographic texture of the jacket material all appear to contribute to this increased strength. All of these conditions contributing to high tangential rupture strength occur in operating fuel element jackets.

Bare coextruded jacket, in which the contained uranium was removed chemically, burst brittlely under fast internal loading with water at 300 C. Simulated jackets of tube material the same size but free of the internal striae characteristic of coextruded jackets also burst brittlely under the conditions, although the extent of crack propagation was less.

The assembly for conducting burst tests on 15 capsules simulating coextruded jackets is ready for checkout prior to loading in a KW Reactor test hole.

Two alloy fuel samples of Th-2 w/o fully enriched uranium are being examined in the Radiometallurgy facility after calculated exposures of 2 and 2-1/2 a/o burnup in the MTR. Dimensional changes indicate a 2-1/2 v/o increase and density measurements reveal a four percent decrease in density. The material fractures during bend testing in a brittle fashion.

A second mockup of the planned seven-rod cluster fuel element failure experiment in the ETR 3x3 fuel testing facility has been operated successfully in ELMO-4 at 300 C and 1450 psi. The improved hydraulic rupturing mechanism operated satisfactorily after a three-day exposure in the loop at operating conditions.

The effect of uranium beta heat treatment on the defect behavior of coextruded NPR fuel material is continuing. Defect behavior is related to the thickness and the mechanical properties of the bond. Excessively thick bonds are to be avoided as bond separation is readily propagated. Embrittled bonds resulting from rapid quenching above 600 C lack ductility. Hardening in the bond alloys system caused by incomplete transformation from uranium-Zircaloy solid solution to uranium-Zircaloy delta (or epsilon) phase at 590-600 C is responsible for the embrittlement.

Autoclave studies by Coatings & Corrosion Operation indicates that ingot quality coextruded fuel material corrodes nearly as fast at 200 C as at 300 C, and that the associated damage to the fuel shape is worse at the lower temperature. The greater than expected rate and damage at 200 C is attributed to the effect of hydrogen at this temperature on the ingot quality uranium. "Open-end" and bare rod tests reveal that the corrosion rate of dingot quality uranium and U-2 w/o Zircaloy alloy is much less sensitive to hydrogen at 200 C, and may offer improved fuel material failure behavior at the lower temperature.

Rate data and failure behavior of tube and tube geometries as affected by coolant annuli are being collected from autoclave and loop tests. An extreme difference in behavior is noted between the static autoclave tests and the dynamic

loop tests with the autoclave producing disastrous fuel shape damage. It does not appear that the autoclave produces a realistic picture of fuel element damage at failure and that dynamic loops will have to be relied upon to furnish this information.

Metallurgical Development. The investigation of controlled additions of zirconium and carbon in the as-cast and heat treated conditions is essentially complete. Preliminary results indicate that the grain size of unalloyed uranium has little effect on the extrusion coefficient of coextruded rods in either the as-cast or heat treated condition. Both zirconium and carbon additions cause a definite increase in the extrusion constant. Heat treatment resulted in no significant reduction in the magnitude of the coefficient. Extrusion coefficients for zirconium additions varied from 32,800 psi at 200 ppm zirconium to 40,000 psi at 2 w/o Zr in the as-cast condition. Carbon alloys, at the same conditions, varied from 30,000 psi at 200 ppm carbon to 36,600 at 1 w/o carbon. A recrystallized alpha uranium structure was observed in the extruded sections of unalloyed uranium. Carbon addition from 200 ppm to 0.25 w/o also resulted in a recrystallized structure. Carbon alloys in the range of 0.50 w/o to 1 w/o carbon revealed a heavily twinned structure with no recrystallization. Zirconium additions from 200 ppm to 0.5 w/o in uranium resulted in complete recrystallization. All of the higher zirconium alloys displayed a two-phase structure which remained essentially constant during extrusion except for excessive twinning. An excessive variation in wall thickness was found in the unheat treated alloys, the heat treated 200 ppm to 0.10 w/o zirconium alloys, and the heat treated 200 ppm to 0.50 w/o carbon alloys. A very uniform Zircaloy-2 wall thickness was observed with all heat treated zirconium alloys above 0.25 w/o zirconium and carbon alloys above 0.5 w/o carbon.

2. REACTOR PROGRAM

Coolant Systems Development

Pigtail Stress Corrosion Testing. A test is being designed to measure the effects of various decontaminating solutions on pigtail stress corrosion cracking. This test will measure the effect of intermittent applications of the solutions to the outside surfaces of hot vibrating pigtails.

Up to 30 pigtails will be connected to common headers and will be heated with a low flow of hot process water. Temperature will be in the range 90-110 C, and will depend on the temperature of available water. Vibration will be produced by magnetic or mechanical vibrators acting on the spring-mounted outlet header.

Each pigtail will be coated with a decontaminating solution at intervals of several days. Process water will drip onto the hot pigtail surfaces at a rate approximately equal to the rate of evaporation from the hot surfaces. The pigtails will be checked frequently with a penetrant dye to detect cracking. Failed pigtails will be replaced, and significant failures will receive metallographic examination.

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Long-Term Decontamination Test. Seven decontamination cycles have been completed in CEP-1. Each cycle consists of one week operation at 300 C with high purity water at pH 10 and one decontamination using Turco-4501, Turco-4502, and 25% nitric acid.

The corrosion on non-sensitized and sensitized stainless steel was very low ($<$ 0.01 mil per cycle), but the Stellite was attacked excessively and was badly etched.

Four different grades (Nos. 14, 16, 39 and 85) of Graphitar were exposed in the loop to the cyclic process for four weeks. Grade 39 Graphitar appeared to have the least attack from the treatment. Next was the Grade 16 followed closely by Grade 85. The Graphitar Grade 14 exhibited the most significant visual attack, showing some surface disintegration and spalling. The other grades exhibited various degrees of surface pitting.

Decontamination of Carbon Steel Systems. The REP Loop, a carbon steel loop located in 1706-KE was decontaminated by three different procedures: (a) Turco 4501, 4502, and 4512, (b) APACE, and (c) the Westinghouse CODS solution. The APACE and Turco procedures gave results which agreed with those from previous experiments, the Turco procedure giving slightly higher decontamination factors and lower corrosion of carbon steel than was obtained with the APACE process. For stainless steels, the four-step APACE procedure and Turco gave similar results. The CODS procedure was unsatisfactory.

The IRP Loop, a stainless steel loop located in 242-B Building, is equipped to study the distribution and removal of UO_2 and fission products. Three runs completed to date employed peroxide-bicarbonate, with success, to remove the UO_2, followed respectively by: (a) APACE, (b) Alkaline permanganate, Wyandotte 1112 (a bisulfate solution), and (c) Alkaline permangante, Turco 55-8A (a bisulfate solution). Both procedures (a) and (b) gave satisfactory decontamination factors and low corrosion for stainless steel and Inconel, but both solutions corroded carbon steel excessively. Since the 1112 solution was recirculated at 90 C, it may be possible to lower the temperature to reduce this corrosion without adversely affecting the decontamination efficiency. Data are not yet available for the Turco 55-8a, which was used at 60 C. The APACE procedure resulted in low carbon steel decontamination factors with deposition of a film on the carbon steel.

Sodium dichromate, propynol, and stannous chloride were tested and proved ineffective in reducing the attack of ammonium citrate on carbon steel. However, the stannous ion, which is normally a good inhibitor in citric acid solutions, may have been adversely affected by the chloride ion present.

pH Control by Ion Exchange. Further tests were conducted to determine the pH control characteristics of Amerlite IRC-50 cation exchange resin. This is a weakly acidic carboxylic type resin that is capable of removing hydrogen ions from deionized water. The resin has been operating in the lithium cycle -- thus providing a high pH, lithium hydroxide effluent.

To date this resin has processed approximately 1350 bed volumes of neutral, deionized water and the effluent pH still has not decreased below 10.30 units. These tests were conducted at high flow rates -- approximately 28 gallons per minute per cubic foot of wet, regenerated resin. It is anticipated that even higher pH values will be obtained at lower flow rates.

A column containing this resin is now being used to control the pH for the IRP-1 loop at 242-B. This resin has processed an estimated 100 bed volumes of water and is performing almost exactly as predicted.

The resin thus appears to have considerable pH control capacity and deserves further study concerning the feasibility of using it in large scale, high pH systems.

Low Temperature Oxygen Scavenging. A series of tests was run to determine the feasibility of using hydrazine to scavenge dissolved oxygen from filtered water in a low temperature, dynamic system. Preliminary tests indicated that hydrazine interference is a controlling factor in the analytical procedure for dissolved oxygen. It was therefore necessary to remove the residual hydrazine on a strongly acidic cation resin prior to collecting the samples. This procedure reduced the residual hydrazine concentration to approximately 0.1 part per million. The scavenging tests were conducted between 35 F and 65 F and hydrazine to oxygen ratios from 7:1 to 72:1. Reaction times were limited to one minute during one test series and ten minutes in the other series. The tests were conducted in a stainless steel system.

In general, the amount of oxygen removed increased with increasing temperature, reaction time or hydrazine to oxygen ratio. The amount of oxygen scavenged was, however, small in all cases. The maximum amount scavenged during a one minute reaction was about 18% (65 F and N_2H_4/O_2 = 72/1). The maximum amount scavenged during a ten-minute reaction was about 25% (65 F and N_2H_4/O_2 = 60/1).

Prototype for Heated Slug Rupture Tests. Two tests were made with a single coextruded U-Zr-2 rod in the isothermal heat treated condition to compare with previous results which indicated that heated rods rupture more severely than unheated rods. The rod was from a different lot than the original but almost identical results were obtained. After two hours exposure to 300 C water at 30 kw/ft power rate and 20 fps velocity, all of the three predefected pinholes had ruptured with the swollen areas measuring about one inch in length and 1/2 inch wide and projecting about 0.15 inch above the original diameter. All of the ruptures had a single longitudinal tear in the Zr cladding as opposed to a circular tear experienced in the unheated rods. About 38 grams of uranium was lost from each defect compared to 14 grams without power generation.

Corrosion of Carbon Steel in Raw Water. Raw water corrosion of A-212 carbon steel has been studied for approximately five exposure weeks at 140 C. A rate of 13.2 mils/year has been experienced after 777 hours, as contrasted with the 9.1 mils/year previously found at 100 C. In both cases

non-uniform corrosion has been noted. Deposition of material from the water has caused pitting of the metal (1-3 mils). These deposits have plated out even at 10 to 15 fps. Pitting of 1 to 3 mils has also occurred in crevices.

Structural Materials Development

NPR Zircaloy Process Tubes. Due to the steel strike, there has been no change in the status of the order with Allegheny Ludlum Steel Corporation for 70 NPR process tubes.

Chase Brass on a similar order has produced 25 extrusions. These extrusions were straight and the copper jackets came through in excellent condition. Surfaces and dimensions will be checked as soon as a new de-jacketing facility is in operation. The remaining 65 extrusions to make the first lot of 30 finished tubes will be extruded about mid-October. Present schedules on delivery and installation of a new, large drawbench indicate drawing will commence about the second week of November.

Harvey Aluminum has cut up one of their first three extrusions for drawing tests. These tests have gone well except that they could not make the third draw because of too much work hardening. Hence, it will be necessary either to employ a larger drawbench or to anneal before the final draw. The outside surface on the test pieces has been very good, about 20-30 micro-inches, but there is some question whether the entire inner surface will meet the 63 micro-inch requirement.

Burst Testing of Zircaloy Tubing. A section of 18% cold worked NPR type process tubing was burst tested at 340 C. The tube failed in a longitudinal split at 9000 psig internal pressure with 29% elongation of the diameter. The unit hoop stress was calculated to be 53,000 psi. This compares with a similar test (reported in June) during which the tube burst at 10,000 psig internal pressure with 8.8% elongation of the diameter and a hoop stress of 57,300 psi, with a tube wall temperature at failure of about 300 C instead of 340 C.

Nonmetallic Materials Development

MTR Graphite Irradiations. Preliminary results are now available from the first L-48 experiment, GEH-19-1. Hanford equivalent exposures are not yet available for this experiment since the MTR-HAPO exposure conversion factor is now being revised. Samples of CSF and CO (needle-type Continental coke graphite) were irradiated at about 700 and 900 C. At approximately 900 C the CO graphite contracted 0.08 percent in three MTR cycles. Based on a preliminary evaluation, the contraction rate for CO graphite at 900 C is half or less of that for TSGBF at the same temperature. The rough exposure figures also indicate that CO graphite contracts at a slower rate than the CSF at this temperature.

GEH-19-3, the third L-48 experiment, has been constructed and was charged into the MTR at the beginning of Cycle 128, September 21, at which time GEH-19-2 was removed after four MTR cycles. GEH-19-3 contains four samples of GL-10 graphite and four CSF reference standards. Design improvements have also been incorporated in an effort to eliminate the periodic malfunctioning of the electrical connector which was previously experienced.

GETR Graphite Irradiations. The two graphite irradiation experiments in the GETR, H-1 and H-2, have been operating successfully since the start of Cycle 5 on September 5, 1959. These two capsules are replacements for the two which were damaged at the start of Cycle 4. The temperatures on H-1, the capsule in the E-5 center loop position, vary from 900 C at the end samples to 1400 C at the center samples. On H-2, in the E-7 side loop position, the temperatures vary from 1000 C to 1500 C. These temperatures are in good agreement with those predicted and are as high or higher than any previous graphite irradiation experiments made by HAPO personnel. After two weeks of operation, the thirteen thermocouples which operated initially continue to function satisfactorily.

Hot Test Capsule Irradiation Experiments. Eighteen capsule experiments were prepared and shipped to the MTR for irradiation. These capsules contain a total of 85 samples of types of graphite considered as NPR candidates. In addition to these samples, one sample of CSF graphite is included in each capsule as a reference standard. These experiments contain no means for instrumentally monitoring the graphite temperature during irradiation but do include a series of temperature-indicating paints which preliminary tests showed were stable under irradiation for short periods.

Snout II Flux Measurements. Among the problems associated with the evaluation of radiation damage studies is the lack of accurate knowledge of flux conditions in the radiation facilities in the Hanford reactors. This is a problem both in defining the total exposure during Hanford irradiations and in comparing off-site exposures with Hanford exposures.

Al-Co and Ni foil monitors were included in a series of graphite irradiations in the Snout II facility in KW Reactor. These foils were the standard variety used at the MTR, and the activities were counted at the MTR after exposure. Thus, the flux measurements, even if inaccurate on an absolute basis, should be useful in comparing MTR exposures with HAPO irradiations.

Four irradiations comprise this series of tests. In the first three only one set of foils was used, but in the fourth approximately sixty foils were used to determine the flux variation parallel to the Snout II axis or perpendicular to the process tubes. The radial and azimuthal variation in flux within the sample carrier was also checked. The results are given below:

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Total Exposure	Thermal Flux per (MWD/AT)	Cadmium Ratio	Fast Flux >1 mev* per (MWD/AT)
5 MWD/AT	1.46×10^{17} nvt	20	3.0×10^{16} nvt
10.5	1.68×10^{17}	19	2.8
27.7	1.65×10^{17}	21	2.7
84	1.76×10^{17}	--	3.6

*This fast flux is computed using the techniques appropriate to the MTR flux and probably underestimates the fast flux in the Hanford reactors.

In the last irradiation periodic variations along the axis of the irradiation facility were observed with the period of the reactor lattice. For the fast flux the maximum and minimum values differed by approximately 15 percent while the thermal flux varied by about five percent. Since the maximum in the thermal flux coincided with the minimum in the fast flux, the fast flux to thermal flux ratio varied by 25 percent. This stresses the error inherent in assigning exposure (MWD/AT) strictly from the thermal or total flux. Radial and azimuthal variations were less than five percent generally and were not significant.

Graphite Irradiation at 80 C. Three CSF and three CO graphite samples were discharged from the 80 degree test hole recently with over 1200 MWD/AT exposure. The test also included a cobalt-aluminum flux monitor which is now being readied for analysis. As soon as all pertinent measurements on the graphite are completed, the samples are to be returned to the test hole.

Hot Test Hole Irradiations. The first discharge of graphite samples from the 2C test hole at KE Reactor since the activation as a hot test hole in April 1959, was completed successfully. The graphite boat was discharged with an exposure of 885 MWD/AT.

Compression set, placed in graphite samples during machining, has been suspected of causing the initial expansion observed under high temperature irradiation. Samples of National Carbon Company, Continental coke graphite were annealed at 650 C before irradiation at 550 C. Another similar set of samples was irradiated without prior annealing. For the annealed samples the transverse and parallel length changes were +0.008 percent and -0.004 percent, respectively. The corresponding values for unannealed samples were +0.024 percent and +0.001 percent which indicates prior annealing will appreciably reduce the initial expansion. Samples annealed to 2600 C will be discharged soon and should indicate whether the expansion observed in 650 C annealed samples was due to insufficient annealing or growth due to radiation damage.

Graphite Burnout Monitoring. Recent burnout monitoring data show an excessive burnout rate of 4.9 percent per 1000 operating days for the central part of channel 3478-D. This is about 2-1/2 times the allowable rate but may have been caused by two tube leaks in the vicinity of this channel. The nominal gas composition during this period was about 60 percent helium and 40 percent CO_2.

Thermal Hydraulics Studies

Effect of Heat Capacity on Damping Reactor Temperature Surges. A study to investigate the magnitude of the damping effect on reactor temperature surges due to the heat capacity of the fuel elements was completed. Such an effect is of considerable importance to the present Hanford reactors where, in some cases, the reactor power levels are limited by the value of bulk outlet water temperature expected after an electrical outage on a reactor power surge. While in both of these cases a reactor scram would be initiated shortly after the incident, a short period would exist during which the water temperature would increase until the reactor scram became effective.

Analytical calculations of these temperature surges were combined with laboratory experiments performed on an electrically heated mockup of a single tube. The results show that for a ramp change in flow, such as would occur in the first few seconds after a BPA electrical outage, the rise in temperature at the outlet of a process tube would be about 55 and 65 percent of the calculated equilibrium values in two and three seconds, respectively. For the case of a step increase in power level, the temperature rise would be about 85 and 95 percent of the equilibrium value after two and three seconds, respectively.

A calculation of this sort is subject to some errors and, in addition, several contributing factors were ignored for the sake of simplicity. The application of these results to the Hanford reactors must also consider the flow mixing in the rear piping which is also difficult to calculate with great precision. Since the accuracy of the combined calculations cannot be as sufficient as is desired for reactor application, it was concluded that the reactor test now planned by IPD personnel would be of significant value.

Equipment Projects. Acceptance tests were concluded on the silicon rectifying equipment (Project CG-661) which was installed in 189-D to provide additional heat generating capacity in the heat transfer laboratory. A 50 percent overload test was run on the rectifiers during which a total current of 48,000 amps was produced for a period of one minute. This value of current is almost 2-1/2 times higher than that which is available from the existing motor generator sets.

Placement of orders for all major equipment items required for the steady-state phase of Project CGH-834 was completed. This project will modify the High Pressure Heat Transfer Apparatus for higher flow and heat generating capacities and will allow transient type experiments to be performed at high pressures.

Hydraulic Studies. Preliminary laboratory studies were performed to determine the degree of flow mixing within NPR type seven-rod cluster fuel elements. Since theoretical calculations indicate that some mixing is necessary to prevent excessive temperature of the coolant in the center of the fuel element, there is an incentive to determine the effectiveness

of different mixing promoters. The test section used in these studies consisted of a 70-inch section of a prototype seven-rod fuel assembly (using 0.704 inch rods) in a 2.70 ID coolant tube. Special end fittings were used to introduce two separate fluid streams at the upstream end of the fuel element prototype -- one fluid stream between the process tube and the outside of seven rods and the other fluid stream inside of the six outer rods of the seven-rod bundle. Likewise, two distinct fluid streams were withdrawn at the downstream end of the test section. A salt solution was introduced in the inlet of the inner flow channel and samples were taken at various locations along the outer channel to determine the degree of mixing.

Three runs which were made at various total coolant flow rates through a test section where each rod was wire wrapped on an 18-inch pitch showed the following results: (1) an inlet stream salt concentration ratio of 900 :1 (inner channel to outer channel) was reduced to a ratio of 1:1 after flowing through the 70-inch long test section; (2) marked concentration changes were noted at initial lengths along the rod bundle corresponding to the wire wrap pitch. The results indicate that wire wrapping is one method to achieve adequate flow mixing in seven-rod fuel elements.

Twenty-four flow meters were calibrated for IPD to use for flow monitoring of special production test channels. Data for several standard CG-558 venturis fell very close together while data for several specially reamed venturis had more scatter. Undoubtedly, this shows the advantages of the burnishing technique used on standard venturis to achieve a smooth finish of close tolerances.

A flow test was conducted for IPD to determine the flow characteristics of a 16-inch long aluminum insert to be placed in the rear nozzle of old reactor process tubes. The insert will provide a seal between the process tube and the rear nozzle in case of a damaged Van Stone flange. The flow test showed that the insert will have negligible effect on the normal operating conditions within a process tube.

Flow tests were conducted to determine coolant flow past the fuel elements during precharging operations when the front nozzle is removed. It was found that, for the BDF assembly, the flow resulting from a front header pressure of 140 inches of water would all go out the front nozzle and none past the fuel elements when the rear header pressure was zero. It takes a positive rear header pressure under these conditions to produce any flow past the fuel elements and a rear header pressure of 20 inches of water produces a reverse flow of about one gpm.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 Facility operated for 90 hours during the month. Operation has been discontinued indefinitely due to lack of a supporting program.

Reactor Technology Development

Neutron and Gamma Attenuation. The perforated ferrophosphorus concrete test slabs were successfully placed in the shield facility for the first irradiation after the slabs had been baked at 50 C. The iron serpentine (268 lb/ft^3) test slabs were removed from the test facility and placed in the oven for the 100 C bake.

A survey of the data on the shielding properties of high density concretes tested in the DR shield facility indicates that the proper mixture of iron, serpentine and cement in the density range of 210 lb/ft^3 is a good candidate for biological shield application where the ambient temperature of the shield may reach 300 C. Such a concrete will have about the same shielding properties at 300 C as magnetite-limonite (210 lb/ft^3) has in the "as-cured" condition and would be superior to magnetite-limonite, iron-limonite (265 lb/ft^3) and ferrophosphorus (300 lb/ft^3) concretes operating at three hundred degrees Centigrade. The reason for this is the ability of the serpentine to retain its water of crystallization at elevated temperatures. Serpentine is an asbestos mineral with the approximate formula $3\ Mg\ 0.2\ SiO_2 \cdot 2H_2O$. The water of hydration amounts to about 13.5% by weight as measured by the Johns-Manville Laboratory. At the Johns-Manville Laboratory a series of high temperature tests were conducted on serpentine for periods varying from a few hours to over 1000 hours. This work is being carried on here for periods greater than 1000 hours at 300 C, and data to date indicate the water loss in ten years (extrapolated) is only about 18% of the water of hydration. Johns-Manville data indicate that at 1000 F the dehydration is rather rapid, but up to 800 F a slow rate of dehydration was observed. Tests are under way now to investigate radiation damage to serpentine when exposed to high neutron and gamma fields. Iron-serpentine test slabs (210 lb/ft^3) have been fabricated for testing as candidate NPR shielding in a joint effort with IPD personnel.

Three ion chambers for shield studies were obtained and wired. Calibration checks proved them acceptable.

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.

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C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. It has been reported previously that a reduction of PuO_2 to a suboxide does not occur when a powder sample is heated in hydrogen. AERE data, however, have shown the existence of approximately 20 percent of BCC Pu_2O_3 when PuO_2 is heated for one hour at 1450 C. To investigate this anomaly, the present hooded facilities were converted from full air flow to an argon atmosphere to prevent oxidation of a possible suboxide. Five grams of PuO_2 powder were heated in dry hydrogen to 1500 C for times of one and eight hours. Immediately after discharge, they were mounted and transferred to a helium atmosphere diffractometer hood. The resulting x-ray diffraction pattern consisted only of the single FCC PuO_2 phase.

To further investigate the possible decomposition of PuO_2, a small sample was held in the molten state in a tungsten wedge for 30 seconds. The vapors were condensed on a copper disc and x-ray diffraction showed only a diffuse PuO_2 (111) reflection in addition to strong copper lines. Longer holding times and an amorphous condenser will be used in future experiments. Diffraction of the melted PuO_2 sample itself showed only a single FCC phase.

Preliminary data on the thermal expansion of PuO_2 indicates the coefficient to be greater than that reported for the isomorphous UO_2. A sintered sample, 90 percent of theoretical density, gave an expansion coefficient of 15.2×10^{-6} in/in/°C over the temperature interval 125-911 C.

Cursory corrosion testing of various fuel core alloys has yielded two markedly superior alloys. These alloys have shown good resistance to corrosion in stagnant demineralized water at 350 C. The nominal compositions of the two alloys are as follows:

	I	II
Pu	2.0	2.0
Ni	1.0	2.0
Fe	0.6	0.5
Si	1.4	0.4
Ti	--	0.1
Others	0.2	0.2
Al	94.8	94.8

Corrosion rates are currently being determined for the two alloys.

Fabrication Studies. Casting techniques are being developed for casting fuel-bearing Al alloys directly into Al cladding for the purpose of making coextrusion-clad fuel rods; an important step in the process is the

casting of the cap material directly over the solidifying fuel alloy. The cap material is cast so that it fuses to the cladding, thus completely sealing the fuel material from the atmosphere and excluding air from the container. This process eliminates billet decontamination and cleaning, assembly, welding, and outgassing. With the elimination of most of the handwork in the preparation of the coextrusion billets, the coextrusion process would be more economical and more adaptable to remote processing of highly radioactive fuels.

Five coextrusion billets were cast into the cladding by this technique. An Al-Ni alloy substituted for the fuel material. Four of five radiographs showed large voids which were attributed to gases arising from etchants entrapped between the can wall and the base which had been welded to the cladding. The fifth radiograph showed the coextrusion billet to be quite sound. This latter billet and three others were extruded into 9/16" diameter rod; the reduction ratio was 20:1. The three billets with large voids exhibited a substantial amount of blisters between the core and cladding; the sound billet had no blisters over the entire length of the 10-foot extrusion, and sectioning indicated complete bonding between the core and cladding. Future work on end configuration will be done with extrusion cans machined from solid stock to eliminate the entrapment of etchants.

The Al-Pu alloy billets produced this month were as follows: six Al-5 w/o Pu billets for further critical mass studies; six Al-1.8 w/o Pu for PRP fuel fabrication; three C-8-10 Al-2 w/o Pu for corrosion studies; and eight Al-1.8 w/o Pu hollow castings to be used in preparing injection cast fuel rods.

A nearly homogeneous casting was produced with 2S aluminum injected into 1/2-inch diameter, 89-inch long Zr tubing. The density of the casting was not improved (94%), but the uniformity of the finely divided shrinkage cavities and the absence of gas porosity were encouraging. Pre-evacuation of the Zr tubing to less than 50 microns and a leak tight seal on the dip tube were responsible for the elimination of gas porosity. Several castings were made in which the aluminum injection rate was reduced to the minimum that would permit full length filling to determine if turbulence was responsible for low density castings. The density of the slowly filled casting was worse, with pronounced piping indicating that the problem is primarily non-directional solidification.

Production techniques are being perfected for extrusion and subsequent core preparation of PRTR fuel elements. Preliminary production rates appear to be six billets (12 fuel rods) extruded, straightened, cut to length, weighted, gauged, and cleaned per two man-days. An extension tube added to the extrusion hood for run out purposes allows uninterrupted extrusion of a full length billet. This has decreased the diametrical variation over the extruded rod.

Al alloys C-8-10, C-8-12, and C-8-23 were extruded into 1/16" diameter rods and submitted to the Coatings and Corrosion group for corrosion evaluation as a potential PRP cladding material. The samples were subjected to approximately the same amount of mechanical work and have similar surfaces to rods produced by coextrusion cladding.

Thermal cycling experiments on three-foot long elements is continuing in the four-foot long autoclave. A group of elements was fabricated with Zircaloy tubing and pure aluminum rods using different techniques in an attempt to better understand and solve the ratcheting problem. Some of the elements were fabricated by applying a graphite lubricant on the cores followed by swage sizing of the cladding. Part of these were wire wrapped with different tensions and part were not wrapped. Others were made using no lubricant on the cores. Some were made using segmented cores both lubricated and not lubricated. All twenty elements, however, were subjected to a light swage sizing operation. Some of the elements have withstood as many as 42 thermal cycles between 100 and 350 C at 1300 psi and at heating and cooling rates of the order of 4 C/minute. The results and general conclusions of the test thus far are as follows:

1. In general, on those elements which are affected, thermal cycling causes the aluminum cores to shorten and Zr cans to increase in length, whereas on those which are not appreciably affected, both the cores and cans shorten slightly.

2. Graphite lubricant applied to the cores definitely improves the thermal cycling behavior of the elements. All of the six which were lubricated and not wire wrapped remained straight after 42 thermal cycles. The cores shortened up to 0.100 inch and the cans shortened up to 0.023 inch on a 33-inch over-all length. It is interesting to note that the cores in all the graphite lubricated elements, even the wrapped ones which are badly bowed, are still loose at room temperature, and there is no evidence of sticking or galling.

3. Wire wrapping increases the core shortening and accentuates the warping and surface bumping. Only two of the six wrapped elements remained unchanged at the end of 42 cycles whereas on two others, the cores shrunk over 1-1/2 inches and the cans elongated about 0.075 inch on a 33-inch over-all length. The amount of warping or bowing of the wrapped elements is considerable, and in all cases follows the contour of the wire around the tube.

4. Segmented cores, whether lubricated or not, appear to be worse than solid one piece cores.

5. There is an indication that warping may be associated with the original condition of a given as-received tube. For instance, two short elements fabricated from the same long tube warp and distort about the same amount on thermal cycling.

6. There does not seem to be any correlation between warping and the tension with which the wire was applied in the ranges tested. With the lower tensions, however, loosening of the wire on cycling is not a problem.

7. Thermal cycling causes some of the tubes to fail by developing longitudinal splits. Two of the twenty elements showed splits at the end of 20 cycles, three more at the end of 36 cycles, and two more at the end of 41 cycles. These tubes had passed the external Zyglo inspection; however, they had not been eddy current tested. It is felt that the longitudinal splitting is due to inferior quality tubing.

Eight additional elements were fabricated with eight-mil 304 stainless steel cladding. These were made by simply slipping aluminum cores into the tubing with no lubrication, no end clearance, and no sizing operation. There was no tendency for galling between the core and tubing. They were cycled under the same conditions as the Zircaloy clad elements. The cores shortened slightly and the cladding elongated slightly as they were examined at the end of six and 12 cycles. At the end of 27 cycles, the cladding was observed to be badly cracked, both in the transverse and longitudinal directions. This cracking could be caused by stress corrosion or excessive straining. Metallography is being performed in an attempt to determine the cause. End clearance will be left to accommodate thermal expansion; however, the tubing must be supported in these areas to prevent collapsing by the external pressure.

An injection cast fuel rod, with restrictions to longitudinal differential expansion necked into the tubing at six-inch intervals before casting, completed 43 thermal cycles. The 42-1/2-inch long element shortened 0.049-inch and decreased in diameter 0.002 inch during the first six cycles. The last 37 cycles produced no dimensional changes, and there are indications that the bond is still intact.

Work has commenced on fabricating the first ten fuel element clusters for the PRTR loading. The alloy has been cast and rods have been extruded and are presently being straightened, cut to length, and inspected. Eddy current and Zyglo inspected perfect tubes are being cut to length, counterbored, cleaned, gauged, and the first end caps are being welded in place. The actual assembly of the elements will be conducted in both the Pilot Plant and 231-Z Building due to equipment availability. Much of the equipment in the Pilot Plant required for the fabrication is still not completed.

Fuel Evaluation. Sixteen Al-Pu and Al-Si-Pu capsules, six PuO_2 impregnated graphite capsules and a seven-rod cluster containing Al-Pu cores are being irradiated in the MTR and a KER loop. Two capsules containing UO_2-PuO_2 cores discharged last month have been measured and show no dimensional changes.

Two experiments are being fabricated for irradiation in the GEH-4 loop facility in the MTR. They will be eleven-inch long Zircaloy clad elements containing Al-3 w/o Pu and arranged in a three-rod cluster array. Each rod will generate 25 kw/ft of length in a thermal flux of 2×10^{14} nv which gives a maximum core temperature of 376 C. One cluster will be fabricated by simply slipping the cores into as-received tubes and not sizing the cladding onto the fuel. In this case there will be as much as eight or nine mils diametral clearance between the core and cladding. The other cluster will be fabricated by swage sizing the can onto graphite lubricated cores. These clusters will be irradiated a maximum of two cycles.

UO_2 Fuel Development

PRTR Fuel Elements. This month a total of 340 fuel rods were swaged; a total of 620 had been swaged previously. All rods swaged this month used tubing that had passed the external fluorescent penetrant inspection and the eddy current test. The use of tubing which has passed the fluorescent penetrant inspection has reduced the rejection rate of swaged rods for surface defects from over 50 percent to less than seven percent. Most of these rejects are reclaimable. Swaging experiments during the coming month will involve tubes that were originally rejected by the fluorescent penetrant inspection, then reconditioned, and then reinspected.

All materials required to fabricate end hangers have been received. Sub-assemblies for the next ten sets of end hangers have been welded. The parts for forty sets of end hangers are approximately two-thirds completed by Technical Shops.

The established welding technique for closing PRTR swaged fuel rods continues to produce very satisfactory results. Radiograph of 127 rods in the past month (254 welds) has revealed one weld with insufficient penetration, requiring rewelding.

Fused uranium dixoide grain is the most promising candidate fuel material for swage compacted or vibratorily compacted PRTR fuel rods. Negotiations were completed for procurement of 6000 pounds of fused oxide from the Spencer Chemical Co. Delivery of the fused oxide will start in four weeks after receipt of the feed material.

Twelve hundred pounds of UO_2 for use in fabricating swaged PRTR fuel rods was prepared by pressing and sintering "micronized" UO_2 to an average density of 96 percent of the theoretical. This material was used as a "stand-in" until arc-fused UO_2 of the desired quality could be obtained.

Fabrication Development. Sintered and crushed UO_2 was compacted in nine-foot long, 0.570" OD x 0.030" wall tubes to an average density of 87 percent of the theoretical by vibration at one kilowatt. The particle size composition was 69 percent (-6 +10), 18% (-35 +65), and 22% (-200) mesh. After addition of a second one kilowatt amplifier to the vibrational

compaction system, the rods were again vibrated. Density measurements with the gamma absorptometer showed that the density had increased to ~ 90 percent of theoretical.

Swaging of PRTR fuel rods to the maximum core density and to specified dimensions requires initial loading of the cladding to a UO_2 density which is 68 percent of the theoretical. Tube loading process which has been used previously has provided a starting density of only 62 percent of the theoretical. This resulted in a wall thickness of 0.033" (0.030" desired) and lessened the probability of reaching maximum UO_2 density.

Fuel Evaluation. Refinements have been made on the gamma absorptometer so that it can now be used to accurately and reliably determine the densities of the swaged PRTR rods, on a "go, no-go" basis. A mechanism to continuously feed rods into the instrument is being fabricated for use in routinely checking the densities of swaged rods. This will eliminate the need for determining densities in the analytical laboratory.

Etching and autoclaving problems were encountered with PRTR fuel rods. Many of the rods inspected after autoclaving have had a spotted or milky oxide film caused by inadequate removal of temporary identification markings. Some of the rods have cracks or scratches which penetrate the oxide film. By removing the oxide film, re-etching and re-autoclaving, some of these rods have been reclaimed.

A spiral marking was found on approximately forty rods. It was determined that the marking was caused by small indentations on the feed roll of the swage feed device. New rolls eliminated the immediate problem and bullet-nosing both ends of the rods before swaging will prevent a recurrence of this problem.

The new vacuum pumping system for leak testing PRTR fuel was placed in service; time spent on leak testing was reduced by a factor of ten. In addition to the advantage of time saving, it was possible to test the entire length of the fuel rod rather than only one welded end at a time. The new system consists of two four-inch diameter tubes and a complete pumping system for evacuating each tube after it has been loaded with five fuel rods. After the tube has been evacuated, it is connected to the leak tester to determine whether any fuel rod is leaking helium. The previous leak testing equipment was connected directly to one end of a rod at a time. This new leak test procedure gives added assurance that none of the swaged fuel rods have small holes in the cladding.

Internal surface defects on Zircaloy-2 tubes which had passed the fluorescent penetrant test were detected by subjecting these tubes to an immersion type ultrasonic test. Metallographic investigations are being made to determine the nature and severity of these internal defects.

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Two samples of electrolytic UO_2 were evaluated for possible swaging applications. The samples were prepared by the Heavy Element Chemistry Operation by the electrolysis of fused salts. Swaged densities were comparable to the sintered and crushed UO_2 now being used for the PRTR loading, but the densities obtained with vibrational compaction were considerably lower.

Swaged UO_2 capsules have attained an estimated maximum exposure of approximately 10,500 MWD/T during irradiation in MTR and ETR. No failures of these capsules or any other swaged fuel elements have occurred to date.

A defected, swaged UO_2 fuel rod was irradiated in the MTR. The 2.42 w/o U-235 enriched UO_2 element was irradiated for approximately one hour and a half in the GEH-4 reflector position of the MTR, at a maximum surface heat flux of approximately 500,000 BTU/hr/ft^2. The coolant temperature was approximately 100 F, at 90 psia. The 24" long, 0.560" OD swaged rod had a 0.005" hole drilled in the cladding prior to the irradiation. The immediate results indicate: (a) much smaller release of fission products than anticipated, with a decrease in activity of the coolant while the element was being irradiated at a constant power; (b) no disintegration of the Zircaloy-2 cladding due to waterlogging or hydriding.

The vibrationally compacted UO_2 fuel element, which was discharged from the MTR in error, because of reported fission product release in the coolant, has been returned to the MTR for reinsertion and irradiation. The element is 1.44" OD and is clad in stainless steel.

A full-size swaged PRTR fuel element has now been under flow test for nine weeks. The element will be reinspected at the next shutdown.

Facilities. The "High Frequency Resistance Welder" produced by the New Rochelle Tool Corporation for welding both straight and spiral ribs on Zircaloy tubes has been received. This machine is to be installed on the mezzanine in the basement of the 325 Building.

Corrosion Studies

Pickling Zircaloy Tubes. An investigation was made as to the probable causes of grey staining observed on the PRTR process tubes being pickled and autoclaved at White Bluffs. A number of equipment and procedural changes were made to bring the pickling process closer to the conditions being employed successfully in 314 Building for PRTR Zircaloy fuel sheathing. Following these changes the grey staining was eliminated, and the pickling and autoclaving of the process tubes is proceeding at full capacity.

An investigation to determine the advantage of using hot aluminum nitrate and tap water rinses following Zircaloy pickling was initiated during the past month. Preliminary results indicate that a hot aluminum nitrate bath (40 C) is slightly better in reducing the amount of acid staining on

PRTR fuel rods. No detectable difference in acid staining was noticed with either a hot or cold tap water rinse following the aluminum nitrate bath.

Comparison of Zircaloy-2 and Zircaloy-4 for Resistance to Hydriding by Molecular Hydrogen. The susceptibility of Zircaloy-4 to hydriding is being compared with standard Zircaloy-2. In the first two runs, the alloys were compared for resistance to dry hydrogen gas with no oxide film present. The 1" x 1/2" samples were etched in HNO_3-HF, dried and weighed, then vacuum annealed at 750 C to prepare oxide-free surfaces. The temperature was then lowered to 400 C and 450 mm Hg dry hydrogen added. The results of two runs were:

Alloy	Hydriding Induction Time	Hydriding Results
Zr-4	12 min.	Destroyed in 36 min.
Zr-2	24 "	" " 72 "

This first comparison showed the Zircaloy-4 sample to hydride at a faster rate than the Zircaloy-2 sample.

In a second comparison two coupons, one of each alloy, were etched together, vacuum annealed together, and both exposed at 500 C to the same mixture of hydrogen at 400 mm pressure with H_2O added to a partial pressure of 0.12 mm. After a three-hour induction time the Zircaloy-4 sample started hydriding first. After the Zircaloy-4 was destroyed, examination of the Zircaloy-2 revealed some hydriding had also started but was much less severe.

Thus, in the two comparisons made to date, the Zircaloy-4 material appears to pick up molecular hydrogen more rapidly than Zircaloy-2. However, this is not necessarily in conflict with Bettis data, which were all concerned with pick-up of corrosion-produced atomic hydrogen. Furthermore, only one small sheet of Zircaloy-4 has been available for testing, and it may or may not be representative of the best Zircaloy-4 available. It has also been noted that this Zircaloy-4 material pits badly in the standard etch bath, producing a rougher finish than Zircaloy-2. However, because of very limited experience with Zircaloy-4, the above conclusions are tentative and subject to further experimentation.

Corrosion of Magnesium and Aluminum in High Temperature Steam. Several tests were conducted during the month to determine whether violent metal-water reactions could be readily produced with magnesium, aluminum or Zircaloy-2 at high temperature. Some rapid corrosion of magnesium and hydriding of Zircaloy-2 was observed; however, no violent or self-sustaining reactions were initiated under the laboratory-scale conditions employed.

Defected capsules of magnesium clad in Zircaloy-2 were exposed to water and steam up to 350 C for several hours. The size of the defect was found to be an important variable in determining how magnesium corrosion would

occur. For example, a capsule with a 12-mil hold through the cladding experienced only a small weight gain in 24 hours at 350 C, while one with a 1/2" round defect corroded about 0.1" in 20 minutes at 300 C.

Higher temperature experiments were conducted by electrically heating undefected capsules of magnesium and aluminum clad in Zircaloy-2. These capsules were about 0.15-inch diameter by 1.5-inch long, with enlarged ends for electrical connections. The center portion consisted of a 10-mil Zircaloy wall over a 1/8-inch diameter pin of magnesium or aluminum. These capsules were exposed to steam in an autoclave at 400 C and 1000 psi. The capsule was then electrically heated and held at a temperature past the melting point of the core material for about one minute. Three or four such heatings were sufficient to corrode through the capsule, exposing the molten core material to the hot steam. No self-sustaining reactions were produced. About one-half of the magnesium metal and nearly all the aluminum metal was left uncorroded. The Zircaloy-2 jackets were oxidized, hydrided, and corroded by the molten metal and steam environment.

An attempt to alloy the jacket and magnesium core before exposure to the autoclave by heating in high-vacuum resulted in capsule failure. The metallography of the failed capsule indicated the magnesium had corroded through a five to ten-mil Zircaloy-2 jacket in less than ten minutes in the 650 to 700 C temperature range. The corrosion did not appear to be intergranular.

Aluminum Alloy Development. Another alloy has been added to the list of logarithmically corroding aluminum. This alloy has a composition of 1.0% Ni, 0.5% Fe, and 0.1% Ti, and was cast using high purity base metals at Argonne National Laboratory. It has a banded distribution of very finely divided second phase particles. Neither the distribution nor the size of these particles appears significantly different from many alloys which corrode parabolically in high temperature deionized water.

Although a great number of melts have been made of the X-8001 and X-8001 + Ti formulation, this is the first melt which has shown corrosion characteristics better than the commonly seen parabolic rate. As the formulation and the microscopically visible second phase distribution are not unique, it would appear that the use of high purity base materials is very important. The first Hanford alloys of this type are now in test.

Structural Materials Development

PRTR Jacket Tubing. The Thermatool ribe-to-tube welding machine has been delivered to Hanford from New Rochelle Tool Corporation and their field engineer will be on-site about mid-October to supervise its installation.

Metallographic and corrosion comparison tests of a new lot of Zircaloy material based on Columbia National Zirconium sponge, and previously used lots based on Carborundum sponge, show very little grain structure differences and very good corrosion test results.

A new order of 1000 Zircaloy-2 tubes of 3/4-inch diameter will be ready for inspection on September 28.

Zircaloy Process Tubes. The ultrasonic, fluorescent dye penetrant, and radiographic testing and inspection of the PRTR process tubes prior to pickling and autoclaving is 80 percent complete. Much of the work remaining consists of investigating defect indications observed during fluorescent dye penetrant checking and ultrasonic flaw detection. Only one tube has thus far been found to contain a serious defect -- a seam apparently greater than 10 mils deep.

Twenty-nine candidate tubes for reactor use have been pickled and autoclaved. The staining problem has been largely resolved, with only minor staining having been observed on about eight of the candidate tubes.

Tube bowing of up to 0.150-inch during autoclaving has been encountered and is believed to be a result of a sag that has developed in the autoclave plus partial stress relief of the tube. The wheels of the tube carriage rack have been reset to compensate for the autoclave sag and provide more level support. With this adjustment, the straightness of the large diameter portion of the last 18 tubes processed has remained within specifications. However, eight of the tubes did bow out of specifications on the small diameter portion and will require straightening.

Pickling and autoclaving of these tubes is now proceeding at a maximum rate of one autoclave load of six tubes every other day. The first ten tubes should be ready for shipment to the PRTR contractor during the last week of September. Allowing time for maintenance of equipment, reprocessing of tubes, and post-pickling and autoclaving inspection, it is estimated that final delivery of tubes will be made during the second week of November.

Radiometallurgy Laboratory Studies

Fission gas samples were collected from three irradiated UO_2 samples and submitted to the analytical laboratory. One metallographic sample removed from a rod of sintered UO_2 (from KER Loop 3) showed that the UO_2 structure was unchanged by irradiation. A dye check of a ruptured, 2.33 a/o enriched, cored, sintered UO_2 fuel element revealed a crack in the weld at the top end-cap. Metallography revealed that the weld penetrated only 10 mils of the 30-mil jacket.

X-ray diffraction studies of unirradiated 8 a/o Pu-Al alloy showed no appreciable strain or damage by the addition of the plutonium atoms. The irradiated specimens were too radioactive to handle in the Radiometallurgy X-Ray Cell.

An epoxy resin has been tested for its suitability to impregnation of ceramic fuels. This resin cures to a tough hard plastic in four hours at room temperature. It also appears to exhibit very little shrinkage, a

desirable property for impregnation where small cracks must be filled and the element must not be deformed by the curing plastic.

The results and conclusions from the above work will be reported in connection with the respective development programs of Ceramic Fuels and Plutonium Metallurgy Operations.

Thermal Hydraulics Studies

Additional laboratory experiments were performed to determine the boiling burnout conditions for the PRTR Mark II fuel element. The test section used in the latest tests was a 0.150-inch cooling annulus between two heated surfaces where the inner surface had a 50 percent eccentricity with respect to the outer surface. Boiling burnout points were found at 1100 psia, 0, 5, and 10 F subcooling, and flow rates of 1,000,000 and 2,100,000 lb/hr ft^2. In general, the burnout heat flux was found to be in the neighborhood of 800,000 B/hr-ft^2. This is roughly a 40 percent reduction in heat flux at the boiling burnout point for this test section having a 50 percent eccentricity as compared to the concentric case. The boiling burnout points for the eccentric test section were reached under steady state conditions and at no time were melting temperatures reached. The details of these experiments are to be reported in a separate document.

The full length, full scale electrically heated mockup of the Mark II-b element was installed in the high pressure heat transfer apparatus for experimentation at higher power levels. Considerable time was spent in determining pressure drops of all components of the test section under non-heated conditions so that a very careful analysis could be made of the hydraulic instability characteristics under heated conditions. Toward the end of the pressure drop determinations, a weld in the test section failed and the experiments were terminated for repair work.

Mechanical Equipment Development

PR-1 Discharge Operation Mockup. The floor beams for mounting the PRTR fueling vehicle were installed in the 314 Building.

Major assembly work on the machine has begun at the factory. The bridge is assembled and mounted on floor rails. The carriage is subassembled to the bridge, and the tower and tower floorplate are mounted on the carriage.

PR-10 - Primary Loop Mockup. The 14-inch gate valve and the three eight-inch check valves were delivered to the Phase III contractor on September 4, 1959, after weld-end preparations and cleaning.

The primary process pump operated for 583 hours during the month with primary seal leakage varying generally between 0.01 and 0.1 gallon per hour, although for several extended periods the leakage was too low to measure.

On August 29, 1959, the prototype process pump was started up following replacement of approximately 50 feet of the underground eight-inch water supply line. Cooling water to the pump was interrupted for approximately 10 to 15 minutes due to air trapped in the line. The primary seal faces were badly damaged, and water in the leak collection tank was heated to boiling. The pump was operated an additional 30 hours at full temperature and pressure, with leakage less than 0.1 gallon per hour, until seal failure when the leakage increased quickly to four gallons per hour. The O-rings on the pump shaft were not damaged since the cooling oil temperature did not get above 180 F.

The prototype pump operated 509 hours during the month, with leakage varying between 0.01 and 0.1 gallon per hour, and with the water saturated with helium at 525 to 530 F.

PR-13 - Injection Pump Test. Testing on Johns Manville packing Style 413 Uneepac rings was discontinued after 415 hours operation when the leakage started to increase, and investigation showed separation of the lips from the body of the packing.

Self-adjusting asbestos chevron packing manufactured by the Q-P Manufacturing Company has been installed, and testing has been resumed.

PR-40 - Shim Control Mockup. Further testing of the second prototype shim rod mockup was delayed awaiting arrival of coated chain and sprockets. The motor-planetary gear reducer assembly, undergoing radiation tests using Standard Oil of California radiation resistant grease No. 335, failed at 1.8×10^9 R on September 25, 1959. The second bids on the shim control assemblies were opened September 3, and found non-responsive because none met the required delivery date. The AEC negotiated with the apparent low bidder, APED-GE. The cost of the 24 units was set at $84,500, excluding purchaser furnished components, with 125 days delivery after notice to proceed is given. The notice to proceed date was estimated to be about October 1, 1959.

Ball bearings for the assemblies have been received.

PR-50 - Reactor Piping Seal Testing. A new spring arrangement for absorbing the differential thermal expansion between the stainless steel nozzle and the chrome-moly hold-down bolts has been developed. These springs are of the flat leaf type with waves. Good results have been obtained on the test mockup and with a compression testing machine. Approximately 2000 pounds on each hold-down bolt is required to provide a good gas seal. Strain gauge evaluation has shown about 4000 pounds maximum pull per hold-down is devebped by 200 F differential temperature (nozzle to hold-down).

Spring materials have been received and test springs are currently being fabricated. Tool steel has been used for test springs to date.

PR-51 - Reactor Piping Structural Integrity. Evaluation of the hold-down bolts has been conducted on the jumper heating loop. An addition of a pressure bleed system was incorporated on the loop.

A heavier wall jumper arrangement is being prepared for installation and evaluation.

PR-53 - Process Tube Thermal Cycling and Pressure Testing. Operation of the process tube has been curtailed due to maintenance work on the loop equipment and installing new test components. Only 243 hours of operation were achieved this month.

Special Tools:

1. A new geared nozzle-to-outlet jumper geared wrench has been designed.
2. Fabrication of one of the shroud tube removal tools is virtually complete.
3. A nozzle cap removing tool has been developed and evaluated.
4. A means of adding a gear to the existing nozzle-to-outlet jumper nut is being investigated.
5. A core saw design has been completed and has been assigned for fabrication.
6. The cut-off saw is being rebuilt to utilize a bandsaw operating around three points.

PR-64 - Gas Sampling Technique. The mockup for testing the gas sampling system has been completed and initial testing begun. The program has been delayed due to injection pump difficulties.

PR-70 - Hleium Compressor Test. The Hofer high pressure compressor has been operated 350 hours during the past month. Continued difficulty was experienced with the gas discharge check valves and the oil compensating pumps.

Four first stage gas discharge valves failed causing punctures of the second stage diaphragms. One valve has been rebuilt using Inconel for the flapper and hold-down plate. Another valve will be tested with the chrome plated parts. The pins used for assembly of these valves have been removed, and a welded assembly is now used. Testing of these valve designs and material modifications has begun.

Steps have been initiated in the procurement of a compressor gas check valve of the type common to U. S. manufactured compressors operating in a similar service.

The second stage oil compensating pump repaired by Technical Shops performed adequately for nearly 300 hours. At this time oil pressure could no longer be maintained on the second stage. The pump stroke was increased by 50 percent, making possible another 25 hours of compressor operation; however, the pump piston cylinder leakage increased to the point where rebuilding was necessary. The oil pump from the second Hofer

compressor was installed, but it also had excessive pump cylinder leakage. Autoclave Engineers was contacted by letter September 3, 1959, regarding the inadequacies of the Hofer gas check valves and oil compensating pumps. Except for acknowledging by phone the receipt of the letter, Autoclave has not as yet offered any solution to these problems.

Commercially available injection oil pumps are being investigated in an attempt to find a reliable pump for use on these Hofer compressors. When a potentially suitable pump is located it will be procured for test evaluations, provided Autoclave Engineers and Andreas Hofer have not supplied us with adequate pumps in the interim.

A third Hofer compressor is being considered as a spare unit and for testing purposes.

The emergency order for Hofer compressor parts issued July 21, 1959, has not yet been received.

During the past month an additional 500 hours of operation of the Corblin low pressure compressor has resulted in one check valve failure and two diaphragm failures. The failed check valve had a carbon steel disc which broke after 800 hours operation. A 416 stainless steel disc has now operated nearly 700 hours without failure.

One of the diaphragm failures was caused by metal particles from the broken check valve. The other failure was an apparent fatigue crack of a Corblin supplied stainless steel diaphragm which has operated 670 hours. One set of stainless steel diaphragms now operating has run for 775 hours without failure.

Further contacts have been made with Mine Safety Appliance Company (MSA) regarding the use of their infrared analyzer for detection of oil in the helium gas streams. It is expected that a definite proposal will be received from MSA within the next two weeks.

PR-80 - Air Cooling Duct Test. The air distribution around the dummy fuel element now appears to be satisfactory after extensive modifications of the internal vanes and addition of a supply pipe from the small capacity, high pressure blower.

In-Reactor Gas Loop. Design of the in-reactor section of the gas loop is continuing. Procurement of the Hastelloy "X", Inconel and Inconel 702 material is under way. The program for welding these materials has been started, and welding procedures are being prepared. Two braid covered bellows connectors were tested. One developed leaks after being heated to 1000 F and the other ruptured when the braid became unfastened at one end.

Inconel "X". The Inconel "X" straight section of 0.019-inch wall tubing failed after 1440 hours operation at 1150 F and 5500 to 6000 psi. The break was radial with no indication of splitting.

Leak Detection. The water vapor leak detection calibration was continued during the month.

High Pressure Seal Testing. An interim report was issued on the seal testing program. Essentially all the commercially available seals tested were inadequate in that their operating limit was approximately 750 psi.

Boiler Tube Sheet Mockup. Installation proof-testing and instrument calibration of the two test boilers were completed.

Reactor Technology Development

PRTR Physics Evaluation. The reactivity effect of substituting X-8001 aluminum alloy for pure aluminum in the Mark I Pu-Al spike fuel elements has been investigated. Values obtained for ηf, the number of fast neutrons released per thermal neutron absorbed, in a PRTR cell are as follows:

Fuel	ηf
Mk I, 1.8 w/o Pu-Al core, Zr clad	1.703
Mk I, 1.8 w/o Pu-X8001 core, Zr clad	1.687
Mk I, 1.8 w/o Pu-X8001 core and clad	1.670

Translating these values to the initial PRTR fuel charge results in a reactivity decrease of about six mk for the X-8001 core material. A further decrease of two mk would occur if this alloy were also substituted for the Zr cladding in the spike fuel. A reactivity penalty of this order would require the addition of roughly two spike columns at the present enrichment level. A further consequence would be a reduction in attainable exposure under steady-state plutonium recycle conditions of the order of 400 MWD/T.

Additional neutron flux distributions and heat generation rates have been calculated for seven-rod cluster test elements to be irradiated in the ETR.

A cylindrical version of the Fortran SNG reactor code for the IBM-709 has been compiled and appears to be operable. All of the SAP subroutines in the original code have been removed, resulting in temporary removal of the "Restart", "Simulated Convergence", and on-line print output features of the code. The slab and spherical version of the code is now being prepared for compilation.

Calculations have been carried out to determine the negative reactivity effect of the PRTR shim rods, taking account of the effect of the radial reflector. A two-group model was utilized. Results were obtained as a function of extrapolation distance from 1.0 to 10 cm. Inconel was found to have an extrapolation distance of 6.0 cm. Analysis of the weighting functions to obtain rod worth as a function of insertion configuration is essentially complete. An IBM-709 Fortran program has been written to compute the weighting for all possible configurations.

Calculations of gamma heating in a shim rod indicate a capture gamma source of close to 0.3 watt/gm will exist in the Inconel. This may result in objectionably high temperatures in the aluminum lead screw if the rod is allowed to rise above the moderator during full power operation. Further calculations of the heating are being carried out to assess the seriousness of this problem.

PRTR Shielding. Cadmium was selected as the most practical material for thermal neutron shielding for the large penetrations of the PRTR bottom primary shield. Cadmium was selected because of its lower maximum temperature during reactor operation and because of fewer mechanical problems in holding it in place.

It was calculated that a cadmium thickness of 1/8" would be required to obtain a useful life of more than 10 years before complete burnup. The maximum temperature attained during operation was estimated to be about 460 F (Cd M.P. = 610 F).

Shop tests are currently under way to select the best method of attachment of cadmium to aluminum.

PRTR Process Instrumentation. A final design of a capacitance probe for calandria dump rate tests has been assembled. Final calibration has begun.

Procurement specifications for resistance temperature detectors based largely on test results were provided the Design operation at their request. A review of the instrumentation on the high pressure steam loop was completed.

Preliminary investigations on the data handling system for the PRTR were completed.

Preliminary investigation using the evacuated sleeve-thermistor temperature probe combination has shown that this first prototype has too much mass and is not sufficiently insulated for practical use. A second prototype to eliminate these difficulties has been designed and is being built by the optical shop. This instrument is to be used for fuel element temperature measurements in the Fuel Examination Facility.

Safeguards Analysis. The PRTR Final Safeguards Report, HW-61236, was issued in rough draft form for comment. Analyses of credible accidents revealed that none of the credible accidents should result in release of fission products to the environs in quantities great enough to give more than a minimal radiation dosage to off-site inhabitants. The rough draft is scheduled for review by the PRTR Startup Council and by the PRTR subcouncil of the G. E. Reactor Safeguards Council late in September.

Several hazards analyses for the PRTR High Pressure Loop are under way. Writing of a preliminary safeguards report for this loop has been started, with completion scheduled for October.

Design Development

Over-all PRTR Contract. The over-all PRTR contract is 47% completed versus 42% scheduled, based on the official PRTR schedule.

Phase III PRTR Contract. The Phase III PRTR contract is approximately 28% completed versus a scheduled 53%. Contract progress is based on a completion date of March 3, 1960, and does not take into account a 35-day extension of contract time granted the contractor by the Commission because of the 21-day HAPO labor disturbance and for 14 days due to change orders.

The contractor continues erection of the inside and outside biological shield liners and forms for the fuel examination facility concrete shielding wall. Placement of the shielding concrete is scheduled to be placed during October; however, it appears that this operation will extend to at least mid-November.

Heat exchanger number 5, the primary pump support structure, and the pressurizer support structure have been installed. Modification to the pressurizer and structural supports was necessary to eliminate interferences with the primary piping system.

Erection of pipe cleaning facilities is essentially completed. Considerable difficulty has been encountered in getting the contractor to provide satisfactory identification of pipe weld radiographs. Review of the first radiographs indicate that considerable weld cutout and repair will be necessary.

The Phase III electrical contractor has pulled power cables from the 480-volt switchgear to the motor control centers in the reactor building.

Phase II-A. The Phase II-A PRTR contract is 94% completed versus a scheduled 100%. The contractor completed driving sheet pilings and has placed the rip-rap directly in front of the structure. He is currently working on river side excavation for the intake channel. Difficulty is being encountered in de-watering the area between the structure and the dike, since the contractor has encountered heavy flow of ground water as well as river water leakage through the dike.

PRTR Stack Addition. The contract for the PRTR stack and stack sample facilities was awarded to Custodus Chimney Company of Chicago on the basis of low bid of $40,625. The fair cost estimate for the work was $45,000. Contract construction time is 90 calendar days.

Service Building Extension. Design of the service building extension is 60% completed versus 80% scheduled. The drawing schedule indicates that all drawings will be approved by October 15. Receipt of comment prints has been slow and indicates that considerable difficulty will be encountered in meeting the October 15 deadline.

Design Analysis. The IBM program for computing PRTR primary coolant transients is nearly completed. The first computer runs will be made early in October. It is anticipated that results will be available by November.

Instrumentation and Control. The drawing revisions incorporating changes to the PRTR safety and containment systems were issued for comment during the month. Approval issues of the revised drawings are expected in early October. Design was started on a "standpipe" to be attached to the pressurizer to accommodate level-sensing instrument taps. The addition was necessary to permit lowering of the pressurizer level as required for protection against loop overpressure.

A contract is being negotiated with GE-ANPD for an engineering review of the PRTR automatic controller design.

Inspection and acceptance testing of the automatic controller and reactor radiation monitoring equipment is scheduled for the first week of October.

Both the electronic and mechanical portions of the fuel element rupture monitor have been placed for bids. The bids for the mechanical portion are due by the end of September; those for the electronic portion during the first part of October.

Reactor and Process Piping. A number of the primary system outlet nozzles showed excessive shrinkage of the lower flange-nozzle body weld. These are being remade to meet specifications. No delay in delivery is anticipated.

The facilities of Yuba Heat Transfer Division were visited for the purpose of making a final inspection on the steam generator and working out details of preparation for shipment. Several leaks at tube-tubesheet welds were disclosed during the halide leak test. These were subsequently repaired and the unit was cleaned and shipped on September 18, and delivered on September 28.

Personnel of the Atwood and Morrill Company were engaged in discussions relative to expediting the fabrication and shipment of the eight-inch special by-pass check valve for the primary pumps. Mid-October shipment is expected.

Preliminary discussions relative to the PRTR primary coolant piping stress analysis (proposed Design, Development and Research Contract DDR-79) were held with personnel of the Electric Boat Division of General Dynamics Corporation in Groton, Connecticut. The scope of work and procedures for reporting progress were worked out in some detail.

The activity monitor heat exchanger, HX-5, was received and mounted in the containment vessel during the month.

Several instances of piping interference with support structures and/or adjacent piping and electrical conduit were resolved. The most prominent of these involved the eight-inch primary coolant by-pass piping around the

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steam generator and control valve linkage interference on the preheater-deaerator.

Modifications were made to the pressurizer support structure and grating supports in the neighborhood of the pressurizer to provide clearance for the by-pass piping. Deaerator linkage interferences resulted from failure of American Water Softener Company to fully assemble the unit for fittings prior to shipment. Interferences were inspected by a representative of the vendor who has agreed to make the necessary corrections.

A purchase specification was written for procurement of two special safety valves for the pressurizer and two liquid relief valves for primary coolant. The purpose of these additions is to provide transient surge volume in the pressurizer and liquid relief for overpressure in the core section in the event of isolation of the core from the heat-exchange equipment during shutdown.

Fuel Handler. The fuel handler is currently being assembled. Cask sections have been mounted to the bridge and carriage assembly. Electrical wiring, controls, and position indicator mechanism are being installed.

An 18-day extension of the contract was granted because of an accident in transport of gamma probe equipment for cask inspection. Completion date is now scheduled for October 10.

Fuel Element Examination Facility. Mosler Safe Company resubmitted revised drawings of the cast iron wall blocks for approval. The drawings were approved for construction.

Mechanical assembly drawings and electrical drawings for the primary manipulator were submitted for approval by the W. F. & John Barnes Company. The drawings were reviewed and approved.

Shop drawings of the light fixtures were submitted for approval by Pacific Steel Products Company. Minor exceptions were noted and the drawings returned approved as noted.

The Phase III contractor submittals for the jet eductor (EP PR-630) and pressure switches PS-1 and PS-2 were approved.

Load Out Cask. The bid opening date for the Load Out Cask was extended to September 28 to permit additional interested vendors to bid.

High Pressure Loop (Project CAH-841). The design criteria has been revised following the preliminary comment issue of several sections and has been issued for final comments. Cost of the project is estimated at $1,100,000, including the $50,000 previously authorized for scoping and preliminary design.

Critical Facility (Project CAH-842). The scope description of the PRP Critical Facility was completed during September.

Writing of the design criteria for the same project has commenced. Rough draft copies of the building and services criteria and the description and fuel element handling sections of the equipment criteria have been written. It is anticipated that this document will be completed and published during November.

Plutonium Fabrication Pilot Plant

Phase III Construction. Completion of equipment installation under the Phase III contract is estimated at 93%, compared with 98% scheduled.

All exceptions have been cleaned up in the swage room, billet lathe room, 30 kw vacuum melting furnace room, welding room and radiography room. In addition, the autoclave room has been accepted without exceptions. The maintenance shop has been accepted with the exception of some door hardware requiring special keying, which has not been received.

Work on the oxide line installation proceeded normally during the month; however, the delay in shipment of the sintering furnaces was being seriously felt at the month's end. Work on the drawbench installation progressed normally. Work on the degrease-decontamination system was hampered by slow delivery of a replacement expansion bellows, a pressure transducer, and a pressure gauge with overpressure alarm switch. These small items, all contractor responsibility, are preventing testing of all major equipment pieces and all hoods of the system.

Procurement. Shipment of the sintering furnaces was delayed by the vendor's failure to obtain satisfactory inflatable gaskets to make the seal between the main furnace shell and the arch shell. Performance of a test of this seal at the vendor's plant was waived so that trials of other gasket configurations can be made on site during installation of the furnaces. The first furnace is now scheduled for shipment October 5, and the second October 12. Shipment will be by through-truck, so receipt of the first furnace about October 12 is expected.

Completion of the Phase III contract by November 1, following such late receipt of the sintering furnaces, will not be possible.

Procurement of the 20-inch rolling mill is about one month behind schedule. Information required for installation drawings, due about September 1, has not yet been received.

Transferred Capital Equipment. A revised project proposal is being prepared which requests additional authorization to cover the value of plant capital equipment planned for transfer to the project. Scheduling of design drawings and installation work related to this equipment is in progress.

PRTR Operations

Major effort was devoted to writing design tests to be performed before startup of PRTR. At month end, the rough drafts of 42 of a total of 44 tests had been completed. After review by interested groups, the tests will be compiled and issued as HW-61900-RD, "PRTR Design Tests". This document will be issued in October.

The accelerated training course for PRTR Technicians continued through the month. This training program will be completed on October 2. As a result of experience gained during this program, the Engineering Assistant training course, to begin October 5, has been modified slightly to insure balanced coverage of all topics. The Engineering Assistants will attend classes in groups of 10 to 15 in the PRTR Building. The Shift Engineers and Technicians will be housed in TC-2 at the construction site.

The PRTR Handbook of Operating and Construction Data was completed and issued during the month.

Design liaison continued with review of the safety and containment system and review of the vendor's drawings of the Fuel Element Examination Facility primary manipulator and shielding. The final rough draft of the High Pressure Loop Design Criteria was also reviewed and comments were issued. Portions of the PRTR Critical Facility Design Criteria were also reviewed.

Rough drafts of PRTR data sheets have been prepared. These will be issued for comment in October. Detailed discussions were initiated with Technical Data Processing Operation personnel for the purpose of machine programming PRTR operating data for routine storage and reporting.

2. BASIC SWELLING STUDIES

Irradiation Program

Four uninstrumented capsules containing precharacterized uranium pellets immersed in NaK have been received and have been assigned for post-irradiation examinations. These capsules were irradiated to gain insight into the effect of irradiation temperature and exposure on the basic swelling characteristics of unrestrained uranium.

Final assembly is now in progress on the slightly modified temperature monitored swelling capsule. This capsule contains four, one cm diameter natural uranium spheres. Heat transfer calculations have indicated that thinner and more numerous heat transfer fins were necessary to provide the desired internal capsule temperatures. These fins and attendant parts have been machined and installed in the capsule. Laboratory bench tests on the modified capsule will begin in the coming month.

Mechanisms and Theory

Uranium tensile specimens irradiated to high burnups and tested under PT-3NA (a HAPO program to study irradiation effects on uranium properties) were selected for density measurements. These specimens had been annealed between 400 and 800 C for times from 10 to 100 hours. Density measurements were completed during the month revealing no significant changes which could be attributed to swelling. It would appear, therefore, that for burnups up to 0.1 a/o, appreciable swelling does not occur from post-irradiation annealing at temperatures below 800 C. No further work is presently being contemplated with these specimens.

There is information on the escape of xenon and krypton from irradiated uranium but no direct information on the rate of diffusion. Calculations of diffusion coefficients varied from 10^{-15} to 10^{-11} cm^2 per sec at 500 C. This can possibly be explained on the basis that surface kinetics are the rate controlling factors in these gas release experiments. If the diffusivity of inert gases is as low as these data would indicate, the mode of pore formation may be radically different from the classical concept of nucleation and growth of inert gas bubbles. One suggested mechanism requires no diffusion of inert gas. A considerable fraction of the xenon and krypton produced in uranium during irradiation results from the decay of other radioactive fission products such as Br, Te, I, etc., several of which have half lives in the order of several hours. As these elements are essentially insoluble in uranium, thermodynamics considerations favor separation of a second phase, which could either be a compound or the element itself. As this second phase decays into xenon or krypton, the gas pore is formed "in situ" obviating the diffusion of inert gas atoms through the uranium lattice. The literature is currently being searched for data pertinent to this concept.

Examination of decay schemes revealed that eight-day I-131 decays to stable Xe-131. This suggests studying inert gas diffusion by alloying uranium with radioiodine and allowing it to decay to xenon.

The amount of xenon deposited in a uranium surface under various conditions of electrical glow discharge is presently being determined. It is also being determined whether or not xenon deposited in a uranium surface in this manner will diffuse into the volume of the material and cause swelling. A uranium disk at 620 C was subjected to an electrical glow discharge (sputtering) of about 16 ma/cm^2 in xenon at a pressure of approximately 2 mm of Hg for four days. X-ray diffraction studies of the surface after sputtering revealed the presence of UO_2, uranium, and a substance which could not be identified as any of the better known uranium compounds. Further x-ray studies of the surface are being made in an attempt to identify this compound. Upon completion of the x-ray study, the disk will be examined by electron and optical microscopy and, finally, analyzed for gas content by vacuum fusion.

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. Specimens irradiated to 0.4 and 0.2 a/o burnup are being used for post-irradiation annealing studies and for establishing a quantitative metallography technique.

Post-irradiation anneals at 600 C for 100 hours have been completed for a specimen in each burnup level and densities for two specimens have been determined. For a burnup of 0.4 a/o, the density has decreased from a pre-anneal value of 18.70 to 14.97, a decrease of 20 percent; for the specimen with a burnup of 0.2 a/o, the density has decreased from a pre-anneal value of 18.56 to 17.26, a decrease of seven percent. These specimens will be prepared for metallographic studies. Similar specimens, annealed at 650 C for 100 hours, revealed densities of 14.95 and 18.14, respectively; the changes in density are: 20 percent and 2.3 percent. Optical and electron microscope examination of the microstructure in these specimens is proceeding. After the 650 C anneal the 0.4 percent burnup specimen shows banded regions which are similar to regions present after a 700 C anneal. Grain structure near the banded regions is exceedingly small, 10 microns or less, and has a shape characteristic of recrystallized uranium. Neither the 700 C nor 650 C annealed specimen with 0.2 a/o burnup shows this banding; after an 880 C anneal, however, the specimen showed the banding. The bubbles in and near the bands have diameters at least ten times greater than those of bubbles located away from the bands. On the other hand, after a 650 or 700 C anneal, the smallest bubbles surround impurity inclusions in the uranium with a burnup of 0.4 a/o. This phenomenon will be further investigated to ascertain if a greater number of nucleation sites are located in the vicinity of the dispersed impurity phases. A 880 C anneal for 100 hours is currently being given to a specimen with a burnup of 0.4 a/o. A specimen annealed at 880 C for 100 hours with a burnup of 0.2 a/o is being prepared for a statistical analysis of (1) effect of etching on apparent bubble size; (2) heterogeneity in bubble size; (3) reproducibility of replications.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility (CAH-822). Design of gas loop components is progressing according to schedule. Struthers-Wells has submitted preliminary equipment specifications during the month on loop electrical equipment, instrumentation, and on safety heads proposed by them as backup for loop safety valves, to minimize gas leakage from the loop. Comments on the above were returned.

Approval drawings for the primary gas blowers, due August 8 from Bristol-Siddeley Engines, Ltd., were received, in part, on August 23; the remainder arrived September 14. Lack of data on the blower characteristics has seriously hampered Struthers-Wells in their design effort.

Bristol-Siddeley has stated that a full set of data on the characteristics will be forthcoming immediately. Design of the in-reactor test sections by MEDO is proceeding on schedule. Comment issues of the design drawings are expected to be issued in early October.

An engineering study was made of the feasibility and cost of converting the gas loop coolant from carbon dioxide to helium with retention of the maximum operating temperature and pressure, and for converting to helium with a minimum change in equipment but with the operating conditions relaxed. Such a change is feasible, and depending on timing and scope of the change, helium can be utilized in the loop at a cost of about $50,000 to about $150,000.

Graphite-Air Oxidation Studies. An experimental program has been initiated to evaluate the hazard of air leakage into a gas cooled reactor. A series of tests has been completed on air oxidation of virgin reactor graphite, with results as follows:

T (°C)	Oxidation Rate g/g hr	Percent/100 days
350	1.68×10^{-5}	1.85
400	2.23×10^{-5}	28.6
450	1.19×10^{-4}	71.3
500	1.23×10^{-3}	295
550	6.28×10^{-3}	1.51×10^{3}

Conditions, Graphite-CO-(AGOT processed)
(Transverse samples with respect to extrusion axis)
Flow - 2 CFH Dry Air.

When the above rates are plotted against 1/T K a linear Arrhenius plot is obtained, which indicates that there is no change in the reaction mechanism within this temperature range. The apparent activation energy is 29.8 K Cal/mole.

Graphite Weight Loss Studies. A series of five 0.628" diameter spheres, machined from CSF graphite, have been oxidized in flowing CO_2 at temperatures of 650, 700, 750, 800 and 850 C. The results expressed in gm/gm hr weight loss were 2.32×10^{-5}, 5.68×10^{-5}, 8.44×10^{-5}, 3.38×10^{-4} and 2.30×10^{-3}, respectively. Above 750 C these rates are of the same order of magnitude as those for hollow cylinders of comparable volume but greater geometric surface. This would appear to indicate a homogeneous reaction with no gradient of CO_2 concentration within the sample. However, this result is in direct contradiction to our comparison of oxidation rates of solid and hollow cylinders. This problem is being pursued further. Below 750 C, non-linearity in the Arrhenius plot indicates a probable change in the mechanism of reaction. An activation energy of about 43 K Cal/mole has been observed for the 750 to 850 C temperature range for the CO_2-graphite reaction, irrespective of surface or volume relationships of the graphite samples.

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Microwave Studies. The equipment has been modified to allow insertion of chromel-alumel thermocouples in graphite samples being oxidized in flowing CO_2. A microwave glow discharge was established upstream from the samples.

Experiments showed that the temperature of graphite samples placed three inches downstream from the flow increased from room temperature (24 C) to about 70 C, presumably due to reaction. A deposit of soot was formed on such samples and on samples whose temperature was raised by a furnace to various temperatures up to about 490 C. If the temperature was raised above this value, no soot was deposited, and any soot already present was oxidized. All samples show relatively large weight loss rates compared to thermal studies, irrespective of soot deposition. Samples placed within flow discharges reached temperatures of about 330 C with no external heat applied. A deposit of carbon suboxide was formed on the reaction tube both upstream and downstream from the sample at low flow rates. All these effects are probably related to an unbalance of the equilibrium of the C-CO-CO_2 system at these temperatures and pressures.

Oxidation Profile Studies. For the purpose of evaluating kinetic data on oxidation it is essential that the extent of oxidation throughout the sample be known. A series of CSF graphite samples has been prepared to check the feasibility of using x-ray data to study oxidation profiles within oxidized graphite. It was found earlier that the C_o spacing and crystallite size, as determined by x-ray techniques, exhibited changes during oxidation. However, these values also are changed when such samples are annealed. To study the effects separately, the samples will be outgassed, annealed and oxidized, and x-ray measurements will be made after annealing and after oxidation. If corrections can be made for effects of annealing, it may be possible to relate the x-ray data to oxidation. This would provide a useful means of obtaining oxidation profiles without the difficulties involved in the differential density method.

D. RADIATION EFFECTS ON METALS - 5000 PROGRAM

Radiation damage recovery is being studied for a number of structural metals; these include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Tensile properties, resistivity, and x-ray diffraction spectra are being measured to determine the effects of various annealing treatments.

Work performed during the month included the completion of metallographic studies and initiation of x-ray diffraction studies of copper, iron, and high purity nickel irradiated to 9×10^{18}, 4.6×10^{18}, and 1.0×10^{19} nvt (fast), respectively. The irradiated and control specimens of molybdenum and zirconium were given their first, one-hour isochronal anneal at 125 and 150 C, respectively. These anneals will be repeated at 25 C increments followed by microhardness and electrical resistance measurements to study the course of radiation damage recovery. Specimens of copper, iron, and "A" nickel irradiated to 1.5×10^{20}, 1.3×10^{20}, and 3.6×10^{18} nvt (fast) were mounted in lead impregnated boat resin for metallographic studies. These specimens have the

highest levels of radioactivity among the series and require special handling techniques. Only subtle differences in the microstructural appearance of the irradiated versus unirradiated specimens of copper, iron, and high purity nickel were observed. These differences cannot yet be positively attributed to irradiation effects. An irradiation of 9×10^{18} nvt (fast) caused 26.7 percent broadening in the (222) reflection for copper. A corresponding decrease of 0.052 percent in the lattice parameter was also measured. Although a decrease in lattice parameter is unusual, such an occurrence has been reported for molybdenum irradiated to higher exposures. Verifications of this measurement are in progress.

E. CUSTOMER WORK

Radiometallurgy Examinations

Nickel Plated Elements from PT-IP-207-A (RM-306). Four nickel plated and two non-plated standard, natural uranium, internally and externally cooled, Hanford production fuel elements, which were irradiated to approximately 400 MWD/T as part of IP-PT-207-A, were shipped to the Radiometallurgy Laboratory this month.

The slugs were selected by Fuels Preparation Department personnel to determine whether hydrogen gas was being trapped in the voids between the nickel plate and aluminum can wall. Two non-plated slugs, which were control pieces for the production test, are also the control samples in the "hydrogen test". Four nickel plated slugs, previously described, are to be initially tested. The control tests have been made, and the gas samples have been submitted to Analytical Operation for analysis.

RM-318 - Direct Cast Core Fuel Elements. Examination of three sections from one element revealed the male end of the piece to be badly distorted while the female end appeared to be almost normal. No reason has been found that could explain the large difference in preferred growth in the uranium from one end to the other.

RM-400 - Self-Supported Fuel Elements. One element has been sectioned transversely and longitudinally through the supports at each end. Examination of the can wall profiles under the supporting ribs has not revealed any erosion or reduction of the can wall thickness at these points.

Examination of a Side Hot Spot Ruptured Natural Uranium I & E Fuel Element From Tube 1165-C (RM-309). Examination work was started on a hot spot ruptured natural uranium I & E fuel element with a 570 MWD/T exposure. The fuel element was visually examined and photographed in the as-received condition. Two samples were sectioned from this element for metallographic studies, and both samples have been ground and polished.

High Level Examination & Cut-Off Cell (Project CG-682). Modification of the photography stage for viewing and photographing fuel elements two feet to four feet in length was completed. Installation was completed except for electrical wiring. Tests of the lighting system, which consists of two

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48-inch long "Power Groove" fluorescent tubes, indicated that uniform illumination was obtained over a 44-inch length. Some loss in fuel element end detail may occur in side view photographs of four-foot long elements. However, this may be overcome by shifting the fuel element laterally. An 80-pound simulated fuel element, four feet long, was easily handled and placed on the photography stage with two Hanford Master Slave manipulators (Mod. III).

Metallography Laboratories

A series of photomicrographs of Zircaloy-2 strip with from 0 to 50 percent cold work has been prepared in chart form. Comparison with this chart should permit close approximation of the amount of cold work present in unknown Zircaloy samples.

Samples Processed During the Month. Total samples processed: 415.

Photographs:	Micrographs	299
	Macrographs	106
		405

F.W. Albaugh

Manager, Reactor and Fuels Research
and Development

FW Albaugh:kb

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
RE Dunn HK Nelson H Harty	8/31	Panellit Inc., Skokie, Ill.	Discuss PRTR instrument panels and 609 computer.	J Gump AC Sperry	No
	9/1-2	GE-ANP, Evendale, O.	Audit PRTR automatic controller design.	MC Leverett et al	No
RE Dunn HK Nelson	9/3-4	Minneapolis-Honeywell, Philadelphia, Pa.	Test automatic controller.	EB Dahlin	No
	9/5	GE-Dresden Power Station, Joliet, Ill.	Discuss design of nuclear power station.	RC Christianson RB Hamilton	No
H Harty WA Burns	9/3	Electric Boat Co., Groton, Conn.	Discuss PRTR primary coolant system stress analysis.	HE Sheets	No
WA Burns	8/30-9/5	Yuba Heat Training Div., Honesdale, Pa Atwood & Morrill Co., Salem Mass.	Design consultation procurement liaison.	WD Comley R Raphael	No No
H Harty	8/31-9/5	General Dynamics, Groton, Conn.	Stress analysis of PRTR piping system.	HE Sheets	No
WK Winegardner	9/19	Williamette Iron & Steel Co., Portland, Ore.	Fabrication of PRTR fueling vehicle.	F Dever A Kitchen	No
KR Merckx	9/1	GE-Dresden Site, Morris, Ill.	Visit Dresden site.	FE Hollenbach	No
	9/2	U. of Illinois, Urbana, Ill.	Present research proposal to Fracture Prevention Committee.	H Corten	No
LJ Chockie BS Kosut	9/8-10	BMI, Columbus, O.	Symposium on in-reactor capsules.	BW Dunnington	Yes
JE Minor	9/10	GE Co. Mtg of KAPL & ANP personnel, Chicago, Ill.	Discuss use of ETR facilities.		No
EA Evans JW Riches	9/11	WAPD, Pittsburgh, Pa.	Discuss problems re Zr-2 & Zr-4 procurement, fabrication & irrad. behavior.	RH Fillnow	Yes

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VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
B Mastel	9/8-11	BMI Columbus, O.	Discuss role of electron microscope in study of swelling.	FR Shober	Yes
	9/8-12	Ohio State U., Columbus, O.	Present paper at 17th Annual Mtg. Electron Microscope Society of America.		
	9/14	WAPD, Pittsburgh, Pa.	Discuss microtomy thin sections of metals for electron microscopy.	TF Padden	Yes
JL Bates	9/13-18	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Observe defected experiment in MTR.	R Neidner	Yes
RC Carlson	9/17	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Assemble fuel experiment for GEH facility.	R Neidner	Yes
RJ Anicetti	9/21	Spencer Chemical Co., Kansas City, Mo.	Discuss fuxed uranium oxide procurement.	H Lambertus	No
DC Kaulitz	9/21-28	Belgium Embassy, Brussels, Belgium	Discuss fuel element fabrication & Equipment.	L Groven	No
	9/28-30	Hareaus Co., Hanau, Germany		Mr. Gruber	No
		Degussa Operations, Hanau, Germany		Dr. Boetcher	No
FE Young MD Freshley	9/22-23	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Recharge Equipment.	R Neidner	Yes
RS Kemper	9/29	Oregon Metallurgical Corp., Albany, Ore.	Discuss Contract DDR-61.	SM Shelton	No
AL Bement	9/29-30	United Electrodynamics, Pasadena, Calif.	Discuss Contract DDR-56.	FB Coker	No
JW Helm	8/31-9/6	GE-APED-Vallecitos, Pleasanton, Calif.	Install H-1 & H-2 experiments in GETR.	EL Cook	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JM Davidson	9/8-11	GE Hotpoint Division, Chicago, Ill.	Attend GE-ETR Users Mtg.	TJE Glasson/KAPL J Provost/ANP	No
DR Doman	9/16	Byron Jackson Co., Los Angeles, Calif.	Discuss mechanical seal & canned rotor pumps.	A Bunke C Blom	No
JW Riches	9/16	Harvey Aluminum, Torrance, Calif.	Consult on fabrication of zirconium.	GA Maudry	No
FW Woodfield	9/20-24	GE Research Lab., & KAPL, Schenectady	Discuss aluminum & zirconium alloys.	JH Holloman WM Cashin	Yes
RL Dillon	9/9-18	Milwaukee, Wisc.	Attend Aluminum Task Force Meeting.		
		WAPD, Pittsburgh, Pa.	Discuss zirconium corrosion problems.		No
GE Neibaur	9/19-10/2	USAEC-IOO, Idaho Falls, Ida.	Assist in chemical opera-	D Walker	Yes
TD Chikalla	9/10-18	Heavy Duty Elec. Co., Milwaukee, Wisc.	Discuss furnace designs.	Mr. Loranger	No
		GE-X-Ray Diffraction School, Milwaukee, Wisc.			No
ED McClanahan	9/14-17	Lawrence Radiation Lab., Livermore, Calif.	Discuss fabrication problems.	WJ Ramsey	Yes
JH Rector	9/23-28	Geo. Gorton Mach. Co., Racine, Wisc.	Discuss design details of new Gorton special lathe.	A Gunderson	No
JB Burnham	9/23	M-B Mfg. Co., Seattle	Discuss vibratory testing equipment.	Salesmanager	No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
RW Porter AE Foche R Plunkett	9/28-29	GE - Eng. Services, N.Y.C. GE - ANPD, Evendale, O. GEL, Schenectady	Reactor Safeguards Sub-Council Meeting	HM Parker FW Albaugh RM Fryar et al	No	300, 325, 326, 309
WE Baily	9/4	WAPD, Pittsburgh, Pa.	Discuss assignment to HAPO	FW Albaugh ID Thomas	No	300, 326, 308
MJ Sinnott	9/8-15	U. of Michigan, Ann Arbor, Mich.	Consultant Agreement CA-224	JJ Cadwell et al OJ Wick et al	Yes	300, 303 200-W, 231-Z 234-5
JP Fanaritis	9/15-16	Struthers-Wells Corp., Warren, Pa.	Discuss PRTR Gas Loop.	JF Fletcher DP Schively	No	700, 703
JC Kyle H Potter	9/1	Technical Industries, Corp., Pasadena, Calif.	Discuss in-reactor creep	JJ Cadwell et al	No	300, 326
RE Burian JE Gates	9/1	BMI, Columbus, O.	Discuss examination of irrad. fuel elements.	JJ Cadwell JE Minor	Yes	300, 326
B Weidenbaum T Slozack J Cleveland CV Backlund	9/1	GE-Vallecitos Pleasanton, Calif. AEC-SFOO, San Francisco	Fuel Element discussions. Discuss Pu facilities for Pu oxide	JJ Cadwell EA Evans OJ Wick ID Thomas	No No	300, 326,325 300, 308
GW Tompkin	9/11	Mallinckrodt Nuclear Corp., St. Louis, Mo.	Discuss UO_2 fuel element fabrication.	JJ Cadwell WE Roake	No	300, 326,325
NA Weil	9/16	Armour Res. Foundation, Chicago, Ill.	Discuss PRP.	JJ Cadwell EA Evans	No	300,326, 325
HW Deem J Matolich, Jr.	9/24-25	BMI Columbus, O.	Discuss exam. of irrad. fuel elements & UO_2 thermal conductivity.	JJ Cadwell EA Evans JE Minor	Yes	300, 326,325
J Whealdon	9/3	Air Supply Co., Garett, Seattle, Wn.	Engineering discussions.	R Harrington	No	100-B; 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
CV Backlund	9/1	USAEC - SFOO, San Francisco	Discuss irradiations in GETR.	RE Nightingale JM Davidson	Yes	300, 326
PJ Hastings R Demaline	8/31	National Carbon Co., Cleveland, O.	NPR Graphite technical discussions.	RE Nightingale DR deHalas	No	300, 326
BL Bailey LH Juel	9/15-16	Great Lakes Carbon Co., Morganton, N.C.	Discuss graphite development & NPR graphite.	RE Nightingale DR deHalas	Yes	300, 326
ER Stover	9/21-22	GERL, Schenectady	Discuss graphite research.	RE Nightingale DR deHalas	No	300, 326
H Suter PN Burkard W George J Schneider DH Tuel	9/22	Wyandotte Chem. Copr., Wyandotte, Mich. Wyandotte, Los Nietos, Calif. " Seattle	Discuss decontamination processes.	JA Ayres et al	No	300, 100-K
R Nash D Stevens	9/16	USAEC, Washington, DC	Discuss graphite program & corrosion studies.	RE Nightingale DR deHalas RL Dillon	No	300, 326
WJ Larkin	9/23	USAEC, OROO, Oak Ridge, Tenn.	Discuss Gas-Graphite studies--4000 Program.	RE Nightingale DR deHalas	Yes	300, 326
P Naillon	9/1-4 9/14-18	LRL, Livermore, Calif.	Discuss fabrication problems.	OJ Wick ID Thomas RW Stewart	Yes	200-W, 2704-Z, 231-Z

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

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FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety for Fuels Preparation Department

A preliminary nuclear safety evaluation was made of the Fuel Cladding Facility (333 Bldg.), which is currently in the scoping design stage. This facility will be used for preparing and assembling the tube-in-tube type fuel elements for the NPR; the uranium enrichment was assumed to be 0.95 percent U-235. The preliminary building layout is shown in Drawing SK-3-8286.

This evaluation showed that the layouts for the billet pre-heat, fuel element cleaning, and the autoclaves are nuclearly safe. The proposed billet and finished fuel element storage arrays, however, are not safe and will probably require additional spacing. A further study is necessary in order to evaluate these spacing requirements; this study will be completed by the time the scope design is established.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Neutron Temperature Study

The study of lutecium has continued in order to better understand its use as a neutron "thermometer." A summary of these studies follows: (A) The cadmium ratios have been remeasured because the accuracy of the first measurement was poor. In addition, activations were made with cadmium covers of various thicknesses. The results of these activations are being analyzed. (B) Lutecium foils were activated in a beam of monoenergetic neutrons at the DR Reactor. The energy of the neutrons was 2.61 ev which is the peak energy of one of the resonances occurring in the cross section of normal lutecium. The activity which was produced in the foils was that of Lu^{176m}. This indicates that the resonance at 2.61 ev belongs in the cross section of Lu^{175}. (C) Wescott "g factors" have been calculated for Lu^{176} for two neutron temperatures. The calculations assume a Breit-Wigner form for the cross section and that the contribution to the g factor comes from the 0.142 ev resonance. The ratio of the two g factors agrees with the corresponding ratio obtained from the experimental data. (D) Lutecium foils of various thicknesses were irradiated to determine the effects of self-shielding. The results indicated a wider range of foil thicknesses is necessary to determine these effects properly.

A rough draft of a letter which concerns the use of lutecium as a neutron thermometer has been prepared. This "letter to the editor" will be submitted to the Journal of Nuclear Science and Engineering in the near future.

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Neutron Temperature Coefficients

Programming of the code to update the nuclear data tape is nearly complete. Several of the subroutines of this program have been debugged and run successfully. The updating program will also provide for the generation of the initial nuclear data tape.

Neutron Thermalization

The preparation for experiments to investigate absorption hardening near the PCTR driver rods and to reduce the fast neutron density in the core have continued through the month.

The reactivity coefficients of lucite rods in the PCTR drivers and leveling slugs were measured. All reactivity coefficients were positive. Three important consequences of this are: 1) Criticality can be altered without moving driver fuel rods so that a difficult reactor loading becomes more flexible; 2) The "slow" lattices can be matched more easily; 3) A flooding hazard exists in the PCTR. From the table of reactivities below one can calculate a potential $(8.00) positive reactivity in the shutdown (face closed) PCTR which would be realized in the event the reactor was submerged in water. The following coefficients were measured with a solid graphite core:

TABLE OF REACTIVITIES

Lucite Rod Size	Lucite Rod Position (cm. radius)	Lucite Reactivity Coefficient (cents)	Remarks
1" dia. x 37.5"	43	21.9	$\Delta\rho$ for center rod of three adjacent rods.
1" dia. x 37.5"	43	21.9	Single rod.
3/4" dia. x 37.5"	43	13.1	Single rod.
3/4" dia. x 8"	43	2.08	In driver extensions.
3/4" dia. x 4"	12	0.70	Center leveling slugs at 6.0"

All leveling slugs at 6.0".

The absorption hardening near the PCTR driver rods is to be determined from thermal neutron temperature measurements.

Multi-Thermal-Neutron-Group Diffusion Programs

The modified version of F_3 is running satisfactorily. Two attempts to speed convergence of the iterative procedure were made, with little success.

A cross-section fitting program, FIT-1, is being written. Using the two-group theory, any parameter in a five-region problem may be iterated upon until

the best fit to an experimental flux traverse is obtained. Any number of parameters may be varied successively. This program will be used in analyzing results of the neutron rethermalization experiments.

The sample input for ZOOM, mentioned in previous monthly reports, has been received. A test case has not been run, however.

Double-Focusing Beta-Ray Spectrometer

Sensitivity and stability checks for the spectrometer were made during the month. The spectrometer operated properly during these checks. However, under continual operation the mercury contacts and the null amplifier are not operating properly. These difficulties must be corrected before long-term operation of the spectrometer is possible.

Instrumentation and Systems Studies

The experimental stack gas effluent monitor at 100-F operated successfully for several months. This method of monitoring, using a scintillation detector and a pulse-height analysis system, was successful in long-term operation. The equipment was removed from service and was loaned, temporarily, for some other measurements in the 100 Area. The equipment will be returned to the 329 Building later for other experimental work.

The speed-of-control studies involving the loss of coolant flow for all the present Hanford reactors have been completed. This work was an investigation of reactor safety for a full pile loading of I α E fuel elements as far as the speed of control safety criterion is concerned.

The study of optical methods for measuring in-reactor graphite temperatures continued with an investigation of the possible application of a two-color infrared pyrometer. One instrument of this type has been developed and is now being fabricated for metallurgy research.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Exponential Pile Measurements of Large Diameter Fuel Elements

Material buckling measurements have been completed for two large diameter fuel elements at a lattice spacing of 14 9/16-inches. One of the lattices had a 0.5-inch graphite rod inserted in each uranium tube. The final buckling values are given in Table I.

TABLE I

Fuel Element	Lattice Spacing	Buckling ($10^{-6}cm^{-2}$)	Side-Side λ (inches)	Volume Ratios Al/U	H_2O/U	C/U
2.5 x 1.6	14 9/16 dry	+70	1.93	0.373	-	70.44
2.5 x 1.6	14 9/16 dry	+63	1.93	0.376	-	65.98

λ is the measured side extrapolation distance. A front-to-rear λ of 1.03-inches was used for all lattices.

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Preliminary buckling measurements available this month are shown in Table II.

TABLE II

Fuel Element	Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios AL/U	H_2O/U	C/U
2.5 x 1.6 w/1.17 solid	14 9/16 wet	-70	0.305	0.631	51.25
2.5 x 1.6 w/0.5 solid	14 9/16 wet	-106	0.376	1.119	65.98
2.5 x 2.0 w/1.66 x 1.1	10 3/8 wet	-49	0.493	1.102	33.86

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

Horizontal traverses have been taken with and without cadmium shields in the 14 9/16" (wet) pile with the 2.5 x 1.6 tube and 0.5-inch rod to determine what effect the shields might have on the measured extrapolation length. The cadmium shields are normally placed close to the exponential piles at the sides in order to minimize effects of neutron reflection from the walls of the laboratory. The results of the traverses along the edge of a cell showed that the presence of the shields made essentially no difference in the measured extrapolation length.

Horizontal traverses have also been taken using a bare counter with and without cadmium shutters. Results of these traverses are now being studied.

PCTR Measurements of Lattice Parameter of Large Diameter Fuel Elements

In the determination of p and ϵ, it is customary to irradiate foils in a section of the fuel that is completely sheathed in cadmium. Therefore, an experiment was performed to investigate the extent and magnitude of the perturbations caused by such a sheath around a large diameter fuel element.

The lattice used in the experiment consisted of a 1.92-inch diameter fuel element, water-cooled, in an 8 3/8-inch graphite lattice. A two-inch long section of the fuel was enclosed with cadmium in a region of the PCTR where the fluxes were level in the axial direction. Bare and cadmium covered gold foils, 5 mils thick, were irradiated near the surface of the process tube at 2-inch intervals out to 10-inches from the center of the cadmium.

It was found that the bare foils were not perturbed (less than 1%) at a distance of 6-inches from the cadmium. However, it was found that the epicadmium activity was depressed by about 6% at the center of the cadmium sheath. This depression is a second generation effect resulting from the depletion of the thermal fission rate in the vicinity of the sheath.

On the basis of this experiment, the schemes for exposing foils in measurements of p and ϵ of 1.92-inch and 2.5-inch diameter fuels were designed to minimize the length of fuel enclosed in cadmium. This length will be about 3/8-inch as compared to the 2" length used in this experiment.

PCTR Measurements of k_∞ and f for Selected Cluster Elements

The determination of k_∞ and f of a seven-rod enriched uranium cluster in a 7-inch graphite lattice with water coolant is now complete. The rods were 0.925-inch diameter and enriched to 1.007% by weight U-235.

The values of the lattice parameters are:

$k_\infty = 1.063 \pm 0.002$

$f = 0.922 \pm 0.003$

The quantities of the various materials in the lattice cell per unit length were:

uranium	546.3 gm/cm
graphite	401.2
water	19.4
aluminum	27.6

The measurement of k_∞ and f of the cluster with natural uranium fuel is now in progress in the PCTR. Other than the enrichment, the fuel and lattice assembly is the same as the enriched cluster discussed above.

Instrumentation and Systems Studies

Development-design and fabrication work was started on three proposed prototype instruments for the 105-N Building. These include a linear four-decade, scintillation remote-area-monitor comprising a central station and four probes; a logarithmic, three-decade scintillation remote-area-monitor comprising a single package of probe and main unit; and a lead-shielded scintillation fixed-filter air-pulling beta-gamma logarithmic air monitor. All units will have chart-recording and incorporated alarming devices. The two remote area monitors will be essentially gamma energy independent above 90 kev. The linear area monitor has ranges of 0-20 mr/hr up to 0-20 r/hr. The logarithmic area monitor covers three decades from 10 mr/hr to 10 r/hr.

Preliminary equipment design and procurement was started on the prototype Fast-Scan Gross-Gamma Fuel Failure Monitor for possible NPR application. A laboratory device is being built to simulate the mechanically interrupted or "chopped" gamma-ray signal for the monitor. This will be used to determine the optimum sampling rates and sample chamber sizes. It will also be used as a signal source for development of the electronic circuits.

All work on the NPR Primary Loop Frequency Response study has been completed and will be reported soon.

The NPR Heat Exchanger was programmed on the Digital Differential Analyzer (DDA). Approximately one-third of the requested runs were made. The results obtained were quite satisfactory. Due to the inherent slowness of the DDA on simulations of this type, the remainder of the runs will be made on the Goodyear computer in October.

The NPR pump coastdown characteristics are being re-evaluated on the analog computer using the revised equations.

Mechanism of Graphite Damage - 2000 Program

Apparatus for irradiating graphite with protons in the positive ion accelerator was completed and was leak tested up to the point of inserting the graphite target.

A piece of graphite that was irradiated with electrons last month was submitted for lattice parameter measurements.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazards Criteria

Nuclear Safety for Hanford Laboratories, Plutonium Metallurgy Operation

The nuclear safety of casting and machining operations involving the fabrication of 6.6 Kg hemispherical shells was evaluated. The basic limitations for these operations were summarized and transmitted to personnel of Plutonium Metallurgy Operation for comments prior to the issuance of an approved nuclear safety specification covering these operations.

Nuclear Safety in 234-5 Building Processing

The nuclear safety of a proposed array of plutonium hemispherical shells in a heat treatment furnace was evaluated and found to be safe. The array consisted of eight shells (2.2 Kg maximum weight) positioned on 12-inch centers. The outside diameter of these shells would range between 9 and 12-inches.

Plutonium Critical Mass Facility

Design of the in-hood reactor components for the initial startup experiments is essentially complete. The reactor vessels for the Pu solutions and the components providing for safety and control have been designed.

A safety rod drive assembly will position a magnet supported, spring accelerated, tubular safety rod which will enter the reactor vessel from above. A similar drive system, attached above that for the safety rod, will position a control rod entering the reactor vessel concentrically within the tubular safety rod. Both drives will operate within housings which will completely contain the atmosphere above the reactor solution. The functions of a reactor vessel dump valve, fill line, and bottom supporting pedestal are combined into

a single assembly at the bottom of the vessel. These in-hood reactor components are designed to provide ease and flexibility in the interchange of reactor vessels.

Further items which have been designed are a water reflector tank, appropriate dump valves, and necessary supporting framework for all the components.

Criticality Studies in Support of Processing Power Reactor Fuels

Experiments with Heterogeneous Systems

The critical approach measurements with 3.063% enriched uranium rods of 0.175-inch diameter were held up by delays in the installation of end caps in the lucite tubes for these rods. These tubes have now been received and the lattice components are being assembled in the 305-B Building.

Experiments with Homogeneous Systems

Experiments in the PCTR to determine k_∞ of 3% enriched UO_3-polyethylene moderated systems at H/U atomic ratios of 30, 35, and 40 have been completed. The preliminary values of k_∞ are 1.123, 1.080 and 1.035 respectively. The "cross over" point at which k_∞ becomes unity has been extrapolated to an H/U ratio of 44. Further measurements will be made to determine this ratio more accurately.

An attempt was made to determine the effect of the aluminum containment on the measured value of k_∞ for this type system; however, excessively large variations in reactivity measurements were observed which nullified the experimental results.

A lucite tank has been fabricated in which to carry out exponential experiments on 3% enriched UO_3-polyethylene systems. This tank, which is 12-inches in diameter and 32-inches in height, has been filled with a UO_3-polyethylene mixture containing 112 lbs. of U at an H/U atomic ratio of 18; exponential experiments will also be conducted for H/U ratios of 6 and 12.

Miscellaneous Experiments for Nuclear Safety Specifications

Exponential experiments were begun for determining the quantity of neutron absorber which must be added to a water moderator in order to "safe" a heterogeneous system of enriched uranium. The buckling was measured with 1.007 percent enriched uranium rods of diameter 0.925-inch at an H_2O/U volume ratio of 1.73 (1.5-inch spacing between rods in a hexagonal lattice). Boron was added to the water moderator in the form of boric acid and the buckling measured as a function of the boron content. The measurements completed this month are given in the following table:

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Buckling Measurements - 1.007 Percent Enriched Uranium - Boron Poisoned Moderator

H_3BO_3 (gm/L)	Boron (gm/L)	Buckling ($10^{-6}cm^{-2}$)	Estimated Critical Mass of Poisoned System for Spherical Geometry
0	0	3391 ± 22	6145 lbs. U
1.5	0.26	1669 ± 51	20,506 lbs. U
3	0.53	362 ± 57	237,000 lbs. U
6	1.05	-2037 ± 102	-

The errors quoted are standard errors calculated from the variation in the least squares fit to the experimental data.

With the addition of about 3.45 gm/L boric acid, or 0.6 gm/L boron, to the moderator of this particular lattice the buckling would be reduced to zero (k_∞ = unity); the critical mass is increased by a factor of about 3 with the addition of 0.26 gm/L boron.

Further measurements are planned with lattice spacings of 1.4, and 1.6 inches. $Cd(NO_3)_2$ will also be used as a soluble poison. The experiments will also be done with 3 percent enriched uranium. These data will have direct bearing on nuclear safety in reference to the use of soluble poisons in criticality control, for example, in dissolvers which may not be geometrically safe.

Critical Mass Theory

A substantial revision of the program to integrate the reactor kinetics equations with time varying reactivity has been found necessary. In this revision, an iterated Taylor series formulation of the problem has been developed. A subroutine of the main program has been written to calculate the derivatives appearing in this formulation. Results of debugging runs with this subroutine confirm that the magnitudes of the higher derivatives increase rapidly with order and will limit the number of terms of the series which may be used. At present another subroutine is being written to evaluate certain coefficients necessary in the solution.

Mass Spectrometry

The critical alignment of the heavy element mass spectrometer for this program has been completed. The mass resolution for which this spectrometer was designed has now been achieved. Studies of the accuracy and precision of uranium isotopic analyses and of optimum sample size are in progress.

NEUTRON CROSS SECTION PROGRAM

Three Axis Spectrometer

This spectrometer has continued to be used for the study of reflectivity characteristics of monochromating crystals for the purpose of increasing the effective intensity in slow neutron scattering experiments. Detailed reflectivity studies were made on an aluminum crystal and a new lead crystal. These investigations and the analysis of the results obtained to date are continuing.

Growth of Single Metal Crystals

A program has been carried on infrequently for several years to grow single metal crystals for possible use as diffraction monochromators for slow neutron work. This program has been accelerated recently in an attempt to provide a larger number of crystals for reflectivity studies in conjunction with the three axis spectrometer. A new oven system has been fabricated to grow single crystals from the melt in either vacuum or controlled inert atmosphere. No method has been found to provide the required degree of stability of pressure of an inert gas atmosphere so that the effort to date has been confined primarily to the vacuum oven techniques. The vacuum oven, however, leads to very high surface temperatures of the heating elements in an oven designed to provide the desired heat conduction characteristics. A radiant type heater with a helical winding of nichrome wire has proven satisfactory for studies with vacuum melts of aluminum. Large (2 to 3 inch diameter by 8 inch long cylinders) single crystals of lead and of aluminum have been grown. These crystals still exhibit a small amount of lineage. The heat conduction characteristics of the system are being continually perturbed in attempts to improve the quality of the crystals.

Pu^{241} Fission Cross Section

A tabulation of the only known available total cross section data on Pu^{241} has been received from the Brookhaven Compilation Group. These data were taken with good resolution but with a low purity Pu^{241} (65 percent) sample. These data have been compared with the fission cross section data obtained at Hanford with a high purity (96.6 percent Pu^{241}) sample but relatively poor resolution in the resonance region. A comparison was made of the total and fission cross section data in the low energy region through the low energy resonance at about 0.255 ev. The ratio of cross sections in the thermal energy region showed no apparent systematic difference from a constant value of alpha up to about 0.15 ev although the total cross section data exhibit a dispersion of about five percent from a smooth curve. The ratio of cross sections through the 0.255 ev resonance exhibit an apparently significant smooth behavior indicating a value of alpha in the resonance some 18 percent lower than the thermal value. A comparison of the data in the resonance region is much more difficult because of resolution effects and differences in interpretation of the data. In addition, it was discovered that an error was made in previous reporting of the value of $\sigma_0\Gamma_f$ for the first three resonances. The results of the present comparisons are shown in the following table:

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Pu^{241} Resonance Parameters

Resonance Energy (fission) E_o(ev)	$\sigma_o\Gamma$ (BNL-325) (b-ev)	$\sigma_o\Gamma_f$ (Hanford) (b-ev)	Alpha from Resonance Parameters $\left(1-\frac{\sigma_o\Gamma}{\sigma_o\Gamma_f}\right)$	Maximum Value of Alpha $\left(1-\frac{\sigma_o(\text{observed})}{\sigma_{fo}(\text{observed})}\right)$
4.32	273	133	1.05	.58
4.65	80	44	.82	.41
5.35	17	17	0	.10
6.03	540	290	.86	.17
6.94	147	194	Neg.	.06
8.61	180	150	.20	---

Pu^{240} Fission Cross Section

A gas scintillation fission counter has been undergoing development tests for use as a counter when short half life alpha emitting isotopes are being used for fission measurements. It is hoped that this counter can be operated with a permanent filling of counting gas by avoiding the use of possible contaminating agents such as wave length shifters. The counter has been assembled with a low pressure filling of purified xenon, quartz windows, and a quartz window RCA 6810 photomultiplier. Two foils of Pu^{240} with an apparent effective mass of 2.2 mg are mounted in the chamber with a light reflecting shield of MgO. The pulses from the multiplier are inverted and discriminated with an EFP 60 discriminator circuit. This discriminator is the only fast pulse circuitry which is necessary. For best operation, however, it seems necessary to pass the tail of the alpha pulse height spectrum along with the larger fission pulses so that a second pulse height discrimination is necessary. This is handled with the relatively slow circuitry of a type A-1 linear amplifier and accompanying discriminator. An easily recognizable plateau of fission pulses was observed from this system in the presence of the resulting 6×10^6 alpha disintegrations per second in the counting gas. The slope of the fission plateau was about 2 percent per 0.1 volt EFP 60 bias. One overnight run was made of the 1.06 ev fission resonance with this equipment which gave a fission cross section in agreement with that previously obtained with lighter foils and a gas ionization fission chamber. More stringent performance testing has been postponed while the 105-DR crystal spectrometer instrumentation is undergoing preventative maintenance for a period of about two weeks.

Fast Neutron Cross Sections

No further work has been done with the Van de Graaff because an extensive realignment of the accelerator system will be required to perform time-of-flight measurements with neutrons. This realignment will possibly be postponed until the modifications to the mounting system have been completed.

A study has been made of the effect of cooling the multiplier structure of the fast neutron scintillation detector system. The assembly has been cooled with acetone circulating through a dry ice bath refrigerant. The multiplier reaches an equilibrium temperature of about -55°C which reduces the dark current counting rate by a factor of 100. This is accompanied by

a substantial increase in pulse height from the scintillator. The bias level attainable with the cooled multiplier corresponds to a neutron threshold of approximately 30 kev.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Theoretical PCTR Studies

A report entitled "Two-Group, Small Source Theory Applied to an Infinite Array of Reactor Superlattices" is being prepared.

The subroutines for evaluating lattice sums encountered in the small source theory analysis of an infinite array of supercells have been completed. By use of these subroutines, together with more representative input data, the Δf for the GCR lattice upon insertion of the control rod is being recalculated. Preliminary results indicate that the previously reported calculation of $\Delta f = 29\%$ is somewhat large.

Lattice Parameters for High Exposure Pu-Al Fuels

Specifications and requirements for the fabrication of the 21.7% Pu-240 material into 0.5-inch diameter fuel rods for PCTR measurements have been transmitted to Plutonium Metallurgy Operation informally, for their use in estimating costs.

The Critical Facility of the PRP

Discussions with the scope designers in order to establish the design criteria have continued through the month. Help was also provided in the preparation of a document which will serve to inform management of the plans which have been made for the facility.

Reactor Theory

In estimating the eigenvalue in a linear equation $H\phi = \lambda\phi$, the Rayleigh quotient will provide a lower bound for λ if the operator H is positive definite. It is desirable to have an upper bound as well to provide an error limit for a variational estimate.

A measure of the error in a trial function ϕ is the angle in Hilbert space between ϕ and $H\phi$, defined by

$$\cos\theta = \frac{(\phi,H\phi)}{(\phi,\phi)^{1/2} \cdot (H\phi,H\phi)^{1/2}}$$

It can be shown that an upper bound on the fractional error in estimating the lowest eigenvalue λ_o by the Rayleigh quotient, $\lambda = (\phi,H\phi)/(\phi,\phi)$, is given by

$$\frac{\lambda - \lambda_o}{\lambda_o} \leq 1 - \cos\theta \cong \frac{\theta^2}{2} .$$

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As an application of the preceding error bound, the geometric buckling was calculated for a sphere of unit radius, using the following trial functions:

	$1 - \cos\theta$	$\frac{\lambda - \lambda_o}{\lambda_o}$
$\phi_1 = 1 - r^2$	.16	.06
$\phi_2 = 7 - 10\,r^2 + 3\,r^4$	.005	.003

It appears that for this case, at least, the upper bound provides a reasonable estimate of the error without a significant increase in computation over the original variational calculation.

Instrumentation and Systems Studies

A portion of the necessary material for the evaluation of 150 multiplier phototubes for the PRTR fuel element rupture detection system was received. The phototubes have arrived and the NaI crystals, the sockets, and the mu-metal shields are due by October 5. Eighty-seven phototubes will be selected from the 150 total with considerations as to low-noise, high-gain, stability, and resolution.

Advice was rendered to the Design Section concerning circuitry modification for the PRTR fuel element rupture detection system to eliminate the use of preamplifiers.

After the obtaining of more information concerning gamma field intensities, a modified circuit proposal will be completed concerning the Materials Test Reactor GEH-4 experimental loop fuel element rupture monitor. The input circuitry of the spectrometer now in use will be modified to permit obtaining of information during conditions of overload of the spectrometer. A simple relation of phototube anode current to gamma field intensity at the detector is to be utilized.

Parts of the PRTR wide angle viewer are being fabricated offsite under a Work Order issued to Tech Shops. The offsite work is due for delivery January 1, 1960, and the total unit will then be assembled and completed locally.

The profilometer to be used for warp and diameter measurements has been split into three parts for fabrication. A part of the work is being done on site. This involves modifications to the prototype warp and diameter measurement units. The other two parts have been submitted for offsite bids and replies are still being awaited. Early bids indicated that the money presently available is insufficient for completion of the fabrication of this instrument.

Work has been started on a method to distinguish gamma rays from fast neutrons with high efficiency and good resolving time. It has been found elsewhere that certain phosphors exhibit a different decay curve depending upon the exciting particle type. There are two main ways to detect this difference. The decay curves may be compared directly, or the ratio of total charge to peak height may be observed. Tests indicate that the latter method is much superior.

The best circuit to date has been a modification of one devised by F. D. Brooks at Harwell. When stilbene is used as a phosphor, the circuit may be adjusted such that all output gamma pulses of any energy are less than about five percent of the peak height from PuBe neutrons. The effective resolving time of the circuit is about ten microseconds. It is expected that the ratio between gamma rays and neutrons and their discrimination can be improved.

A program has been prepared and an analog circuit designed to test the PRTR controller when it is received on plant the last half of October.

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

This is the first set of measurements in which a non-linear fuel coefficient has been obtained. Such an effect has been suspected by theoreticians, but for some unexplained reason has never been found. The data were taken during four heating runs. Three of the heating cycles differed only in the time required to reach the maximum fuel temperature attained. The fourth one was made without the cylindrical layer of lampblack insulation around the fuel cluster. One of the three physically comparable runs required 220 minutes and then fell short by ~150 C of reaching the maximum fuel temperature attained in the other two. It yielded results consistent with the other two over most of its range but began to diverge after the heat leakage from the heated cell could be felt at a rather large distance (16 to 18-inches) out into the surrounding moderator. The other two heating cycles took 42 minutes and 65 minutes respectively. In neither of these was the reactivity loss a linear function of the change in fuel temperature. Therefore, in each case, a curve having an equation of the form

$$\Delta\rho_{PCTR} = C_o + C_1 (\Delta T)_{fuel} + C_2 (\Delta T)^2_{fuel}$$

was fitted to the experimentally determined points by a least squares analysis program for the IBM 709 computer. Thus the PCTR reactivity loss with change in fuel temperature, $\Delta\rho_{PCTR}/(\Delta T)_{fuel}$ is obtained. The 42 minute run yields a value of

$$\frac{1}{P}\frac{\Delta P}{\Delta T} = \frac{1}{k_\infty}\frac{\Delta k_\infty}{\Delta T} = -3.46 \times 10^{-5} + 2.81 \times 10^{-8} \Delta T$$

over the temperature range 49 to 494°C, and the 65 minute run yields

$$- 3.53 \times 10^{-5} + 2.63 \times 10^{-8} \Delta T$$

over the range 50 to 516°C. An uncertainty of about 8 percent should be attached to these results until the error evaluation is complete. Both the heating cycle using the uninsulated cell and the cooling cycle, following the 65 minute heating run, yield results that differ from those quoted above by as much as 18 to 20 percent. For the cooling period, a large part of this difference may be attributable to moderator heating quite far out into the surrounding graphite as a result of the long cooling time involved (~4 hrs). However, the divergence of the reactivity curve for the uninsulated cell before appreciable moderator heating occurs, may, at least in part, be due

to an energy shift in the spectrum incident on the fuel that is not sensed by the copper poison. Measurements taken during this run indicate that the temperature drops by a factor of four at a distance one-inch into the surrounding graphite. Therefore, the incoming neutrons may be appreciably affected by this higher temperature layer immediately adjacent to the fuel.

Lattice Parameter Measurements

A re-evaluation of the data from the PCTR measurements of k_∞, f, p, and ϵ for the GCR lattice has been completed. The following results were obtained for the cell used in the experiment:

k_∞	1.1468
f	0.8029
p	0.8050
ϵ	1.0167
η	1.7449 (inferred)

The actual KEAC cell is 7.125-inches longer than the cell used in the PCTR experiment, and the following values were deduced for the KEAC cell:

k_∞	1.1550
f	0.8182
p	0.7956
ϵ	1.0167
η	1.7449

Variation of the Doppler Coefficient with S/M Ratio

A 709 program has been written which computes the spatial temperature distribution in a finite solid cylinder as a function of time and surface boundary conditions. The case considered is one of initially uniform temperature, with radiative cooling from the surface.

Preliminary results of the measurements to determine k_∞ and f for 1.92-inch diameter solid natural uranium fuel rods in a square 8 3/8-inch graphite lattice with air coolant and with H_2O coolant are presented in Table I, together with some pertinent experimental data and assembly parameters.

TABLE I

	C/U	H/U	.005" Au	k_∞	f
1.92 (air)	22.65	--	3.434	1.011	0.945
1.92 (H_2O)	22.65	0.288	4.515	1.0185	0.910

The error analysis has not yet been performed in detail; however, the standard deviation of k_∞ is not expected to be greater than ± 0.002 in k.

These results do not agree very well with values computed from exponential pile measurements. Further analysis is necessary to evaluate these differences.

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TEST REACTOR OPERATIONS

The TTR operating time was divided about equally between (1) irradiating lutecium foils to obtain basic data for their application as a "neutron thermometer" and (2) obtaining data which may make operating the TTR at a higher power level possible.

There were no unscheduled shutdowns during the month.

Operation of the PCTR continued routinely during the month with one unscheduled shutdown due to electronic failure.

Further tests were made on the reproducibility of reactivity measurements. There was an intermittent change in reactivity which was traced to failure of the moving face to reposition. Changes as large as 0.1 cent were observed. Corrective adjustments were made to the drive rails, clutch and limit switch.

K_∞ measurements were completed on the 3 percent enriched $UO_3 \cdot H_2O$ system.

Measurements were made to determine the reactivity effect of adding moderator inside the driver fuel. "Lucite" rods were placed in the drivers, the driver extensions, and the leveling slugs. The effect on reactivity was positive in all cases. Because of the possible danger from flooding that this effect raises, the shutdown procedure has been revised to require leaving the face in the full open position.

K_∞ measurements were started on the 7-rod cluster natural uranium fuel elements.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

The two special dispersion experiments described in the Monthly Report for August and scheduled for completion in early September were successfully conducted on August 30 and September 3. In the first, the total emission time was increased from the usual one-half hour to one hour and all air sampling equipment was operated until the tracer plume had crossed each arc. In the second experiment, fluorescent pigment was emitted continuously and at a constant rate for four hours. The air sampling schedule was then arranged so that a precise two-hour sample was taken at each sampling point during the time the continuous plume was over the sampling grid. All equipment operated satisfactorily during both experiments, and definitive measures of the horizontal and vertical distributions of tracer concentration were obtained. The emission rate was held constant at 7 kg per hour for both experiments. This is an emission rate of very nearly 7×10^{13} particles per hour.

Attempts to establish a precise calibration curve for the automatic counters using a visual count of particle loading on filters (under UV light) were unsuccessful. Uncertainties of 20% or more of the indicated reading were

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encountered, almost all of which must be ascribed to uncertainties in the visual estimation system. In order to overcome this problem, and reduce uncertainties to $\pm 5\%$, the assistance of Analytical Chemistry, Chemical Research Operation, was enlisted to provide a precise assay of tracer material on a representative number of filters. Neutron activation of the zinc, and possibly the maganese, in this tracer material with subsequent radiochemical analysis for amounts of these materials, is being done by the Analytical Chemistry group. A basic calibration, using only filters which are free of dust and other impurities, is being done first. The second step will be a similar analysis for dirty filters, for which the efficiency of the automatic counters is reduced by obscuration. A correction factor for this obscuration is required.

Principal effort has been turned to the reduction of meteorological data pertinent to these experiments. Data from the 400-foot tower and the station network were reduced at month's end. Reduction of the portable mast data was scheduled for completion and IBM machine processing by the end of October.

Arcs 5 and 6 (12,800 and 25,600 meters) were dismantled and all equipment cleaned and stored. Arcs 1 through 4 were placed in a standby status in anticipation of further experimental work during the next nine months.

DOSIMETRY

During the month 99 people were counted at the Shielded Personnel Monitoring Station. One of these was a plutonium wound case. No plutonium was present. Another was a recheck for Zr^{95}-Nb^{95}. He was found to have eliminated about 70% of his previous burden. Regional Monitoring Operation gathered samples of vegetation and produce from the farm of the man who was found last month to have eight times the usual Cs^{137} burden. All showed an unusually high Cs^{137} content. All but the milk also showed other long-lived fission products.

An employee was examined who has a small farm on a local pumping project where he uses sprinkler irrigation. Many of the items of his diet are obtained from his own farm. His Zn^{65} burden was 0.105 μc. This is the highest we have observed so far.

Calibration of the big NaI crystal for Na^{22} and Zn^{65} were completed.

A method was found for obtaining reproducible counting rates from the BF_3 counters used in the precision long counter. The maximum variation observed in a three-week period was less than 2% but four counters agreed to better than 0.4%.

The polyethylene double moderator was tested with radioactive neutron sources.

In collaboration with Radiation Monitoring Operation our realistic plastic phantom was exposed to neutrons and then examined for radioactivity induced by slow neutrons. Radiation Monitoring Operation conducted studies with survey instruments and personnel meters. We measured the Na^{24} content of the phantom with the scintillation counter system developed earlier this year. After several days of radioactivity decay the phantom was counted in the Shielded Personnel Monitoring Station. There is a discrepancy in the Na^{24} data that has not yet been explained.

Nuclear track film was exposed to the PuF_4 source for the Naval Radiological Defense Laboratory.

Members of CPD were assisted in assembling and testing an automatic system for double moderator measurements in the 234 Building.

INSTRUMENTATION

The scintillation transistorized combined alpha-beta-gamma hand and shoe counter has now operated satisfactorily for seven continuous months in general use in the 329 Building. Total downtime in seven months was three hours for repair of a commercial transistorized power supply component. Plant drawings of the instrument are scheduled to be started shortly with demonstrations of the instrument to take place at various buildings on the plant thereafter.

A laboratory experimental alpha air monitor was fabricated in laboratory test form. The unit utilizes a discriminator and anticoincident circuit to reduce effects of radon, thoron concentrations in the air being monitored for plutonium alpha activity. A goal sensitivity for alarm of 20 MPC of Pu^{239} in three minutes is being sought. Data are now being collected during continuous operation of the experimental unit. Additional experiments were continued concerning absorption of radon-thoron by an activated charcoal in the input air line to the monitor.

The experimental transistorized high-level alpha air monitor and the experimental dual alpha and beta-gamma air monitor continue to operate satisfactorily in the laboratory. It is planned to transistorize, as much as possible, all of the experimental air monitoring units now in vacuum-tube form to greatly increase the reliability factors.

A simple alarm circuit device for the personally-carried personnel alarming dosimeters is being investigated. The alarm unit uses a specific size copper wire in a mild acid bath. The wire breaks after a specific amount of current has passed through the wire; this causes the alarm to be activated. The alarming capsule can be quite small--a matter of a few cubic centimeters. The objective is to have specific alarms for accumulated doses of 50, 100, 150 and 200 mr. Test units have been quite reproducible in alarm points.

Further experiments were conducted on the logarithmic, scintillation remote area monitor. The unit uses a terphenyl-in-polyvinyltoluene detector which has excellent beta response characteristics and is essentially gamma energy independent above 90 kev. The obtained logarithmic response covers three decades from 10 mr/hr to 10 r/hr or one mr/hr to one r/hr as desired by the specific application. Other suitable three-decade range coverage can also be provided. Alarming can be accomplished at any desired point over the three-decade range. All reading errors are of the positive nature or "safe side" type. The reading-point errors, typical in any logarithmic device, vary from 0 to +15%. Recording via a 10 to 50 millivolt-type chart recorder is provided. Two prototype units will be fabricated eventually.

Investigation of various plant area radiation background conditions continued during September. The 200-channel analyzer was used to study conditions at the Biology animal farm at 100-F. The detector was placed in the

underground structure being fabricated for the location of an animal experimental total body counter. The investigations will permit calculations concerning forthcoming shielding problems. To date, the analyzer has been employed in similar investigations at Purex, Redox, 222-S, 234-5 and Biology. Further, other area investigations are scheduled. Only qualitative information is being obtained and will be reported. Additional radiation background monitoring continued at Purex. This information is of the gamma dose-rate type with chart recording. Comparison of the scintillation detection information is backed up by pencil ionization chamber information. This portion of the work is now completed.

Experiments continued concerning a scintillation detector and transistorized circuit for a portable battery-operated beta-gamma dose-rate meter to possibly replace the CP-type ionization chamber instruments. Sensitivities of one to five mr/hr full scale first range are expected. The unit will be completely transistorized using a semiconductor chopper, a-c amplifier, demodulator and high-voltage supply. Only better temperature stability of the oscillator used to drive the chopper remains to be resolved.

Light pipe and specialized scintillation detector investigations continued. The design work was completed for a specialized alpha-only light-pipe detector for Pu^{239}. This unit uses a two-inch by four-inch active area wedge-shaped detector light pipe using zinc sulfide for the detection. The forward end of the wedge is only one-fourth inch thick thereby permitting survey in tight spaces. The probe will be used with the transistorized a-c operated SCINTRAN monitor which has both a loudspeaker and a three-range count-rate meter. The probe has a uniform geometry, over the full detector area, of better than 10 percent while having no gamma interference background counts in a radium gamma field of three r/hr.

Design work was completed for a combination light pipe and detector probe to be used for measuring approximate beta dose rate in solutions of single radioisotopes and in various animal organs at Biology. A second probe of a similar detecting nature is being evaluated. This probe uses a light pipe 12 inches long with an effective diameter of three millimeters. The probe is used to evaluate the relationship between dose rate and count rate in a 0.1 μc/ml solution of Cs^{137}. The terphenyl-in-polyvinyltoluene detector is inserted in the center of a spherical volume solution of Cs^{137}. The container radii varied from 0.8 cm to 7.8 cm.

Fabrication continued on an experimental prototype completely transistorized aural plus count-rate meter alpha-beta-gamma detecting instrument which will be 110 VAC operated. The combination scintillation alpha-beta-gamma probe will be used. One speaker will produce "pops" for alpha-caused pulses and the second speaker will produce distinctly different 1.0 KC notes for beta-gamma-caused pulses. The count-rate meter indication will be selectable for alpha only or alpha-beta-gamma combined.

The instruction manual for the Radiotelemetering Network Data Stations is about one-fourth completed.

The chassis, steering, and drive system for a small robot is being fabricated. With the development of suitable servo-resolver and memory circuits,

efforts will be made to develop an accurate method for enabling the robot to determine its location without using a directional gyro.

WASHINGTON DESIGNATED PROGRAM

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

Some trouble was encountered in electrical leakage in the mass spectrometer ion source. The ion source was disassembled and cleaned which greatly reduced the apparent leakage but has not completely removed the difficulty.

A new 10 megacycle discriminator for the pulse counting system was received and tested. The pulse resolving time was measured to be 0.06 μsec and the output pulse characteristics are independent of input rates.

Equipment has been put into operation to study the ion optics of a mass spectrometer ion source. This equipment produces an electrical two dimensional analog to equipotential plots of the ion source region. Some equipotential plots of the geometry of the presently existing ion source assembly have been obtained.

CUSTOMER WORK

Analog Computer

A preliminary study of the characteristics of a stirred chemical dissolver was completed on work order from the Chemical Development Operation, HLO. The results indicate that the solution must be obtained in steps in order to provide the accuracy required. A continuous solution is not practical without using some form of a true time lag simulator. This work will be completed on the Goodyear computer in October.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	90	82.2
General	60	82.5
Special	121	86.0

A long dry period in which only .03 inch of rain fell between June 11 and September 12 ended abruptly with a 3-day total of .67 inch, September 13-15. Subsequent rains swelled the September total to 1.26 inches. This was 3-1/2 times normal and was only .08 inch short of the 48-year-record September high established in 1947. Temperatures averaged more than 2 degrees below normal despite a few very warm days shortly before midmonth. There was more cloudiness than in any previous September in 13 years of record, and, as a result, solar radiation averaged at a 7-year record low for the month.

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Instrumentation

Fabrication work was completed in the 328 Building electronics shop on eight transistorized plug-in printed circuit amplifiers of our latest developed type. This amplifier is used in all portable and 110 VAC fixed instruments of the transistorized types and is completely interchangeable in a large variety of instruments either in use or scheduled.

Fabrication work continued on 12 scintillation criticality alarm units being built to our specifications and to be installed in various 300-Area buildings.

Fabrication continued in the 328 Building electronics shop on three G-M tube detector beta-gamma alarming monitors for Redox. Approximate alarm levels for the transistorized meter-relay units will be from 0.1 to 5.0 mr/hr as desired.

Fabrication continued in the 328 Building electronics shop on a prototype completely transistorized loudspeaker plus count-rate meter alpha-only 110 VAC-operated monitor which can be used with either an air proportional-type poppy probe or a scintillation alpha probe as desired by the user. The unit is being fabricated for the Calibrations Unit, HLO.

A final check with several manufacturers of digital data handling equipment shows that the requirements set forth in the tentative specifications for the PCTR Automatic Data Recording System are within the capabilities of presently available components.

Evaluation tests were completed on:

a) The Riggs Remote Area Gamma Monitor. Operation was unsatisfactory.
b) First run tests were completed on the Ohmart Remote Area Monitor. It failed to operate properly and was returned to IPD for repair and readjustment.
c) Evaluation tests of Eveready "Leakproof" batteries showed them to be not leakproof. Ray-O-Vac batteries were superior in this regard.

Field tests were conducted on the portable transistorized loudspeaker G-M, the portable alpha, beta, gamma transistorized instrument, and the portable combination BF_3 tube and scintillation probe slow and fast neutron instrument.

Acceptance tests were started on seven newly-purchased C-P instruments.

Optical Work

The measurement of the inside diameter of IOE fuel elements to ± 0.002 inch now seems possible as a result of testing and adapting an idea originally described by T. L. Deobald of IPD. Alternate designs are being studied. Three possible systems have been mocked up and demonstrated. The method employs illumination of the bore of the fuel element from behind and an objective lens in front to project the image of the inside diameter at 30X magnification. Only a very narrow annular ring is in focus at one time. The diameter of this ring can be measured in the enlarged image. With proper

mechanical design, internal warp and minor irregularities can also be measured.

Electronic parts for the two-color infrared pyrometer are on order. The mechanical arrangement design is 80 percent complete and fabrication will begin in one week. The pyrometer is to be employed to determine the temperature of a specimen in the hot stage of a metallograph. The temperature range covered is 500°C to 1000°C. The instrument is completely automatic and will provide an output which can be used for recording and control purposes. Expected completion date: December 1.

The 680 manhours of optics shop work for the period August 16 to September 27 consisted of 4% for FPD, 23% for IPD, 14% for CPD, 1% for CEUO, and 58% for HLO. This work included:

1. Fabrication of a scratch depth microscope for the Radiographic Testing Operation.
2. Repair of one Redox three-power head.
3. Fabrication of tools for glass bearing work.
4. Polishing of four lead glass windows.
5. Servicing of one large Lenox borescope.
6. Lapping of ten pump seal faces.
7. Fabrication of two thermistor probes.
8. Fabrication of a quartz coil form.
9. Fabrication of a black light inspection device to be used in viewing fluorescent penetrant dies in the bore of long tubes thus revealing hidden flaws.
10. Silver plating several quartz transducers.
11. Fabrication of quartz parts.
12. Modifications to prototype components of the profilometer for PRTR.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
J. L. Powell	8/31-9/11	University of Oregon Eugene, Oregon	Consulting.	JE Faulkner	Yes	300: 326 105-KE
M. Larson J. Cayanus	9/18	Walla Walla District Army Corps of Engineers Walla Walla, Wash.	Discuss wind speed and direction integration instrumentation on Columbia River.	GE Driver	No	300: 329
J. C. Sheffield L. A. Dietz	9/22-24	Knolls Atomic Power Laboratory Schenectady, N. Y.	Discuss mass spectrometry.	CR Lagergren WJ Friesen	No	300: 326 325 305-B
E. E. Parker R. C. Allen	9/24-25	General Electric Instrument Department West Lynn, Mass.	Discuss instrumentation with HAPO personnel.	PF Gast RS Paul	Yes	300: 326 3760 303 202-A 105-H

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
I. T. Myers	9/10-12	Yale University New Haven, Conn.	Attend Fourteenth Calorimetry Conference.	--	No
	9/14-15	General Electric Co. Schenectady, N. Y.	Discuss radiation damage in graphite.	R. M. Walker	No
G. R. Hilst	9/14	U. S. Weather Bureau Washington, D. C.	Revision of "Meteorology and Atomic Energy."	Joshua Z. Holland	No
			Discuss meteorology.	D. H. Pack	No
	9/26	Industrial Hygiene Assn. Portland, Oregon.	Deliver invited paper.	Daniel Bessmer	No

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. S. Paul	9/16	U. S. Atomic Energy Comm. Washington, D. C.	Nondestructive Testing Steering Committee Meeting.	Jules Simmons	Yes
C. L. Brown	9/21-10/5	Oak Ridge National Lab. Oak Ridge, Tenn.	Attend nuclear safety course.	Hugh Henry	No
R. A. Harvey A. L. Ruiz	9/25	Univ. of Washington Seattle, Wash.	Discussion of instrumentation, and automatic control systems.	R. N. Clark	No
H. V. Larson	9/28-30	Columbia University New York, N. Y.	Learn technical details of construction and calibration of tissue equivalent chambers.	H. H. Rossi	Yes

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Chemical Research and Development

RESEARCH AND ENGINEERING

IRRADIATION PROCESSES

Decontamination of Reactor Components

A more detailed examination of the factors affecting corrosion rates obtained during use of decontamination reagents was made. This was done in an attempt to explain the discrepancy between rates observed for carbon steel in the laboratory and in loop tests. Corrosion rates have been higher consistently in the loop tests. In tests made with dibasic ammonium citrate -- EDTA solutions (APACE Step II) at 90 C, carbon steel corrosion rates were increased by increased velocity of the solution past the metal surface, by increased contact time of a given solution with the metal, and by coupling the carbon steel with stainless steel. The last effect was the most prominent. The corrosion rate for a carbon steel coupon fixed inside a section of stainless steel pipe was about six times that for an uncoupled coupon.

Scaled carbon and stainless steel coupons were contaminated with uranium dioxide and fission products from very short cooled irradiated uranium. Some coupons were then decontaminated by the APACE process and some by the alkaline permanganate - Wyandotte 1112 process previously described. The decontamination tests were completed within 52 hours after removal of the uranium from F Pile. Over-all decontamination was less by factors of 10-20 for the APACE process and 5-10 for the latter process than has been obtained previously when using uranium cooled more than 30 days. The only isotope which could be identified on the cleaned coupons was Te^{132}.

A few decontamination tests were made in a rocking autoclave at 130-150 C. Poor decontamination, high corrosion rates, and decomposition of cleaning solutions characterize these runs.

Investigation of bisulfate solutions as decontaminants was continued. Turco 55-8A (a new bisulfate cleaner), when preceded by alkaline permanganate descaled coupons completely with low corrosion rates. The addition of sulfasalicylic acid to a bisulfate formulation did not improve decontamination.

Automatic Analyzing Monitor

A telemetry circuit utilizing telephone lines for remote inquiry of the operational status of the instrument was tested and found to have promise of usefulness. Some changes in mechanical and chemical components indicated reliability. At month's end the formal report, HW-61117, describing the instrument was issued, thus completing currently planned development work on the monitor.

Uranium Oxidation and Fission Product Volatilization

A series of uranium-steam fission product release experiments was completed. Three steam atmosphere runs were made in which MSA ultra filters were installed in the off-gas train. The temperature of the filters was maintained at 140 C. Ninety-eight

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per cent of the released I^{131} and Te^{132} were retained on the filter. Particles of UO_2, ranging in size from 17 microns to less than 1 micron were also identified on one of the filters.

Tests with a prototype furnace, designed for induction heating of uranium for the high level fission product release tests, showed that the oxidation rate of unirradiated uranium was dependent upon air inlet velocity. In general, higher oxidation rates were obtained with the induction furnace than with a resistance furnace under similar temperature and time conditions.

Processing of NPR Fuel

Data acquired over the past few months are summarized and employed to evaluate potential hazards in processing NPR fuels (metallic uranium metallurgically bonded to Zircaloy cladding) by the Zirflex process in HW-62109, "An Estimation of the Explosive Hazard in Processing Metallic Uranium Fuel Elements Metallurgically Bonded to Zircaloy Cladding," J. L. Swanson. It is concluded that circumstances leading to accumulation of sufficient explosive delta phase residue ("UZr_2") to produce a significant explosion in a plant operation are so remote as to be of no practical concern.

Special Geological Studies

All seven seismic disturbances detected at Hanford between 10:40 p.m. August 17 and 7:30 a.m. August 18 were determined to be the West Yellowstone quake and subsequent aftershocks. The intensity of the initial quake at West Yellowstone was 7.1 on the Modified Mercalli scale. It's intensity at Hanford averaged about 3.5-4. Two aftershocks during that period were evidently not detected at Hanford. Also, the nine aftershocks recorded by the US Coast and Geodetic Survey subsequent to 7:30 a.m. August 18 up to 11:14 a.m. August 20, if felt here, were not recorded by our instruments. These failures indicate the inadequacy of our present methods of detection in arriving at realistic estimates of the damage potential here of earthquakes.

Effluent Decontamination

The possibility of recasting waste alsi ingots into a form suitable for use as a metal bed packing for decontaminating reactor effluent was ruled out because of the poor casting properties of the metal. However, machining the alsi into appropriate shapes may be economically feasible.

Analytical Services

Uranium contents were measured in solutions of HNO_3+HF used to etch Zircaloy-clad slugs. The data were used to determine the amount of uranium diffused through the cladding.

Measurements of the Co^{60} and Zr^{95} contents of 100-F raw water were made by gamma counting 500 ml samples in the 9-1/4 inch NaI well crystal. Use of the large crystal avoided extensive evaporation of samples.

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In work on iodine analyses for the uranium oxidation studies, the continued presence of a disproportionate amount of Te-I^{132} in samples necessitated distillation of the $I^{131-133}$ prior to counting. When present, Te-I^{132} introduces a large compton correction at the 0.36 Mev $I^{131-133}$ peak.

Cerium-143, europium-152, and samarium-153 were prepared by neutron irradiation of stable salts. The isotopes will be used to calibrate the 400-channel gamma analyzer.

The induction furnace method of carbon analysis was extended in its normal form to analysis of carbon (as uranium monocarbide) in powdered uranium dioxide. Ceramic Fuels requires carbon analysis of carbon-arc fused and sintered test samples.

Scandium-46 measurements in farm produce samples were begun. In addition, methods for the measurement of P^{32} are being investigated.

SEPARATION PROCESSES

Dissolution of Nickel Cladding

The "as-deposited" nickel coating proposed for aluminum clad production fuels is a metastable phase. At temperatures at or above 300 C it tranforms rapidly to a phase mixture of crystalline nickel and Ni_3P. The equilibrium phase mixture dissolves much more rapidly than the "as-deposited" coating in dilute (1 M) nitric acid. Observed dissolution rates for the equilibrated coating in boiling 1 M HNO_3 were about 0.15 g/cm^2-hr; rates for the "as-deposited" coating were about 0.006 g/cm^2-hr. Attempts to strip the "as-deposited" coating with sodium cyanide -- Enstrip S-solutions were not successful. Enstrip S is a proprietary compound made by Euthone, Inc. and is reported to remove plated nickel from iron alloys when in alkaline cyanide solutions.

Palmolive Program

Olive Processing. Exploratory studies have begun on solvent extraction flowsheets for processing irradiated neptunium in the Hot Semiworks. Several approaches are being considered, all of them compatible with the existing and scoped equipment in the Hot Semiworks. The flowsheet presently scoped for this job employs a mild oxidant such as dichromate in the feed to the first column, thus enabling simultaneous extraction of neptunium(VI) and plutonium(IV). Partition of plutonium-238 from neptunium-237 would be accomplished in the second column where plutonium would be reduced with ferrous sulfamate to inextractable plutonium(III) and recovered in the aqueous phase. Neptunium(VI) would be reduced to extractable neptunium(IV) in this column and would be retained in the organic phase. The neptunium would be recovered in an aqueous solution in a strip column, the third column of the first cycle. The plutonium product from the first cycle would be further concentrated and purified by a "spin" or total reflux flowsheet in a second cycle. The first cycle neptunium product would be stored and further purified and concentrated in batches via batch anion exchange process prosecuted on a campaign basis.

Although chemically feasible, this flowsheet has certain disadvantages, particularly in that the use of dichromate in the first extraction column may lead to poor fission product decontamination and the necessity for reducing both plutonium and neptunium in the partition column will require a very high ratio of ferrous sulfamate to plutonium in the partition column. This will lead to a correspondingly high ratio of sulfate (which inhibits plutonium extraction) to plutonium in the second plutonium cycle.

Accordingly, two alternate approaches have been subjected to brief experimental study, using plutonium-239 as a stand-in for plutonium-238. In the first alternate it was attempted to effect simultaneous extraction of neptunium(IV) and plutonium(IV) in the first extraction column by use of ferrous sulfamate in a feed made sufficiently high in acid (9 M HNO_3) to avoid formation of plutonium(III). In a miniature mixer-settler run extraction of both neptunium and plutonium was reasonably efficient. However, a low acid scrub section was used in an attempt to produce a low-acid organic product appropriate for feeding to the partition column. In the low acid environment of the scrub section the reaction

$$Np^{+4} + Pu^{+4} + 2H_2O \rightleftharpoons NpO_2^{+} + Pu^{+3} + 4H^{+}$$

apparently occurred at a sufficient rate to convert a substantial fraction of the neptunium and plutonium to the inextractable Np(V) and Pu(III). This produced a substantial reflux of both neptunium and plutonium and a net ten per cent loss of neptunium to the aqueous waste. Although it is probable that conditions could be chosen which would reduce this reflux to a manageable level, it was felt that such a flowsheet might be unduly sensitive to control variables and this approach was abandoned in favor of a second alternative.

In the second alternative the aluminum-bearing dissolver solution is adjusted to about 1 M HNO_3, 0.75 M $Al(NO_3)_3$ and partition of plutonium from neptunium is accomplished in the first extraction column by retaining neptunium as inextractable neptunium(V) while extracting plutonium(IV). A low-acid scrub stream containing iron(III) (to oxidize traces of Np(IV)) can be used to further improve partition of neptunium and plutonium. The plutonium-bearing organic extract is stripped and the aqueous plutonium product processed through a second "spin" cycle as before. Only in the event a reducing strip is employed for plutonium will the second cycle feed contain sulfate and in any case the sulfate concentration can be greatly reduced.

The aqueous neptunium-bearing waste from the first cycle would be acidified and processed on a fairly conventional neptunium(IV) extraction flowsheet followed by anion exchange. Equipment available in the Hot Semiworks would enable neptunium and plutonium processing to be conducted either in parallel or in sequence, as desired.

Four miniature mixer-settler runs have been made testing this first cycle approach. Analytical data are incomplete but indicate this approach to be feasible since excellent recovery of plutonium and excellent separation from neptunium was obtained.

Thus, it is believed this approach represents an acceptable alternate to the presently-scoped co-extraction flowsheet.

Chemistry of Actinide Elements

Direct experimental confirmation has been obtained that the species of uranium(IV), plutonium(IV), and neptunium(IV) absorbed by strong base anion exchange resins is the hexanitrato complex, $M(NO_3)_6$. A variety of indirect evidence had been previously obtained which led to this conclusion. Recently, using the infrared source provided with the Carey Model 14 Spectrophotometer as an intense source of light in the visible wave lengths it has been possible to measure directly the absorption spectrum of actinide-loaded anion exchange resins against a nitrate-loaded resin as the blank. In the case of plutonium, the absorption spectra of Dowex-1, X-1 loaded with plutonium out of 4 M and 8 M HNO_3 and 4 M $Ca(NO_3)_2$ are identical and are identical with the absorption spectra of plutonium(IV) in concentrated nitric acid and that of the salt $((C_2H_5)_4N)_2\ Pu(NO_3)_6$ in solution in acetone, acetonitrile, acetic anhydride, or nitromethane. Similarly, the spectra of uranium(IV) or neptunium(IV) loaded resin were identical with the spectra of the elements in strong nitric acid and the spectra of the salt $((C_2H_5)_4N)_2\ M(NO_3)_6$ in solution in acetone.

In the case of the salt $((C_2H_5)_4N)_2\ U(NO_3)_6$ the spectrophotometric technique has been extended to measurement of the absorption spectrum of the solid salt. By mulling with petrolatum and employing a 0.5 mm path length it was possible to obtain a very sharp spectrum, which is quite similar to that of the salt in solution in acetone. Environmental perturbations are apparent, however, in that the relative intensities of certain of the peaks are altered and a shift of about five millimicrons is observed in three of the five absorption maxima.

The spectrum of Dowex-1, X-1 loaded with uranium(VI) out of aluminum nitrate has been also measured and compared with that of uranyl nitrate in aluminum nitrate and the known spectrum of the trinitrato complex $UO_2(NO_3)_3^-$. The three spectra were decidedly different. Similarly, distinctly different spectra were obtained for Dowex-1, X-1 loaded with uranyl out of 8 M HCl, the solid salt $(CH_3)_4\ N\ UO_2Cl_3$ precipitated from 8 M HCl, and the salt dissolved in nitromethane. Unfortunately, these results do not permit a clear-cut conclusion since the effect of environmental influences on the U-O vibrational peaks is not known, and these account for most of the visible absorption spectrum.

The spectra of uranium(IV) in nitric acid-perchloric acid mixtures, of the uranium(IV) tetramethylammonium hexanitrato salt and of uranium(IV) extracted into tri-n-octylamine have been measured for comparison with neptunium. The spectra of organic solutions of trinitrato salts of uranium(VI) and neptunium(VI) were also measured. The results support the view that the species that extract into amines is the hexanitrato in the case of the tetrapositive actinides and the trinitrato in the case of the hexavalent ("yl") ions. A value (preliminary) of 1.1 was also obtained from the spectral data for the formation constant of the first uranium(IV) nitrate complex.

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Analytical Services

The thermal ionization mass spectrometer was used for isotopic analysis of cerium. Results for natural cerium, in a chemical form simulating plant cerium, agreed with the literature as the following indicates:

	Atom % Ce^{136}	Atom % Ce^{138}	Atom % Ce^{140}	Atom % Ce^{142}
Found	0.17 ± 0.01	0.24 ± 0.01	88.5 ± 0.22	11.08 ± 0.22
GE Chart of Nuclides	0.19	0.26	88.47	11.08

Sample size may be as low as 3 micrograms; although, 30 micrograms are required to show mass 136 and mass 138 peaks. When as little as 0.33 microgram samples were used mass 140 results were 86.7 ± 0.9 per cent and mass 142, 12.8 ± 0.9 per cent.

WASTE TREATMENT

Materials of Construction for Storage of Acidic Purex 1WW

Stainless steels 304-L, 309-L, 316-L and titanium A-55 corroded at rates of 2, 2, 6, and $<$ 0.01 mils/mo, respectively, in boiling synthetic Purex 1WW. All three stainless steels showed intergranular attack. Samples of these materials, as well as zirconium and Ni-o-nel, were exposed to boiling solutions simulating Purex 1WW after 60 per cent concentration and destruction of part of the nitric acid by formaldehyde. Residual nitric acid concentrations ranged from zero to three molar. Corrosion rates in mils/mo increased with increasing nitric acid as follows: zirconium less than 0.01, titanium from 0.01 to 0.07, 309-L from 0.7 to 1.3, 304-L from 1.5 to 4, 316-L from 1.8 to 8.6 and Ni-o-nel from 3 to 30. All of the stainless steels and Ni-o-nel showed intergranular attack. When exposed at 35 C to the concentrated 1WW at acidities from 0.5 to 3 M, 304-L, 309-L, 316-L and A-55 titanium corrosion rates were below detection limits. At 65 C, 304-L and 316-L corroded at rates about 0.02 to 0.04 mils/mo; corrosion rates for 309-L and A-55 titanium were below detection. Studies to determine the effects of varying nitrate and sulfate concentrations in 1WW and the effects of sludge deposition on the corrosion of 304-L, 309-L, 316-L, and A-55 titanium are in progress.

ANL Fluid-Bed Calcination Studies

Exploratory studies at ANL on fluid-bed calcination of simulated Purex "formaldehyde-killed" and threefold concentrated acid waste have continued with five runs at a bed temperature of 500 C using sugar in the feed. One run was made with 75 g/l sugar in the feed. This run was somewhat unsuccessful, in that some lumps were formed. The remaining tests were made with 125 g/l sugar in the feed. One of these latter tests was for 30 hours duration. In general, the results were very good. About 0.6 scfm attrition air was successful in preventing excessive particle

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size growth. The powder from these runs was the lightest yet obtained (with a bulk density of 0.8 to 0.9 g/cc). The powder was softer than that made from feed without added sugar but was just as free-flowing. With sugar addition the amount of sulfate in the condensate from the condenser increased from a previous value of about 25 ppm to about 300 ppm. Heat load requirements were reduced by 18 per cent with the addition of 125 g/l sugar to the feed. It may be generally concluded from recent runs that the frangible powder produced from feeds with sugar added provides better particle size control, hence, better operability of the calciner.

Observation Wells

The concentrations of radioactive material in wells 699-34-39A, 699-31-30, and 699-24-33 continued a slow increase. The gross beta concentrations range from 10^{-5} to 10^{-6} uc/cc. The phenomenon is difficult to explain with our present knowledge of the regional hydrology as these wells are located on the slope of the 200 East ground water mound, and the observed radioactive concentrations in them are higher than has been reported in the waters of the Purex swamp which formed the mound. Depth sampling in these wells revealed essentially uniform concentrations of radioactive material throughout the ground water profile available for sampling.

A deep well located about 1-1/2 miles south of the 216-BC cribs and trenches was found to have a detectable concentration of radioactive material in the zone immediately above the basalt layer at a depth of 380 feet below the water table. Samples obtained at five-foot intervals throughout this well revealed that the radioactive material is restricted to a zone near the bottom of the well.

Disposal to Ground

Core samples of material from beneath the 216-Z-9 crib were sectioned and examined to determine the distribution of plutonium in these soils. The results of these studies were reported in Document HW-61787-RD. A rough integration of the data from the cores indicated a total plutonium deposition in the zone sampled that is approximately 70 per cent of the summation of all wastes sent to this crib. It is felt that this accounting is well within the accuracy of the techniques employed.

Laboratory column experiments were performed with samples of 234-5 Building laboratory and process waste to estimate the life of the 216-Z-9 crib. The laboratory columns gave no indication of Pu or Am breakthrough after passage of more than 100 column volumes of the waste. Based on a conservative estimate of the effective volume of soil beneath this crib, the structure should be operative for many years under current waste conditions and disposal limits.

Analytical Service

Sulfate in IWW waste was determined indirectly by coulometric titration of chromate. Sulfate in the sample was removed by adding the sample to a standard barium chromate solution. Adding NH_4OH to the supernate precipitated, as barium chromate, the barium in excess of that required for sulfate precipitation. Residual chromate

was titrated in the alkaline solution. Phosphate is an interference. The minimum titratable chromate is equivalent to 0.5 mg of $SO_4^=$ with the optimum being 2.5 to 7.5 mg. Error is less than 10 per cent and radiation hazards are less than those of other methods.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Fission Product Isolation and Packaging Prototype

The hydrolyzer was dismantled for modifications. The modifications include redesigned elements for the forward rotor bearing, the powder discharge section of the rotor, and a new electrical coupling layer. The present design of the crystal dryer has proven ineffective in reducing lumps of wet salt into a satisfactory product. Currently the over-all problem of crystal drying is under evaluation to determine the necessary corrective action.

The forward rotor bearing in the hydrolyzer wore rapidly because gas entrained powders entered the bearing and abraded the surfaces. The redesign includes a packed seal to prevent the entry of these abrasive dusts. The powder discharge section of the rotor was redesigned to alleviate a plugging problem. As mentioned in earlier reports, under certain modes of operation sticky agglomerates are formed. With the initial design these agglomerated materials stuck to the rear shaft support elements and frequently plugged the tube (rotor). The original sprayed copper coupling layer burned off during tests because the sprayed-on aluminum protective layer was too porous to prevent diffusion of atmospheric oxygen. The new copper layer will be protected by a sheath made of sheet stainless steel welded into place.

The crystal dryer has not proven satisfactory because lumps of wet salt are not broken up and dried. Two types of screw agitator conveyors have been tried, the open ribbon and the closed center auger types. Neither have been satisfactory. Sticking of wet salt upon the screw has been the major cause of trouble. An electrical vibrator attached to the outside of the dryer assembly has been only partially effective. Currently several schemes are being studied to determine ways to overcome the difficulties.

Multicurie Cell Investigations

Another rare earth precipitation run was completed this month. This differed from previous runs in that precipitation was carried out without neutralization or pH adjustment. The as-received Purex plant 1WW was butted with sodium sulfate, digested at 90 C for 24 hours, and then filtered. Most of the cerium precipitated and was subsequently removed from the solids by a series of 1 M HNO_3 leaches. The bulk of the strontium and yttrium was not precipitated. The leached cerium was subsequently precipitated as the hydroxide and then metathesized to the oxalate for purification from residual traces of iron. About 100 curies of purified cerium was obtained.

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Cerium-Promethium Recovery

An intensive study has been completed aimed at determining the effect of process variables on the peroxide-acetate process for the separation of cerium from the trivalent rare earths. A procedure has been worked out for potential Purex application. Laboratory tests of the procedure show that better than 99 per cent of the cerium should be recovered in the cerium product fraction. This will be contaminated with up to 15 per cent of the trivalent rare earths; however, their concentration can be reduced to one per cent, or less, by a reprecipitation.

The possible evolution of ruthenium during the digestion or during subsequent nitric acid dissolution of the cerium(IV) acetate cake was also studied. None could be detected (DF to off-gas $>10^4$). About half of the feed ruthenium and all of the zirconium-niobium was found in the cerium product. The rest of the ruthenium and most of the cesium accompanied the trivalent rare earths. Since excellent decontamination is obtained in the double sulfate precipitation, little additional decontamination is actually required.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

"Burn-Up" Measurement

A non-destructive method for determining the relative number of fissions which have occurred at various points along an irradiated fuel element could be used to reduce the number of "burn-up" analyses required on the fuel element and would be of value in selecting representative samples for analysis. Such a non-destructive relative exposure measurement may be possible using gamma spectrometry to measure the Ce-Pr-144, 2.18 Mev gamma. This pair has most of the characteristics required of a fission product for this purpose and tests with a sample of 120 day cooled dissolver solution indicate that the Pr-144 gamma can be measured without appreciable error from the high energy Ru-Rh-106 gamma, which is the only fission product gamma likely to interfere after such a cooling time. Tests with clad fuel elements in air and in a water will be made to establish optimum measurement conditions.

Spectrographic Analysis

A substantial amount of experimental work in a study of the mechanism of the carrier concentration method of analysis of refractory oxides has been carried out and a preliminary report is being written. The analysis of uranium oxide as a type of sample was studied using several representative carriers and impurity elements. Most of the work was done with a few per cent Ga_2O_3 as a carrier in U_3O_8. The common assumption that the mechanism of the carrier action is that of vapor distillation has been found to be an over simplification and the following roles of the carrier explain the data more completely:

1. The carrier both lowers the melting point of the matrix and retards sintering, thus helping free the impurities from the UO_2 crystals.

[redacted]

2. The distillation of the carrier from the arc sweeps the impurity vapors out of the matrix in the electrode crater.

3. The carrier and its vapor in the arc tend to maintain a lower and constant temperature in the crater and to stabilize the arc during the arcing period.

4. The carrier vapor intensifies the impurity emission spectra, probably by an energy transfer mechanism.

5. The carrier suppresses the uranium spectral emission, possibly by maintaining a low arc temperature.

Although many aspects of the carrier concentration mechanism have not been studied, some progress toward a better understanding of the process has been made. The continuation of such a study could lead to such practical applications of the knowledge gained as the use of carrier methods to remove certain impurities from refractory solids, and an extension of the use of additives to modify or control sintering.

EQUIPMENT AND MATERIALS

234-5 Plutonium Oxalate Disc Filter Studies

Document HW-62091, entitled, "Plutonium Oxalate Disc Filter and Filter Media Studies," is currently being issued.

Pump and Agitator Studies

Testing has begun on a slow-speed, hollow-shaft agitator designed for both Redox and Purex plant application. The agitator uses a specially built 10-horsepower motor designed to operate at approximately 300 rpm and to accommodate hollow agitator shafts up to approximately 4-inches in diameter. Initial testing is in progress with a shaft approximately 16.5 feet long -- the longest shaft currently required in the separations plants. Testing will continue on shafts at various lengths of interest.

Document HW-61921 was issued. This document describes the successful testing of a special Hanford discharge head designed for use with deepwell turbine pumps. By placing the liquid throttle bushing well down the pump shaft and inside the tank, this discharge head eliminates the throttle bushing leakage from the tank as the bushing wears.

Non-Metallic Materials Testing

Plexiglas 5009B, a nonflammable, transparent cast acrylic sheet material manufactured by Rohm and Haas, was tested by static immersion at room temperature in solutions which it might contact during hood service in the 234-5 Building. This plastic dissolved in trichlorethylene, swelled 13 per cent in 48 per cent HF and 7 per cent in 30 per cent nitric acid. It swelled less than 2 per cent in both 10 and 20 per cent nitric acid, oxalic acid, and Purex HAX. It swelled 2 per cent in potassium permanganate, 3 per cent in Recuplex CAX and 4 per cent in

hydrogen peroxide. Both carbon tetrachloride and perchlorethylene caused less than one per cent swell. On the basis of these tests, Plexiglas 5009B is the chemical resistance equivalent of Plexiglas 5009. The manufacturer rates it as more fire resistant.

HW-62090 entitled, "Tabulation of Chemical Compatability Tests," is currently being issued. This document summarizes the chemical compatibility testing of various materials (e.g., plastics, protective coatings, cementing compounds, elastomeric compounds, ceramic compounds) over the period from January, 1953 to January, 1959. Test solutions include caustic, nitric acid, carbon tetrachloride, hexone, Purex HAX, Recuplex CAX, and miscellaneous solutions of special interest for specific test materials.

PROCESS CONTROL DEVELOPMENT

C-Column Instrumentation Studies

A series of ten C-column runs were made to check the operability of a number of the control instruments and some of the data gathering techniques. The traveling photometer was found to be temperature sensitive, with approximately a six-gram per liter shift in calibration observed for a 25 C increase in temperature. The error is believed to be caused by a combination of increased phototube dark current, decreased phototube sensitivity, and decreased light intensity resulting from the expanded distance between the light source and the phototube. A scheme for water cooling the sensing unit is being tested which should eliminate or minimize temperature effects for sample temperatures up to about 80 C.

The inclusion of a 15-second time-constant in the Keithly micro microammeter measuring circuit for the traveling photometer significantly decreased the effect of organic bubbles passing through the phase-separating sample cell. This extends the usefulness of the instrument into the regions of column conditions usually referred to as "tight," i.e., where the organic phase is in very small droplets and shows little tendency to coalesce.

Analysis of the data obtained from the traveling photometer reveals the expected over-all uranium concentration profile. Under certain conditions the data also indicate some interesting uranium refluxing in the upper sections of the column and possible equilibrium shifting about some of the plates in the lower section of the column. These micro effects are being studied in more detail.

C-Column Programming Studies

The construction of the Data Scanning Programmer was completed this month. This programmer will automatically, upon command, scan the readings of all the instrumentation which is now in use, or will be used, on the C-column test facility, and print out a permanent record in digital form. The 30 instrument voltages which will be scanned while any one of the 15 ports are sampled are as follows: six readings each of the "standardize" and "read" voltages from the mid-column uranium photometer; the five mid-column temperatures, the mid-column photometer temperature and the temperature of the 1CX and 1CF streams; the pulse rate, the 1CX pH, the 1CW uranium concentration, mid-column aqueous acid concentration, the flow rates of the 1CF and 1CX, the time of day, the position of the cartridge relative to a datum plane, and two readings of a regulated instrument supply voltage.

A FORTRAN program has been written for the IBM-709 computer, which can be used to reduce directly the data printed out by the Data Scanning Programmer, after it has been punched on cards. The output of the program will give listings of aqueous and organic uranium and acid concentrations as a function of position in the column, as well as the corresponding equilibrium aqueous and organic uranium concentration, the number of transfer units throughout the column, and the flow rates of the two phases.

Integrated Plutonium Output Redox 3B Column

A multiplier and integrator system has been designed to multiply a flowmeter reading by a plutonium concentration value (as given by a neutron counter) and integrate this result over the period of a process run. Thus, the total units of product passing a certain point may be known at any time. The first step in testing this system will be to install an integrator on the plutonium concentration measurement.

Prototype Contact Alpha Monitor

A contact alpha counter cell for jumper installation has been designed and fabricated. A phosphor made by cementing 0.005-inch thick sheet terphenyl-in-polyvinyltoluene to a 1/8-inch thick sheet of polystrene will be tested in the unit. Both external surfaces are optically polished. This cell will be tested in the sample pot of the Purex 1BP canyon jumper.

NON-PRODUCTION FUELS PROCESSING

Mechanical Head-End Studies

Studies during the month included continued coldsaw testing and renewed hacksaw testing. Both saws were used in cutting simulated fuel hardware. The studies indicated:

1. The hacksaw, using a two-piece blade, is a serious competitor of the coldsaw. The two-piece blade has high-speed steel teeth welded to a tough alloy back. The combination blade is vastly superior to the conventional hacksaw blades previously tested. The "rugged" blade permits prolonged cutting of the various test pieces with little blade breakage.

2. Both saws require special clamping fixtures (i.e., "combs" for rod bundles), but hacksaw clamping requirements are less rigorous than those for the coldsaw.

3. The coldsaw, being a simpler mechanism, is more adaptable mechanically for both remote cell service and multi-purpose cutting (transverse and longitudinal cuts).

4. Coldsaw chips are larger than hacksaw chips but chips from either may be collected by simple screens. Pyrophoric hazards will be neglibible for underwater storage.

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5. Water-lubricated cutting (minus conventional lubricants) will not affect blade life significantly for either saw.

Feed Preparation

Recirculating Dissolvers. A theoretical comparison of types of recirculating dissolvers with reservoirs has been undertaken. Combinations of plug-flow and well-stirred dissolvers and reservoirs were compared for decladding of metal by a first-order reaction mechanism. Recirculation rates, reaction rates, and the quantity of metal to be dissolved were arbitrarily taken to be the same in each dissolver. It was concluded that a combination using a well agitated dissolver and a plug-flow reservoir would produce the highest dissolution rates.

A typical comparison is given below for a reservoir-to-dissolver volumetric ratio of nine and an excess-reactant to total-reactant ratio of 0.2.

	Relative Dissolution Rates
Batch Dissolver	100
Stirred Dissolver - Plug-Flow Reservoir	82
Stirred Dissolver - Stirred Reservoir	68
Plug-Flow Dissolver - Stirred Reservoir	59

Recirculating Tube Dissolver. Operation of the recirculating tube dissolver was resumed after a shut down of two weeks for equipment modification (capacity increase), maintenance, and dissolver system calibrations. Testing was continued for the definition of the hydraulics and operability of the system for cladding and core dissolution of spent nuclear fuels.

A recirculating dissolver run for dissolution of Zircaloy-2 in 5.5 M NH_4F-0.5 M NH_4NO_3 solution using water boil off for removal of ammonia was stopped at the end of one hour. Precipitation of zirconium had occurred due to over-concentration of the dissolver solution. The recirculation rate during operation was 25 gallons per minute obtained by a bottom air sparge of 20 cfm at a lift to submergence ratio of 0.78. A maximum dissolution rate of 28 mils per hour was obtained as the dissolver reached boiling. The average dissolution rate during the 15-minute heating up period was 24 mils per hour. Rates of 35 mils per hour would be predicted from batch data.

Sintered UO_2 was dissolved in 3 M HNO_3 (average) from a 27-inch high, 45 per cent void volume, packed bed. The air rate required to recirculate cold 1 M HNO_3 at 15 gallons per minute with a lift to submergence ratio of 0.84 was 40 cfm. Only five cfm was required to recirculate hot 4 M HNO_3 at 55 gallons per minute with a lift to submergence ratio of 0.37. The dissolution rate averaged 22 per cent per hour.

Hydraulic Studies. A second air-lift recirculation tube is being installed on the glass unit used for hydraulic studies. This second tube will permit evaluation of interaction between multiple tubes when operating with a common reservoir.

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Flooded Tray Dissolver. A total of four runs have been made to explore the dissolution of sintered uranium dioxide in 13 M HNO_3 employing recirculation rate of three liters per minute (18.8 gph/ft^2 charge). Dissolution rates varied almost a factor of three, i.e., 121, 194, 280, and 322 mils per hour. Since dissolution conditions were essentially identical, the variation is attributed to the method of forming the uranium dioxide pieces and the uncertainty in interpreting data for a complete dissolution. In the one run where residual uranium dioxide rings remained in the dissolver they were conical (originally cylinders) with the maximum dissolution on the upstream side being about 1.3 times the average rate.

Two dissolutions of 97 per cent uranium - three per cent molybdenum alloy have been completed using a nitric acid-ferric nitrate solution in the first run and uranyl nitrate, nitric acid and ammonia molybdate solution for the second run. Dissolution rates were the expected 40 mils per hour. The second run produced some precipitate, and the solutions are now being analyzed.

Depassivation of Stainless Steel in H_2SO_4. Further studies on means of assuring dissolution of 304-L stainless steel in dilute sulfuric acid were made. Coupons were passivated for use in these studies by immersing them for one hour in boiling 4 M H_2SO_4 - 0.5 M HNO_3, rinsing them in water and allowing them to flash dry in air. Coupons so treated were passive to boiling 4 M H_2SO_4 for more than 20 minutes. Active surfaces were prepared by heating 304-L coupons to 2000 F for 30-60 minutes and cooling rapidly in air. Passivation and depassivation tests were made in boiling 4 M H_2SO_4. Active coupons can be made passive by removing them from and reimmersing them in the boiling solution -- also by immersing them in solution at ambient temperature and heating the solution to boiling. Active specimens become passive in boiling 4 M H_2SO_4 when the nitrate concentration is above 0.5 M.

No satisfactory chemical agents for depassivating passive surfaces in 4 M H_2SO_4 were found. Coupling the passive surfaces to carbon steel, Hastelloy F or Ni-o-nel produced depassivation. Coupling to platinum did not. Very low nitric acid concentrations (ca. 0.001 M) prevented depassivation by coupling to Ni-o-nel. Further studies on the effect of temperature, electrode separation and applied potential on electrolytic depassivation were made. As expected, depassivation time decreases with increasing applied voltage and with decreasing electrode separation. An applied potential of 10 volts produced depassivation in ten seconds or less at electrode separation distances up to four feet. Electrolytic depassivation was not effective when the nitrate concentration was greater than 0.015 M.

Total Dissolution of Zirconium Clad Fuels. A study of total dissolution of zirconium clad uranium dioxide fuels and subsequent preparation of feed solutions suitable for Redox processing was initiated. The scheme explored involved dissolution of the zirconium cladding by the Zirflex process and subsequent core dissolution without removing the decladding solution. Preliminary results indicate that stable (toward solids formation) solutions containing ca. 0.4 M zirconium and less than one molar free nitric acid can be prepared by this scheme. Stability appeared to depend primarily on zirconium and free acid concentration as expected. Rate of oxidation of plutonium(IV) in the feed solutions was dependent on the Al/F (free fluoride) mole ratio; a ratio of two or more was required for adequate oxidation of plutonium in two hours.

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Dissolution of U-Mo Alloys. Heats of U-3 w/o Mo-0.2 w/o Al and U-3 w/o Mo-0.2 w/o Si alloys were prepared. Studies will be made to determine if the proposed use of these alloys in the Piqua reactor fuel will introduce any new processing problems.

Materials of Construction

In tests made on samples of vacuum-melted Ni-o-nel obtained from the Oregon Metallurgical Company, Albany, Oregon, boiling point corrosion rates in mils/mo were 75 in 1 M HNO_3 - 2 M HF, 8 in Zirflex dissolver solution, 0.9 in 65 w/o HNO_3 and from 3-20 in 3.5 M H_2SO_4 as dissolved stainless steel was increased from zero to 20 g/l. No preferential weld metal attack occurred in the welded specimens. The corrosion rate in 1 M HNO_3 - 2 M HF is threefold to fourfold lower than previously noted for air-melted Ni-o-nel.

Tests were made on the heat (FV-123) of vacuum-melted Hastelloy F sent to BMI for use in alloy improvement studies show that its corrosion resistance in HNO_3-HF solutions is comparable to that of the two heats (FV-153, FV-155) used in construction of the 321 Building dissolver.

Evaluation of the corrosion resistance of vacuum-melted Hastelloy F weldments produced by G. Conner (CPD-FEO) was terminated. A high-carbon (0.05 per cent C-heat FV-152) welding rod was used in fabricating the welds. All welds show excessive weld-metal attack.

Negotiations for the contract with BMI on improved welding alloys for service in HNO_3-HF and H_2SO_4-stainless steel solutions have been completed and work at BMI has started. It is the intention of BMI personnel to prepare all of the initial twelve alloy heats before corrosion studies are started. Provision has been made for weekly telephone contact between BMI and Development and Corrosion Chemistry Operation personnel after the corrosion tests begin.

Precision Level Measurement

The analysis of the data from the precision level experiments is now complete. These experiments in connection with non-production fuel accountability were made to determine the calibration scheme required for suitable manometer-tank calibrations. The results, as analyzed by Operations Research are as follows:

ACCURACY OF VOLUME MEASUREMENT TANK T-4

Nominal Tank Level Gallons	Nominal Manometer Reading Inches	Estimated Accuracy 95% C.L. One Calibration	Estimated Accuracy 95% C.L. Three Calibrations
500	25	± 0.62%	± 0.58%
1000	50	± 0.47%	± 0.42%
2000	100	± 0.36%	± 0.30%
3000	150	± 0.33%	± 0.26%

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These results give the accuracy of a volume prediction based on one water calibration and three water calibrations. Actually, three different calibration methods were used in the experiments; water in, water out, and UNH in. Although there was some indication that a small difference existed in the slope estimates (gallons/inch) obtained by the three methods, the experimental results were such that differences are not statistically significant. Therefore, the number of batches measured in the vessel will tend to reduce the volume (random) errors as tabulated. Complete reports of this experiment and the data analysis are in progress.

Criticality Studies - Feed Materials Preparation

A core material for the sixth PCTR criticality experiment (H/U atomic ratio of 18) using three per cent enriched uranium trioxide was prepared and delivered. The shipment consisted of approximately 180 pounds of polyethylene moderated uranium trioxide.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Salt Cycle Process

The preparation of five kilograms of dense UO_2 was completed, using the electrolytic technique under conditions previously described (HW-61702-C, p. 17). The separate products were composited into two batches according to whether the tap densities were greater or less than 6 g/cm^3.

Sieve analyses showed that the higher density material consisted of larger particles, approximately 32 per cent being larger than 14 mesh. The less dense material, on the other hand, had a more normal distribution with about 75 per cent of the particles ranging between -20 + 100. Less than two per cent was larger than 14 mesh size.

The tap densities of the two composites were 5.4 and 6.2; aggregate densities by fluid displacement were 10.5 to 10.7 g/cm^3 or 96 to 98 per cent of theoretical density. Oxygen to uranium ratios, as determined by oxidation to U_3O_8, have been variable. In contrast to the values of 2.2 to 2.4 previously reported, recent runs with a new batch of solvent salt resulted in O/U ratios of 2.03 to 2.07, indicating, perhaps, that impurities may have built up in the melt which affected the product quality.

The O/U ratios obtained by conversion to U_3O_8 were confirmed by dissolution of the oxide in sulfuric acid, followed by determination of the U(VI)/U(IV) ratio.

The rate of chemical reduction of uranyl chloride in NaCl-KCl eutectic was qualitatively examined in a series of exploratory experiments. Tin, lead, bismuth, cadmium, and zinc, listed in order of increasing rate, were all effective in reducing uranyl chloride to the oxide. Reduction with aluminum, however, resulted in the production of aluminum-uranium alloy and UCl_3 in solution. Two large scale reductions using zinc were made to obtain product for evaluation. The product density compared unfavorably with that obtained electrolytically.

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$AlCl_3$-KCl System

An attempt was made to analyze the reduction behavior of uranium in the system $AlCl_3$-KCl-UCl_3-Al-U by the use of the IBM-709 computer. The method used is, in principle, simple. Using the equilibrium constant for the reaction

$$Al + UCl_3 \rightleftharpoons U + AlCl_3$$

as calculated from thermodynamic data and assuming unit activity coefficients, it is possible to calculate a value for the quantity $\phi_{ex} = \log \left[UCl_3/AlCl_3\right]$ from the experimentally determined distribution coefficients using only the metal phase data.

By assuming a mechanism for the reduction involving the following reactions:

$$2AlCl_3 + Cl^- \rightleftharpoons Al_2Cl_7^-;\ K_1$$

$$Al_2Cl_7^- + Cl^- \rightleftharpoons 2AlCl_4^-;\ K_4$$

$$UCl_3 + 3Cl^- \rightleftharpoons UCl_6^{\equiv};\ K_2$$

and considering them to be competitive acid-base type reactions, it was possible to derive an expression for $\phi_{th} = \log \dfrac{UCl_3}{AlCl_3}$ in terms of the equilibrium constants, K_1, K_2, and K_4 and the potassium to aluminum ratio in the salt phase. The computer was used to calculate the values for ϕ_{th} for the potassium to aluminum ratios used in the experimental study using over 2000 combinations of K_1, K_2, and K_4, and compare them with the values of ϕ_{ex} at corresponding potassium to aluminum ratios. A unique set of values for K_1, K_2, and K_4 was found which gave a very good fit between the theoretically and experimentally determined distribution coefficients. The values are 3.2×10^{14}, 3.2×10^{5} and 10^{4}, respectively. In this study 24 experimental data points were used over a $KCl/AlCl_3$ range from 0.53 to 2.6 representing a 60-fold variation in distribution coefficient. The average deviation between theoretical and experimental values was 37 per cent as compared to an average deviation of 15 per cent for experimantal duplicates. It is recognized that the validity of these data for the constants depends upon the assumed theoretical model and that the one chosen in this instance may not necessarily be the correct one. It is, however, noteworthy that the distribution curve for uranium in this system could be so faithfully reproduced from purely theoretical considerations, particularly in the light of the complex nature of the distribution as a function of the $KCl/AlCl_3$ ratio.

Investigation of the distribution behavior of uranium in the $AlCl_3$-KCl-Al system disclosed little or no temperature dependence over the range 725 to 875 C.

Partial analytical data indicate the distribution coefficients are roughly halved when sodium chloride replaces potassium chloride in this system. The solubility of UCl_3 in NaCl-$AlCl_3$ is apparently much less than in KCl-$AlCl_3$ as inferred from qualitative observations.

Continuous Ion-Exchange Contactor Development

Jiggler Contactor. Shakedown runs have been started on the initial pilot jigged-bed continuous counter-current ion-exchange contactor. Under the impetus of the pulsation, the resin can be moved (counter to the pumped feed) down through the column and transported to a height greater than the column length. This presents, then, the possibility of delivery of the resin to an overhead feed in a second column. Qualitative tests in a single column with water feed and Permutit SK resin over several hours demonstrate that the quantity of resin remains more or less constant in the absorption section of the contactor. In other words, the resin feed is self-adjusting. Slip liquid (feed in this case) is required to assist the resin flow through the effluent line.

To attain a more dependable constant pulse and a positive downward move of column contents, the original direct air pulsing has been replaced by a mechanical-liquid pulsing action.

Efficiency tests using thorium as a plutonium stand-in are to be initiated shortly.

Dissolver Off-Gas Analysis

The thermal conductivity cell for use at Redox has been installed in an acid and fume resistant container in preparation for installation of the analyzer system early in October. Final calibration and repeatability checks are in progress on both the combustible gas analyzer and the thermal conductivity cell, interconnected exactly as they will be in the plant installation. The system has been calibrated for the conventional dissolution process. Calibrations will also be made on off-gases from plutonium-aluminum alloy dissolutions.

The difference method for determining the per cent hydrogen in hydrogen-ammonia mixtures reported last month has been evaluated in the laboratory. This method gives the per cent hydrogen to ± 0.5 per cent over the range 0-4 per cent hydrogen in a background of ammonia and air.

A new type of thermal conductivity cell was fabricated and tested. The cell compensates for thermal convection effects and will indicate 0 to 4 ± 0.2 per cent hydrogen in a fluctuating background of 0-8 per cent ammonia in air. The new method, after further development, may also be adaptable to the analysis of hydrogen in a background of either nitric oxide or nitrous oxide.

Analytical Services

A flame photometric method was adapted successfully to produce heat transfer data simply by following the sodium concentration in water solutions undergoing mixing in test PRTR rod bundle assemblies. Feed stream (A) was made up to contain 900 ppm sodium while supply water (B) had 1 ppm. After the streams were mixed in the bundles, the resultant stream (AB) contained 170 ppm sodium. Further runs are anticipated.

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X-ray spectrometry was used for qualitative measurement of yttrium in iron, chromium, and aluminum alloys. Yttrium (near 0.5 per cent) was confirmed in one alloy. Two other alloys contained none. X-ray spectrometry was faster and simpler than emission spectroscopy or wet chemistry.

WASTE FIXATION

Radiant Heat Spray Calciner

A total of six runs were made in the eight-inch calciner during the month. All employed the melt-pot and operated smoothly. Equipment changes prior to these runs included addition of a clean-out rod at the top of the pot to eliminate bridging and provision of more insulation around the melt-down furnace for more complete melting. High spot findings are given below. Details will be found in the forthcoming Quarterly Progress Report, Research and Development Activities, Radioactive Waste Fixation.

1. A dense (2.17 gm/cc) clear amber glass was produced from TBP-25 waste by addition of sodium tetraborate (one mole of boron per metal ion equivalent). Hold-up on the column was negligible. The feed was a thick slurry which atomized easily but presented some problems in pumping. This problem was solved by bucking the feed pressure with a variable speed centrifugal pump mounted in the reverse direction. Pump mixing kept the slurry in suspension and the pump speed controlled rate of flow.

2. Addition of sugar to Purex waste has been found to significantly increase removal or destruction of sulfate during calcination. Sulfate removal also bears an inverse relation to the amount of excess oxygen present in the reactor. Without sugar addition, the direct powder product from the calciner contained 42 weight per cent sulfate and the melt pot product 21 weight per cent. With sugar (250 gms/liter) and 80 per cent excess oxygen, the corresponding values were 25 and 11 per cent. With only 16 per cent excess oxygen, the numbers were 13 per cent and "not detectable." Low sulfur balances (analyses for sulfate, sulfite, SO_2, and SO_3) suggest that a portion of the sulfur is escaping as carbonyl sulfide (COS).

3. Evidence is accumulating of moderate to severe corrosion of the filters and off-gas system when processing high-sulfate Purex waste. Since the need for off-gas handling equipment is common to all types of waste calciners, this corrosion problem will be of concern in any calcination of sulfate containing wastes. Porous ceramic filters have been ordered and will be studied in this service.

4. Occasional sharp vertical rapping on the column has been found more effective in preventing powder build-up than the continuous horizontal vibration formerly used. It also reduced the probability of fatigue failure.

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Mineral Reactions

The flow rates through an experimental clinoptilolite column were erroneously reported last month as 2.7 and 6.0 gal/ft^2/day; the unit should have read per minute. The column used in the experiment had received 13,600 column volumes (226 gal.) of filtered river water traced with Cs^{137} instead of the 13,600 gallons reported. The flow rate through this column averaged 6.5 gal/ft^2/min during nine days of operation this month. The decontamination factor for cesium achieved through this 50-gram column decreased from greater than 500 to about 100 after five days of operation. The total throughput of the column at the end of the period was 29,000 column volumes.

A study was made of the removal of cesium from diluted synthetic Purex 1WW waste by clinoptilolite. The solutions were prepared with C.P. chemicals and neutralized to pH 12 with commercial grade caustic; supernatant liquids from this system were decanted and diluted with tap water to produce test solutions containing 75, 50, 25, 10 and 1.0 volume per cent synthetic waste. The removal of cesium from each of these solutions by clinoptilolite was measured. The capacity of clinoptilolite for cesium from these solutions was found to be considerably less than that obtained from solutions of the same concentration of sodium nitrate. The reason for the reduction is not immediately evident.

The CR In-Farm Scavenging Facility (271-CR and 241-C-60 Buildings) was rented to CET by CPD for studying mineral bed decontamination of condensate streams. The buildings are presently being renovated; occupancy will be in early October. Scope designs of equipment and modifications to the facilities are being prepared.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

The importance of river channels incised into the Ringold formation below water table levels is again emphasized by the detection of a strong flow of thermally hot, radioactive water existing beneath the 181-B Building. Ground water sample data obtained in 1951 during construction of the 181-C addition to the 181-B Building disclosed that reactor effluent was even then moving into the 181-C site from the vicinity of the leaking 107 basins. This local westward flow of water occurs in a now roughly defined east-west trending channel filled with highly permeable fluviatile gravels. The travel time of the ground water from the line or basin leak to the 181-B Building is estimated to be about one week, based on decay curve comparisons. The distance, a minimum of 1400 feet, thus requires a rate of movement of about 200 feet per day, a figure compatible with rate of flow data elsewhere in similar sediments. The ground water is evidently further channelled beneath the building foundations and could endanger them. The water, losing little heat in its path, is pumped into the reactor coolant stream and reduces reactor efficiency.

Research to study unsaturated flow phenomena has long been hampered by the lack of a suitable instrument for measuring the moisture content of soils in place in the field or in laboratory models. These measurements must be obtained

rapidly and must give the average moisture content of a small enough soil volume to be equivalent to a point measurement on the experimental scale used. A commercial soil moisture measuring instrument utilizing a neutron probe was found to be most satisfactory with regard to speed of response. However, the probe measures the average moisture content of a one to two-foot sphere of soil which is too large a volume for laboratory-scale experiments. An equation was developed to convert a soil profile survey with such an instrument to the true moisture content profile reflecting point values. Tests of this technique will be made to establish its applicability to unsaturated flow models in the laboratory.

Soil Chemistry and Geochemistry

The removal of radiocesium from solution by columns of clinoptilolite is reduced by increased flow rate, temperature, and grain size. The effects of these variables are not completely independent. At 25 C a C/C_o value of 0.1 was obtained after passage of 33 column volumes at a flow rate of 72 gal/ft^2/hr., while this C/C_o was achieved after passage of 16 column volumes at a flow rate of 208 gal/ft^2/hr. On the other hand at 60 C these two flow rates produced a $C/C_o = 0.1$ breakthrough after the passage of 24 and 20 column volumes, respectively. These experiments were performed with 0.25 - 1.0 mm clinoptilolite and solutions containing 1.0 M sodium and 0.01 M cesium at a pH of 3.0. The capacity of clinoptilolite columns for cesium is reduced for grain sizes larger than 0.25-1.0 mm. In this size range the mineral has a capacity of about 73 meq. Cs^+/100g. from 0.01 M cesium solutions containing 1.0 M sodium. The capacity is reduced to about 60 meq. Cs^+/100 g for 1.0 to 2.0 mm material and to 8.1 meq. Cs^+/100g for 2.0 to 4.0 mm material.

Samples of synthetic zeolites were studied to determine their selectivity for adsorbing strontium from solution. The samples obtained for this purpose were those having a structure believed to be most suitable for selectively adsorbing ions of the diameter of hydrated strontium. Linde-4A zeolite was found to have the greatest Sr^{+2} selectivity of those tested. The pelletized form of this material was found to have a greatly reduced capacity compared to the powdered zeolite. It was found possible to prepare a bed of the material from 4A powder cemented with sodium silicate which permitted adequate throughput rates. The removal of strontium from a 0.01 N solution is not appreciably affected by the presence of sodium in concentrations up to 0.1 N. At higher sodium concentrations the rate of removal of strontium decreases but the capacity of the zeolite for strontium appears to remain unchanged.

Studies were continued to investigate the physicochemical properties of cerium in solutions contacting soils. The formation of cerous hydroxide colloids was studied by observing the movement of radiocerium through dialysis membranes at various pH values. It was found that the physical state of 4.2×10^{-7} M cerium is probably all ionic at pH less than 2.0. Some colloid formation was indicated by experiments with pH 4.0 and pH 7.8 solutions. Experiments at pH 11.4 indicated nearly complete colloid formation.

Soil column studies were made of the possible movement of radiocolloids of cerium through the soil. A calcareous subsoil typical of the Hanford region was used. Solutions of 4.2×10^{-7} M cerium at pH 2.0 gave no breakthrough after passage of

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147 column volumes. A similar experiment with the influent adjusted to pH 7.8 resulted in an effluent concentration about 10 per cent of that in the influent. For an influent pH of 11.4 the soil column did not appreciably remove radiocerium from solution. The cerium movement is ascribed to peptized radiocolloids moving through the soil pores.

Equilibrium experiments demonstrated that 10^{-3} M sodium and cesium had little effect on the soil adsorption of cerium in the low pH range. This tends to indicate that the marked difference these accompanying ions displayed in influencing the behavior of cerium in the alkaline range is probably related to their relative ability to disperse colloids and not to any real chemical differences in their ion exchange reactions.

Ground Waste Investigations

The flow of Sr^{85}-traced calcium nitrate solution into the small (6-inch x 6-inch) experimental crib was continued, about 1500 gallons having been discharged by month's end. Samples of ground water from nearby wells revealed the breakthrough of nitrate ion. At 800 gallons addition to the crib one well contained nitrate ion at about half the influent concentration. Later results indicated that nitrate ion breakthrough may be nearing 100 per cent in this well at 1200 gallons discharge. The well showing most rapid appearance of nitrate ion does not bottom directly beneath the crib, indicating some lateral movement of the solution before it reaches the ground water. Rather erratic sample results for the other six wells near the test crib do not indicate a nitrate ion breakthrough exceeding 10 per cent of the influent concentration.

The uniform, fine-grained soil used for laboratory investigations of soil column variables was separated into six fractions according to grain size and each fraction studied. It was hoped that information concerning an apparent strontium removal reaction other than ion exchange would be obtained. The standard exchange capacity (ammonium acetate method) and the strontium equilibrium distribution coefficient (K_d) for each of these fractions was determined. It is evident from the data that the standard cation exchange capacities of the fractions do not accurately reflect their ability to remove strontium from solution. Further work is planned to determine if the anomaly is associated with the carbonate fraction of the soil.

Field Apparatus Development

Porous weighing thimbles for direct measurement of soil moisture in models were further studied to determine the effect of thimble screen opening size. In equilibrium studies the moisture content of soil in the thimble nearly duplicated the soil body moisture when the screen pore size was increased to 0.006-inch. The method holds promise for soil moisture measurements in certain laboratory experiments. The rate of approach to equilibrium must be checked against rate in the body of soil.

The possible use of radio waves as a tool for measuring moisture in soil was tested in a preliminary way. Soil containing 18 per cent moisture by volume in

a shielded box placed in the path of 12 cm radio waves showed marked absorption of the wave energy. Transmission was about 1 per cent of that through dry soil of the same thickness (4-inches). Extensive development in equipment is indicated before the method can be effectively evaluated. Initial experiments were promising.

A neutron-gamma probe and related instruments for moisture measurement in soil surrounding a well were received and tested. Moisture in soil determined with this equipment agreed well with direct laboratory measurement. Calibration for the conditions of use is expected to permit accurate moisture measurements in the field.

Preparation was made for forthcoming well pumping tests in the hydrology test site north of Gable Mountain. Careful measurement of ground water contours permitted more advantageous placing of two wells of the pattern. Equipment was prepared and scheduling worked out for the tests.

Two reports were issued, "An In-Well Permeability Packer," HW-62048, and a "Test of Refraction Seismic System on the Hanford Project," HW-61796.

Micromeritics

An experimental set-up was readied for measurement of particle deposition velocities in tubes and the parameters affecting retention on sampling lines. An elutriator for obtaining narrow size ranges of particles was assembled.

Two reports were issued, "Filtering Abrasive-Wheel Uranium Cuttings," HW-61917, and "Trip Report, Atmospheric and Source Sampling, USPHS Training Institute."

Analytical, Bioassay and Counting Methods

A coincidence summing gamma spectrometer was assembled and tested which should prove useful for qualitative and sometimes quantitative analysis of mixtures of radioisotopes. In this apparatus information is stored in the multi-channel analyzer only when photon interactions occur simultaneously in the two detector heads. Except for some backscatter of a small fraction of the gamma rays, this arrangement allows only those radioisotopes which emit two or more photons per disintegration to be counted. By comparing a sum coincidence spectrum with a normal gamma spectrum on the same mixture identification and measurement of the radioisotopes would be facilitated.

A bioassay procedure for the determination of Pu^{241} was developed which utilizes liquid scintillation counting. This procedure is applied subsequent to the standard Pu^{239} bioassay procedure and thus provides measurement of the two plutonium isotopes on the same sample.

Chemical Dosimetry

Blue aqueous solutions of erioglaucine turn yellow upon the addition of acid indicating an alteration in the chemical form of the dye molecules. The acid

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association constant of this system was determined as a function of ionic strength in order to more fully interpret the radiation chemistry of these solutions and to obtain a protection index for the acid form of erioglaucine which could be used to evaluate indices of acidic protective agents. A tentative model for the structural changes occurring in going from the blue form to the yellow form was proposed for which the calculated acid association constant agrees well with the measured value.

L. P. Bupp
Manager,
Chemical Research & Development

LP Bupp:bp

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ORGANIZATION AND PERSONNEL

W. H. Bierschenk, Engineer I, terminated to accept employment elsewhere.

R. L. Braun, Jr. Scientist, completed his temporary assignment.

D. J. Brown, Engineer I - L, was granted a three-month leave of absence to go to school.

C. R. Cooley, Engineer I, was transferred to Chemical Processing Department.

J. L. Daniel, Sr. Scientist - L, terminated to return to school.

G. R. Fowles, Sr. Scientist, completed his temporary assignment.

H. Freund, Sr. Scientist, completed his temporary assignment.

W. Y. Matsumoto, Chemist I, terminated to return to school.

W. Meyer, Engineer I, completed his temporary assignment.

J. E. Poelman, Chemist II - L, terminated to accept employment elsewhere.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
Pierre Cohen C. Gailledreau	9/1/	French AEC Saclay, France	Discuss Waste Disposal.	LP Bupp DW Pearce CE Linderoth JF Honstead JL Nelson GJ Alkire JM Nielsen BM Johnson RT Alleman	No
B. Weidenbaum J. Cleveland	9/1/	APED San Jose, Cal.	Discuss UO_2-PuO_2	WH Reas EE Voiland AS Wilson	No

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
R. J. McNamee A. D. Ryon	9/1-2/	Oak Ridge National Lab. Oak Ridge, Tennessee	Solvent Extraction Technology, work on NPF-Redox & review of work on organic-wet cartridges for Purex systems.	AM Platt RJ Sloat GJ Alkire	No
G. Kligfield J. Koslov	9/2/	Vitro Corporation New York, New York	Discuss NPF reprocessing technology.	OF Hill RJ Sloat AM Platt RE Burns	No
R. O. Hill J. H. Rushton J. Jones	9/2-4/	Air Reduction Sales Murray Hill, N.J. Martin Company Baltimore, Md.	Discuss separation of radioisotopes, waste handling & fission product recovery.	WH Reas RL Moore GJ Alkire J Dunn AM Platt RJ Sloat RW Wirta	No
H. O. Paxson	9/3/	TEMPO Santa Barbara, Calif.	Special isotope separation.	LP Bupp	No
G. Salzano D. Duda	9/10/	Vitro Corporation New York, New York	Discuss NPF.	RJ Sloat VP Kelly VL Hammond	No
R. P. Wischow	9/14-15/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss fission product recovery and waste composition.	RL Moore RE Burns	Yes
J. Downing	9/16/	Division of International Affairs Washington, D.C.	Automation of extraction discussed.	AM Platt RD Dierks NP Wilburn	No

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
B. Galliger	9/18/	Bohna Company San Francisco, Calif.	Discuss 325-A Building waste storage vault.	RJ Sloat	No
W. Schwinker	9/21/	Silicon Products Waterford, N.Y.	Personnel placement.	OF Hill	No
H. Suter P. N. Burkard W. George J. Schneider D. H. Tule	9/22/	Wyandotte Chemicals Corp. Wyandotte, Michigan	Discuss decontamination of reactors.	RE Burns JE Mendel	No
G. Sherrad, Jr.	9/23/	Bird Centrifuge Co. South Walpole, Mass.	Discuss centrifuge studies for NPF centrifuge.	RJ Sloat LC Amos RE Burns	No
L. A. Dietz J. C. Sheffield	9/23/	Knolls Atomic Power Lab. Schenectady, N.Y.	Discuss mass spectrometry.	HJ Anderson EB Street	No
P. F. Thomason W. D. Shults	9/24-25/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss Pu and Np analyses by controlled potential coulometry.	RJ Brouns FA Scott RW Stromatt	Yes
M. W. Sims H. W. Gouldthorpe	9/29/	Engineering Services New York, New York	Engineering Services activities.	LP Bupp	No
E. E. Jukkola	9/30/	Dow Chemical Company Rocky Flats, Boulder, Colorado	Ion-Exchange.	AM Platt GA Nicholson HL Brandt	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. W. Schulz	9/2/	Argonne National Lab. Lemont, Illinois	Pyrochemical processing discussions.	S Lawroski	Yes
	9/3-4/	Oak Ridge National Lab. Oak Ridge, Tennessee	Non-Production Fuels Reprocessing.	R Blanco	Yes
J. R. Morrey	9/1-4/	Gordon Research Conf. Meridan, N. H.	Attend Conference.		No
	9/5/	University of New York New York, New York	Discuss fused salts and spectrophotometric problems.	Prof. Sundhein	No
J. L. Ryan E. J. Wheelwright	9/4-11/	Gatlinburg Ion Exchange Conference Gatlinburg, Tennessee	Attend Conference Present Paper		No
O. F. Hill	9/9-10/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss NPFR program and Eurochemic exchange	FL Culler EM Shank	Yes
	9/11/	Division of International Affairs - AEC Washington, D.C.	" "	FP Baranowski EE Sinclair	Yes
G. J. Alkire	9/13-16/	ACS National Meeting Atlantic City, N.J.	Present Paper		No
	9/17-18/	Brown Instrument Co. Philadelphia, Pa.	Discuss process control computers & instrumentation.	JW O'Hara	No
		Fischer & Porter, Co. Philadelphia, Pa.	Flow devices and instruments.		No
H. G. Rieck	9/14-18/	ACS National Meeting Atlantic City, N.J.	Present Paper		No
C. E. Huck	9/21-25/	GE Lamp & Glass Div. Cleveland, Ohio	Discuss developments in glass & plastic luminous panels and applications to alpha particle counting.	FJ Shonebarger	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. L. Burger	9/14-15/	ACS National Meeting Atlantic City, N.J.	Attend Meeting		No
	9/21/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss organic phosphorus compounds.	WH Baldwin	Yes
	9/22/	Argonne National Lab. Lemont, Illinois	Discuss solvent extraction.	JM Ferraro	Yes
J. M. Skarpelos	9/24/	Manufacturers Mineral Co. Seattle, Washington	Discuss crushing and screening of clinoptilolite.	FM Adderson	No
L. P. Bupp	9/24-25/	TEMPO Santa Barbara, Calif.	Technical programmatic discussions.	HO Paxson	No
W. L. Lyon	9/24-25/	Argonne National Lab. Lemont, Illinois	Discuss pyro-zinc processing.	H. Feder	Yes
	9/28-30/	AIChE National Meeting St. Paul, Minnesota	Attend Meeting		No
F. P. Brauer	9/28-30/	AEC Washington, D.C.	Attend Steering Committee Meeting on Washington Designated Programs.	D. R. Miller	No
J. M. Nielsen	9/30/	Argonne National Lab. Lemont, Illinois	Discuss low-level counting techniques.	DL Horrocks	No
U. L. Upson	9/30/	Wilson-Sprow Co. Spokane, Washington	Inspect equipment.	H. Wilson	No

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

L. A. Temple, Biological Scientist, was transferred from Pharmacology to Biological Analyses on September 1.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

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

Location	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
Prosser Barricade	2×10^{-4}	5×10^{-4}	+ 2
Wahluke Slope	2×10^{-4}	8×10^{-4}	+ 3
4 Miles SW of Redox	1×10^{-4}	2×10^{-4}	- 2

Columbia River Contamination

Concentrations of gross beta emitters in Columbia River organisms collected at Hanford were approximately one-third of those observed one year ago. Values of indicator organisms follow:

Sample Type	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
Minnows (entire)	1×10^{-2}	1×10^{-2}	-

Preliminary tests were initiated to evaluate the rate of mutation of columnaris to drug resistance. An initial experiment showed only a slight increase in mutation rate to distrycin-resistance forms by 10 Kr of X-rays.

A strain of C. columnaris isolated from the Columbia in the Hanford locale appeared to be more virulent for trout than Dr. Ordal's hot strain No. 1. Ordal's strain No. 1 was less effective in killing trout than in killing salmon. The locally derived strain has not been tested for virulence in salmon due to non-availability of fingerling salmon.

Fallout Contamination

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

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

Effect of Reactor Effluent on Aquatic Organisms

Routine monitoring of effluent from the 100-KE reactor was continued. Mortality was greater among the young trout held in 3 per cent strength effluent than among the controls while results at the 2 per cent level were not consistent. Most of the mortality experienced during the month was attributed to "columnaris" disease.

A test was started in which two groups of juvenile suckers are exposed to 3 per cent strength effluent under simulated natural conditions. In one case the effluent is passed through a bed of aluminum turnings with the hope that this will result in reduced contamination in the fish.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Phosphorus

A test was started to determine the effect of deposited P^{32} on the viability of sex products of a species of tropical fish. The cichlids are being reared in water containing 1×10^{-4} μc/ml, 5×10^{-4} μc/ml, or 2×10^{-3} μc/ml until they reach maturity. Survival of eggs and young will be determined.

Zinc

Preliminary results from studies to determine the transfer of Zn^{65} across the placenta indicate no unusual deposition in the fetus. In one case about 50 per cent of zinc retained by the mother during a five-day feeding period was present in the fetuses. In another case in which Zn^{65} feeding was continued for 5 days, about 15 per cent was present in the fetuses.

Gonad Dose

Studies continued applying daily oral feeding of Zn^{65} to a ram for a period of 15 days. Tissue dosages measurements taken at autopsy on the 16th day showed the relative tissue dosages based on a body burden of 60 μc were: gastrointestinal tract - 100; liver - 75; kidney - 50; and testes - 30 mr/hr.

The measurements indicate that the gonads may be a critical organ for Zn^{65}. It was noted that the dose to the gonads from the radionuclide deposited in the rest of the body was nearly twice the dose originating from the Zn^{65} in the gonads.

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Strontium

Cinebar and Ephrata soils were surface contaminated with Sr^{90} in solution. After drying the surfaces were treated with $NH_4H_2PO_4$ at levels up to 2,000 lbs P/acre. No reduction of Sr^{90} uptake was noted in plants grown on the acid Cinebar soil. There was, however, a 2 to 4-fold reduction of uptake from the Ephrata soil. This suggests that treatment of this sort may be effective on calcareous soils while liming is effective in reducing Sr^{90} uptake from acid soil.

A test was terminated in which yearling rainbow trout received intramuscular injections of Sr^{90}-Y^{90} for seventeen weeks. The highest level was 1.5×10^{-2} $\mu c/g$ of fish twice each week. At necropsy none of the fish showed any gross pathology. There was considerable variation in the size of the fish in the high level group, however.

No clinical changes have been detected in any of the miniature swine fed 25 μc Sr^{90}/day for over 6 months.

Iodine

Two new groups of weaned lambs from the 0.5 and 0.15 μc/day groups were started on the same I^{131} regimen as the dams. Additional numbers of animals in these two groups were considered necessary with the finding of tumors at the 1.5 μc/day level.

Again this year a single oral tracer dose of 5 μc I^{131} was given to ewes that received a single 3 mc dose of I^{131} following weaning two years ago. This is done to determine the degree of thyroid damage in these animals being kept for their lifetime to determine if thyroid tumors will develop following an acute dose as it does following an equivalent total dose in a chronic feeding regimen. The average uptake was 15 per cent (range 6 to 25%) and is similar to the 17 per cent (range 5 to 25%) observed in these same animals last year. At weaning a 50 per cent uptake was observed in these same animals.

I^{131} Decontamination from Plants

Radish, lettuce, and geranium leaves exposed to the products of a melted fuel element were washed for 5 minutes with shaking in 40 ml of a variety of solutions. Distilled water, "tris", NaI, $Na_2S_2O_3$, dilute NH_4OH, and dilute HCl each removed from 50 to 60% of the iodine from leaves. Alcohol, acetone, and the commercial detergent, Tide, removed from 70 to 80 per cent of the iodine. Coating the leaves with collodion and subsequently stripping the partially dried collodion removed 80 to 90 per cent of the I^{131}. The leaves were undamaged by this treatment.

From these data and related autoradiograms, it appears that much of the material is particulate. Previous studies using a gaseous atmosphere had shown nearly 50 per cent of the iodine penetrating inside leaves while the stripping data from this study indicates that probably no more than 10 per cent of the iodine penetrated to the inside of the leaf. Thus, under the conditions of this melt-down, it seems probable that minute particles of material were present in ample supply to permit the I^{131} gas to adsorb to these particles before settling out on the plant material approximately 100 meters from the point of melt-down.

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Cesium Studies

In studies of the transfer of Cs^{137} up the food chain, a 2.7 increase was demonstrated in the transfer from algae to tadpoles.

The final ratios of Cs^{137} concentrations in plants grown in soil containing field capacity, saturation and 2½" of standing water above the soil were 1, 30 and 450, respectively.

Plutonium

For 12 rats receiving 100 r X-ray per week, the median survival time was 179 days and the median X-ray dose at death was 2600 r. For 12 rats previously injected with 5 μc/kg Pu^{239}, the median survival time was 120 days and the median X-ray dose at death was 1800 r. The effect of age on acute plutonium toxicity was studied by administering 38 μc/kg Pu^{239} to groups of rats ranging in age from 100 to 400 days. While a few animals survived at 38 days, there is no significant effect of age on the survival time.

Attempts to measure the effectiveness of DTPA in removing plutonium from miniature swine continued. In order to check some untoward effects observed previously in swine administered single 14 g doses of a chemical grade of DTPA, an adult animal was given a similar dose of pharmaceutical DTPA. The animal failed to eat for about four days. Although the animal appeared lethargic it was apprehensive. It also manifested hindquarter weakness and humped-up appearance. By the tenth day (when he was sacrificed) he seemed almost fully recovered. At autopsy it showed a thickened gall bladder (observed on the 1st group of swine) and some fibrinous pericarditis, probably the result of the injection of some of the DTPA into the pericardial sac.

Dosage levels of DTPA utilized in limited studies in man (6 g given over a period of 5 days) were administered to two swine possessing established body burdens of Pu^{239}. No gross pathology was observed at autopsy on the 10th day.

The areas of pig skin previously injected with 0.2 N $Pu^{239}(NO_3)_4$ at levels up to 1 μc/site show some mild exfoliation. At least one-half of the Pu^{239} remaining in the injected site seems to be restricted to area one-half inch in diameter.

Radioactive Particles

Tissues from 5 dogs which died three to four months after deposition of about 100 μc $Pu^{239}O_2$ were assayed for Pu^{239} content. The concentration of Pu^{239} in the tracheobronchial lymph nodes was 1.5 to 6 times that in the lung of four of the dogs. In the other dog the concentration was three times greater in the lung.

Bronchiolar carcinomas were observed in two mice. One was killed 500 days after intratracheal administration of 5 μc $Ru^{106}O_2$ and the other was killed 500 days after inhalation of $Pu^{239}O_2$ and total deposition of 0.08 μc. The

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latter is the first malignant lung tumor we have observed after inhalation of radioactive particles. Histologic examination of tissues from other mice in the experiment is continuing.

Two experiments were completed with rats testing agents for increasing the pulmonary clearance of inhaled $Pu^{239}O_2$. Results are incomplete.

Gastrointestinal Radiation Injury

Experiments were performed utilizing I^{131} labelled polyvinylpyrrolidone to determine whether the loss of serum protein following irradiation is due to decreased production in the liver or to increased loss through the damaged intestine.

Microbiological Studies

Averages of several experiments show that respiratory deficient yeasts have a noticeable "oxygen effect" but one which is appreciably lower than observed in the parental non-respiratory deficient strain. This observation correlates with the previously reported lower catalase content of these RD strains. Tests for "after effect" constantly were negative for both RD and parental strains. Observations on the "oxygen effect" and "after effect" appear to correlate well with the known catalase content of the cells, with the presence of traces of catalase preventing any expression of after effect. Reduced catalase should cause the radiation damage to RD strains to be more comparable under aerobic and anaerobic conditions than in parental strains containing a full compliment of catalase, as was observed.

HA Kornberg

Manager
BIOLOGY OPERATION

HA Kornberg:es

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C. OFF-SITE VISITS AND TRIPS

NAME (VISITORS)	DATES OF VISITS	COMPANY OR ORGANIZATION REPRESENTED AND ADDRESS	REASON FOR VISIT	PERSONNEL CONTACTED	ACCESS TO RESTRICTED DATA	AREAS AND BUILDINGS VISITED
40 Veterinarians	9/1/59	AMVA Convention	Tour Biology	Bustad, Foster	No	100-F, 141, 146
Dr. Ensminger	9/1/59	WSU, Pullman, Wash.	Discuss research.	Kornberg, Bustad	No	100-F, 108, 141
Pierre Cohen and Claude Gailleredreau	9/1/59	French Atomic Energy Establishment, Saclay, France	Discuss radioactive waste disposal.	Biology Staff	No	100-F, Biology
L.D. Carlson, JL McCarthy, GW Farwell, RW Moulton, RW Hill, AH Whiteley, KB Bengston	9/21/59	U. of Wash. - HLO Liaison Committee	Discuss HLO programs and tour.	Kornberg	No	" "
100 Teachers	9/26/59	Richland & Kennewick High Schools.	Tour	Foster, Bustad	No	100-F, 141, 146
Dr. Zelle, HA Stanwood	9/29	AEC, Wash. DC	Tour facilities and discuss program.	Kornberg and staff.	No	100-F, Biol.
Dr. A. Hollaender	"	Oak Ridge, Tennessee	" " "	"	"	" "
Dr. Lister	9/30/59	British AERE	Tour.	Bustad, Kornberg	"	" "
TRIPS TO OTHER INSTALLATIONS						
RL Uhler and JE Stewart	8/17-9/8	Dugway, Utah	Participate in fuel element burn-down experiments.	AEC, USAF, Convair	No	-
RF Foster	9/16-18	Cincinnati, Ohio (USPHS)	Present lecture at Radiol. Health Training Course.	Palange	No	
LK Bustad	9/15-18	Washington, D.C.	ANP Committee Mtg. Bone marrow studies.	Maj. Barnes	No	
JJ Davis, WC Hanson, DG Watson, HE Erdman	9/10-22	Packwood, Quinault, Twin Lakes, Washington	Fallout sampling trip.	-	-	
MP Fujihara and RT O'Brien	9/11-13	Portland, Oregon	Attend Soc. of Am. Bacteriologists Mtg.	-	-	
F.P. Hungate	9/1-3	Coos Bay, Oregon	Lecture at Coos Bay Educational Conference	-	-	
RC Pendleton	9/3	Seattle, Wash. (University)	Identification of lichens, mosses.	Dr. Grace Howard	-	
LA George	9/10-11	Columbus, Ohio	Electron Microscope Mtg.	-	-	-
JR McKenney, (Capt. West & Capt. Persing)	9/11/59	Rad. Labs, Univ. of Washington, Seattle	Tour facilities.	Dr. Seymour	-	-

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D. Lectures

a. Papers presented at Meetings.

None

b. Off-Site Seminars

F. P. Hungate, 9/2/59, "Radiobiology at Hanford", Coos Bay Educational Conference, Coos Bay, Oregon.

R. F. Foster, 9/15-17, "Behavior of Radionuclides in Food Chains Fresh Water Studies," Radiological Health Training Course, USPHS, RA Taft Sanitary Engineering Center, Cincinnati, Ohio.

c. Biology Seminars

R. C. Thompson, 9/30-59, "Radioisotopes Absorption and Method of Elimination: Nutritional Considerations".

W. J. Bair, 9/30/59, "Radioisotope Toxicity from Pulmonary Absorption".

E. Publications

a. HW Publications (external distribution)

None

b. HW Publications (internal Distribution)

None

c. Open Literature

Kawin, B., "A portable radioactive solution container," Int. J. of Applied Radn. & Isotopes 5, 305 (1959).

Kawin, B., "Effects of stable calcium and strontium on deposition of Ca^{45} and Sr^{90} in bone", Experientia 15, 313 (1959).

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

September, 1959

ORGANIZATION AND PERSONNEL

Effective September 14, 1959, Kathryn S. Scott replaced Janice B. Kennedy as secretary to the Manager, Operations Research and Synthesis. Mrs. Kennedy resigned to devote herself completely to home responsibilities.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Programming work on the computer program has been completed and debugging is under way. Further work on this area is awaiting the completion of this program.

Other

Work was initiated on the preparation of the declassified version of the Operation Pool report.

OPERATIONS ANALYSIS STUDIES

Redox Dissolver Study

Work in this area continued to be delayed by the unavailability of a computer program. Some additional work was done on the editing of the available data and some preliminary information was obtained through a study of correlation matrices.

Z Plant Information Study

Work on the IBM-709 programming is continuing. A firm date for the delivery of the necessary A.P.R. equipment has not been received. If a firm date cannot be established soon, the entire program may be placed in jeopardy due to possible coincidence of the test with production changes.

FPD Process Control and Experimentation

Data were analysed from three pilot plant experiments designed to locate an optimum duplex bath temperature with respect to external and internal porosity. Canning conditions were varied between experiments in order to account for possible interaction effects.

Some further effects on the incidence of non-wets of various component cleaning treatments were evaluated.

An earlier report indicated that dimensional distortion during heat treatment of co-extruded tubes was a function of the reduction ratio employed in the process, although it was pointed out that failure to replicate could result

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in misleading conclusions. Additional data have suggested that the previously labelled reduction ratio effect may in fact be a wall thickness and/or clad thickness effect, these having been confounded in the original set of data. Further data are required to resolve this uncertainty.

Eight-inch sections of co-extruded tubes are to be given different quench treatments in order to evaluate the effects on dimensional changes of several quench variables. The variables involved are surface on which cooling is applied (3 levels), temperature of the quench (3 levels), and delay time before quenching (4 levels). Since not all 8" sections could be taken from the same tube, the resulting 3 x 3 x 4 factorial experiment was designed so that unimportant effects are confounded with the three blocks utilized.

Two-step quenching was compared with one-step quenching with respect to effects on braze porosity of normal production fuel elements as measured by visual ranking of radiograph results.

Production Tests

Warp data from several production tests have been summarized in order to obtain an up-to-date picture of the warp performance of current normal fuel elements.

Process Tube Leaks

One quantity entering into the leak severity index is "wetness," which is supposed to depict the amount of water from previous leaks which has affected a given tube. A definition of wetness had been hypothesized, but upon application it proved too cumbersome to use in practice. A revised definition was suggested and investigated. Results thus far indicate that this will be a workable definition, but no indication as to its success in obtaining better predictions of which tubes are potential leakers is available as yet.

Reactor Calculations

A rough draft report was issued in connection with this problem, and was circulated for comment prior to issuance of a final report. The major conclusion in this study was that the systematic uncertainties in the plutonium prediction equations are a limiting consideration.

Fuel Element Failures

Further work was done in evaluating possible courses of action with respect to adjusting reactor powers and exposures on the basis of rupture experience. It is evident that a thorough investigation of this problem area is desirable, and that computing machines will have to be utilized in order to adequately consider the problem.

Aluminum Corrosion

Four models are being evaluated with respect to their adequacy in describing reactor fuel element corrosion data. They are being compared on the basis of relative bias for different combinations of power and temperature, and on the magnitude of the residual variances.

Final Product Specifications

In connection with a meeting held at Los Alamos on September 22 and 23, a proposal for acceptance of final product parts on an individual basis was prepared. Also, up to date estimates of the various process and measurement parameters were found.

CPD Control

An investigation was made of the adequacy of the CPD referee analytical control program as prompted by criticisms of this program contained in routine survey reports issued by the AEC-HOO. It was determined that the amount of data arising from this program is adequate for accountability needs, and that analytical precision has little effect on throughput measurements which are predominately bias control problem areas. These ideas were discussed with AEC-HOO personnel, and agreement was reached on the adequacy of the program.

An analysis of data obtained in a sampling experiment conducted in the plutonium nitrate receipt measurement equipment (Hd 6-C) indicated that systematic sampling errors appear to be non-existent. Estimates of the random sampling and measurement errors were also found.

The results of a data analysis arising from segregated HLO oxide recoveries were used as a basis for SS Measurement's recommendation of a change in the factor used in transfer of this material between HLO and CPD Plutonium Recovery Operation.

Radiation Protection Studies

An analysis of data to investigate the effect of exposure angle on gamma film badge response was completed. The magnitude of the bias introduced by the angle of incidence effect was determined for the past and current methods of estimating density due to beta and gamma exposure, and improved equations which correct for the average effect were suggested. A report will be issued as soon as data from a recent repeat of the experiment have been analyzed.

The data analysis of the experiment to test validity of the inverse square law as it applies to radium gamma film badge calibration is still in progress.

A discussion was held with personnel of the Bio-Assay Operation concerning a proposed statistical study of spike analyses in order to estimate the precision and accuracy of bio-assay plutonium deposition estimates. Appropriate data are being collected and will subsequently be analyzed by Experimental Statistics personnel.

Systems Reliability

Work continued on a systems reliability study of the K reactors. Additional alternatives to the existing plant have been included in the digital computer program which has been written for the study.

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STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Zircaloy Corrosion

Corrosion and Coatings Operation recently initiated an experimental program to investigate the corrosion of various zirconium alloys as a function of several independent variables including etching time, storage time, autoclave time and surface stains. A pilot study was conducted to evaluate the characteristics of the experimental apparatus which will be used in the investigation. A statistical analysis of this study was recently completed which pinpointed several anomalies in the apparatus and also estimated the effect of storage time, autoclave time, and flow rate on one zirconium alloy. (Unclassified letter to H. P. Maffei, dated 9-25-59, "Corrosion Test of Zircaloy.")

4000 Program - Swelling Studies

Micrographs of pre- and post-anneal uranium samples, edge and center, were analyzed and void fraction and pore density estimates supplied along with pore growth trends. Functional representation of the pore radii distribution for any particular micrograph is being developed in order that the effects of different conditions on such distributions may be compared. Study continues of the effect of different etch times and other sample preparation variables by statistical techniques.

4000 Program - Fuel Element Studies

Mathematical investigations continued on methods and techniques available to obtain exact or approximate thermo-elastic solutions for various geometrically shaped reactor fuel elements. This is part of a continuing program of investigation suggested by Fuels Design Operation, HLO.

6000 Program - Biology and Medicine

Work continued on statistical analysis of excretion data from an experiment involving plutonium inhalation by dogs for Pharmacology Operation.

General

The mathematical equation, and hence the dimensional specifications, of a parabolic reflector having certain size and focal length restrictions was derived at the request of a member of the Optical Shop, HLO.

A mathematical method was devised to obtain the pointwise values of a desired function once its continuous running average over a fixed length interval is known. The method, based on the solution of a linear integral equation, has practical application in determining moisture content profiles in the soil from data taken by instruments which read average values over sizeable regions.

Analysis of data from tests to determine how accurately volumes of solution in a large process vessel could be measured was completed. A seminar on this subject was presented to interested personnel during the month. A complete report will be issued during October.

[redacted]

A statistical analysis was recently initiated to determine the relative precision and accuracy of several radiochemical isotopic analysis methods. Single channel analyzers are soon to be replaced by 256 multiple channel ones, and in an attempt to anticipate customer questions the relative characteristics of the two instruments are being evaluated. In connection with this analysis, an exact statistical technique was devised for testing the hypothesis that the two instruments have the same precision in the presence of appreciable sample variation.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

Assistance was requested in applying mathematical methods to the problem of procurement of zircaloy components for NPR fuel elements. The problem involved here is basically that of allocation of orders between vendors, although it also includes the question of when and how much to order to meet HAPO requirements.

Irradiation Processing Department

The first of a series of discussions was held with a member of Process Technology Operation, IPD, for the purpose of studying their concept of "net return," and to discover what implications to reactor operations are dictated by optimizing their mathematical expression for this variable.

A system of first order linear differential equations arising from a two phase flow problem was solved for personnel of Process Design Operation.

Chemical Processing Department

Continued mathematical assistance was provided on the problem of designing and manufacturing cams to control Gorton lathes during machining operations.

Construction Engineering and Utilities Operation

A program to test the applicability of the proposed method for evaluating fair cost estimates was agreed upon. Discussions were also held with respect to possible assistance in developing a more meaningful and factual billing system for services rendered by the General Stores and Excess Property Operation.

Relations Operation

Assistance was given in formulating methods for the analysis of psychological test score data and the evaluation of the reliability of a new test.

Carl A. Bennett
Manager
OPERATIONS RESEARCH & SYNTHESIS

CA BENNETT:kss

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
F. T. Hagemann	9-9-59	Argonne Nat'l Lab. Lemont, Ill	Wash. Desig. Pro.	C. A. Bennett J. L. Jaech W. L. Nicholson	Yes
P. M. Thompson	9-18-59	Market Res. Corp. of America. Chicago, Ill.	Consultation	C. A. Bennett R. C. Burke R. Y. Dean	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. L. Jaech	9-22,23	Los Alamos, N.M.	Consultation	R. K. Zeigler	Yes
D. F. Shepard	9-22,23	Los Alamos, N.M.	Consultation	R. K. Zeigler	Yes
C. A. Bennett	9-14,15,16	Vallecitos	Request for consultation	A. W. McKinney R. D. Bennett et al	No
C. A. Bennett	9-28	Div. of Research AEC-Washington	Consultation	Dr. S.G. English	Yes

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PROGRAMMING OPERATION
SEPTEMBER 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

Special Radioisotopes

Review was made of flow sheets and process chemistry of all U. S. uranium ore milling plants to determine which used processes favorable for the recovery of Th-230 (ionium) from wastes. Approximately one-half the domestic milling capacity was found to use appropriate processes. Several mills appear to use processes leading to especially high ionium content in waste streams. Preliminary analysis of samples received from one ore mill indicates that a rich source of ionium (50 ppm) exists, and in some quantity. However, firm results on the ratio of Th-230 to Th-232 in this sample are not yet in hand. Knowledge of this aspect is quite important since ionium mixed with gross quantities of natural thorium is not amenable to easy production of U-232 or Th-228.

Study was given to uses of the products resulting from irradiation of ionium other than as radioisotope heat sources. Thorium-228 was examined as a potential neutron source material when used in conjunction with beryllium. It is outstanding as a neutron producer. Milligram quantities of Th-228 are equivalent to gram quantities of radium, now widely used for neutron sources. Gram quantities of Th-228 will produce about 10^{10} neutrons per second. Used in this manner Th-228 may be competitive with low flux research reactors and may have wide industrial application.

A report summarizing work done to date on ionium is now being written.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Cycle Analysis

Computer Code Development. An additional group of about 20 Meleager cases were run to compare calculations with the results of single-channel experiments. Analysis of these comparisons is now under way.

The RBU code debugging was virtually completed, with a final trial run of the entire system scheduled for the end of the month. The existing system will be further improved and modified as times goes on, but is expected to be usable for some problems in the immediate future. Work is continuing on the basic library and the input and output routines, which will be essential parts of the code for general-purpose use but are not required for debugging and testing, nor for certain specially-prepared problems.

Analytical Studies. Work is continued on the generalized initial evaluation of self-sustaining plutonium recycle in uniformly enriched thermal reactors. As originally programmed for the IBM-650 and 702 computers, a total of 18 subroutine codes were involved in conjunction with some graphical methods used to compute the apparent value of plutonium to a reactor operation using self-sustaining plutonium recycle. With replacement of the IBM-650 and 702 at Hanford with an IBM-709, consolidation of the codes to fully exploit the larger memory and greater computer speed of the IBM-709 was undertaken and is now nearing completion. This consolidated system will print out answers corresponding to each set of input parameters without the graphical solutions and hand tabulation steps necessary with the IBM-650-702 machine method.

The steps to consolidate the IBM-650 and 702 codes relate to the four major computation sections employed to compute the value of plutonium for a given set of conditions. Consolidation for the IBM-709 has been essentially completed on procedures which compute the total fuel cost as a function of assigned plutonium price for a given uranium enrichment. This is done for the same reactor in two parts, for self-sustaining plutonium recycle without sale of plutonium on the one hand and for once-through operation and sale of plutonium on the other. Next, an IBM-709 routine is being prepared to determine the fuel enrichment at which this total fuel cost is a minimum for each mode. This results in equations which relate the total minimized fuel cost as a function of assigned plutonium price for self-sustaining plutonium recycle and for once-through operation. These equations are then solved simultaneously (by another routine) for the value of plutonium that yields the same fuel cost to the reactor operator for both fueling schemes. This value is defined as the value of plutonium to the reactor operator for the conditions examined. In the case of self-sustaining plutonium recycle, the lower the "market price" of plutonium, the lower is the fuel cost (because of reduced inventory charges) while for uranium once-through, the higher the market price of plutonium, the lower the fuel cost (because of plutonium sales credits). An operator of a reactor capable of self-sustained plutonium recycle encounters his highest fuel cost when the plutonium market price equals the value of plutonium to him. If its value is otherwise, it will be prudent to either buy or sell plutonium.

In addition to coding work, a production run was completed this month on the IBM-709 of the plutonium recycle cost determination part of the consolidated code, and as much work was done in 2-1/2 hours as could be accomplished in 200 hours on the IBM-650. In addition, no manual data handling was necessary which on the IBM-650 involved nine separate codes each requiring personal attention to approximately 25,000 punched cards for input and output data.

An improved method for comparing the relative worths of zirconium and stainless steel as fuel element jacketing materials was devised and application started. These studies are an extension of earlier work. A section of this study will serve a dual purpose in that it will be used to check thermal utilization factors computed by the recently developed Meleager code.

A standard compilation of composition and density specifications for alloys and engineering materials of interest in reactor analysis was started, for use in future physics investigations.

PRTR Plans and Schedules

A preliminary study was undertaken in cooperation with others to formulate a method which can be used for plutonium accountability during PRTR operation. The proposed method will employ a series of graphs showing plutonium content as a function of exposure. Data for the graphs will be produced by the Meleager code.

Detailed loading, unloading, and chemical processing schedules were developed for three alternate cases of PRTR operation, incorporating desirable changes in experimental schedules. The three cases examined had to do with operation using only high exposure plutonium available (a) from power reactor fuels, (b) from irradiation of depleted uranium at Hanford, and (c) from irradiation of plutonium-aluminum alloy fuel elements at Savannah River. Achievement of self-sustaining operation about 600 days earlier will result if extra high exposure plutonium is provided from either Hanford or Savannah River. Costs and scheduling information for all three cases was assembled. Gains to the program, over and above the earlier achievement of self-sustaining operation, were established and evaluated. These relate primarily to earlier practical fabricating experience with high exposure plutonium and to earlier aquisition of physics data applicable to the higher isotopes of plutonium.

PRTR Hazards Analysis. Calculations on the radiological consequences of an accident in the PRTR were completed.

C. BIOLOGY AND MEDICINE - 6000 PROGRAM

Radiological Consultation

An outline was prepared for a chapter in the forthcoming revision of Meteorology and Atomic Energy and was transmitted to the U. S. Weather Bureau's representative for comparison and compilation with other chapters. Consultation was also rendered on the NPR Containment System, an ASA Subcommittee report for Uranium Mines and Concentrators, a health and safety report prepared by Euratom, the Shielded Personnel Monitor, and the need for geological research.

Other studies comprised a review of NCRP Handbook 54. Comments received on the revised draft of Handbook 42 were also reviewed and are being incorporated into the text.

Counsel was also rendered to the Inhalation Hazards Subcommittee of the NAS-NRC Committee on the Pathological Effects of Atomic Energy.

A review of the research needs for setting maximum permissible limits was made in conjunction with various Hanford personnel. A draft of the conclusions was prepared.

A report of the Radiological Evaluation Task Force was prepared as a final draft with the exception of three appendices. This draft will be circulated to the members of the Task Force for final comment and revision as needed before final issuance.

D. OTHER ACTIVITIES

The final report on the 1959 Summer Institute on Nuclear Energy - Chemical Processing was completed, as was a summary of the appraisal of the course by the participants. This appraisal indicated that the 1959 program was highly satisfactory and that repeating the program next year would be appropriate.

A meeting tock place at Hanford on September 21 between the Hanford Laboratories University Relations Council and the University of Washington Hanford Liaison Committee. Hanford programs were described for the visitors. Research areas of mutual interest were discussed and it was agreed to develop a series of technical speaker exchanges in these areas. The immediate goal would be a better knowledge of the type and quality of research at the two institutions leading to mutually beneficial information exchanges. Eventually, exchange of researchers for fixed periods of time might be undertaken. The meeting ended with a tour of Hanford facilities.

Assistance was rendered in arranging for seven tours (involving 211 people) through HLO and HAPO facilities.

L H McEwen
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	Areas & Bldgs. Visited
E. J. Leshan J. R. Burr Mark Temme	9/19-25 9/1-30 9/1-30	Advanced Technology Laboratories Mountain View, California	Work on the RBU computer code.	J.R. Triplett	No	700, 713
L. D. Carlson J. L. McCarthy R. W. Moulton G. W. Farwell A. H. Whitelay E. H. Fischer	9/21/59	University of Washington Seattle, Wash.	Discuss research of mutual interest and inspect research and development facilities.	M. Lewis	No	700, 300, 100-F

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. W. Healy	9/1/59	General Electric Company Chicago, Illinois	Attend meeting of the GE Reactor Safeguards Council.	K.P. Cohen	No
L. H. McEwen	9/21-22	AEC, Division of Reactor Development Washington, D.C.	Consultation with the DRD on the Plutonium Recycle Program.	H.E. Vann	No

RADIATION PROTECTION OPERATION
MONTHLY REPORT -- SEPTEMBER 1959

A. ORGANIZATION AND PERSONNEL

P. E. Bramson (Technical Graduate) rotated to a new assignment on September 1, 1959. J. D. Forsythe was added to the rolls of EE & RO on September 21, 1959. One beneficial move was made within RPO during the month. J. F. Evans and L. L. McIntyre terminated on September 10 and September 25, respectively. The force of the Radiation Protection Operation totals 131.

B. ACTIVITIES

Three new plutonium deposition cases were confirmed during the month. All were less than five per cent (5%) of the maximum permissible body burden. There are 240 cases of plutonium deposition on record. The total number of deposition cases that have occurred at HAPO is 235 and 169 are currently employed.

An explosion occurred in the plutonium oxide hood in cell 5, 231 Building. A section of the top of the hood was displaced and rubber hood gloves were ruptured by the reaction. No injuries occurred to nearby employees. Four people who were in the room at the time received minor amounts of plutonium contamination on their clothing and/or person. Decontamination of these employees was successful. Internal deposition of plutonium in these employees appeared to be unlikely.

A dose rate of 500 r/hr above the 327 Building sump trap was measured after two irradiated UO_2 samples were inadvertently sucked into the trap during routine cleanup operations. The samples were removed remotely with a maximum dose rate of 4 r/hr at 16 feet.

Another allegedly radioactive 55-gallon drum which was discovered in the Bay off Tacoma, Washington was delivered to HAPO for inspection and analysis. Preliminary surveys indicated no radioactive materials were involved.

Measurements of radioisotopes in vegetation showed expected variations. The concentration of I^{131} was $< 1.5 \times 10^{-6}$ μc/gm in all of the 27 zones sampled. Fission products other than I^{131} showed an average of 2.2×10^{-5} μc/gm from the separations areas, project, Eastern Washington, and Franklin County Irrigation District; all other locations were $< 1.0 \times 10^{-5}$ μc/gm. In all vegetation samples $Ce^{141-144}$ was found at an average of 1.0×10^{-5} μc/gm, except the South-Central Washington and Northern Oregon and Zone AA sample groups which averaged $< 5.0 \times 10^{-6}$ μc/gm. Zr^{95}-Nb^{95} results averaged 3.9×10^{-6} μc/gm from the separations areas, project, South-Central Washington and Northern Oregon, and Franklin County Irrigation District; all other vegetation sample groups averaged $< 2.0 \times 10^{-6}$ μc/gm.

Fallout, as measured by disintegrations per cubic meter, collected on air filters at local and distant points have been consistently below background (1.0 $d/m/m^3$) for the past two months.

A minor emission of radioactive particulates occurred at the Redox plant late in the month. The emission was confined primarily to the immediate ground area. Stack filters indicated 90 per cent Ru^{103} and small amounts of iodine, zirconium, and antimony.

Measurements with larger ionization chambers and with the scintillation counter of the dose rate in the Columbia River upstream from the plant did not verify suspected gradual increases indicated by routine pulse pencil measurements. Changes in the program measurement techniques were made to improve the quality of the results.

A schedule was initiated for quarterly cross-section surveys of the Columbia River using the scintillation counter to determine the most effective sampling points in each cross section. Use of the scintillation counter in conjunction with cross-section river water samples will provide data on optimum sampling points with about half of the cross-section samples previously required.

A vacuum-operated system for raising and lowering the radium source for film calibration was installed in the 3745 Building. Tests showed the "fail-safe" device was very satisfactory for time and position controls. The auto-rotation feature of the source eliminated a minor effect from source asymmetry encountered with previous methods. The accuracy of the one-half curie sources and their respective calibration wells was checked with an R-meter recently calibrated at the National Bureau of Standards. Both calibration wells were found to be within plus or minus three per cent ($\pm$ 3%). Seven new CP meters were received from the vendor. These were purchased on the PRTR project. Acceptance tests were satisfactory and the instruments were placed in the operating pool.

Laboratory tests continued on the small volume bioassay sampling procedure. Correspondence was received from the duPont Savannah River Plant on their new procedure for plutonium bioassay analyses and its possible application at HAPO.

Ninety-nine people were counted on the whole-body counter during the month. Data processing programming of the counter analyzer data was essentially completed. The tape unit for the analyzer was ordered for 60-day delivery. The data will be hand punched until the tape punch equipment is installed. Full application of data processing methods and equipment should eventually permit the counting of about 14 people per day.

A test using a phantom, sodium-chloride solution, and personal items such as coins and keys confirmed that a delivered dose of about 4 rads of fast neutrons (about 2 Mev.) was sufficient to cause a GM reading of about 400 c/m from the Na^{24} in the blood. The use of a GM meter for gross survey is currently specified as a quick-sort method for detecting high-level neutron exposures in the event of a criticality accident.

A comprehensive study of plutonium contaminated injuries at HAPO was initiated. All available information on each incident has been collected and is being analyzed.

Preliminary revisions were made in the 3705 Building for installation of the automatic film processing equipment. Complete shutdown of the south darkroom and installation of the equipment was scheduled for October.

C. EMPLOYEE RELATIONS

There was one medical treatment injury for an estimated frequency of 0.48. No security violations occurred during the month.

One suggestion was received for evaluation. Two suggestion evaluations were made during the month. One suggestion pertaining to improved calibration techniques was adopted and recommended for award consideration. There were no outstanding suggestions at month end. No awards were made.

Several Radiation Protection Operation employees toured the PRTR during the month.

Radiological training included: two lectures for 300 Area personnel on radiological aspects of Hanford processing; radiation protection considerations for contractor personnel--presented to Facilities Engineering Operation; four orientation discussions were presented to Plutonium Metallurgy and Biology Research employees; discussions and a tour for 17 radiation monitors on the whole-body counter; attendance by two radiation monitors at the PRTR training course.

D. SIGNIFICANT REPORTS

HW-61801 "Radiological Protective Apparel Approved for HAPO Application" by T. C. Mehas.

HW-61743 "Rubber Ring Dosimeter Calibration with the Plutonium Spectrum" by F. Swanberg, Jr. and B. V. Andersen.

HW-62123 "Monthly Report - September 1959, Radiation Monitoring Operation" by A. J. Stevens.

HW-61826 "Analysis of Radiological Data for the Month of August, 1959" by R. L. Junkins.

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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. G. V. Beard Dr. John Norcross	9/24 - 25/59	Office of Health and Safety U.S.A.E.C., Washington, D.C.	Discuss various phases of radiation protection	A.R. Keene and staff	Yes	3746, 325, 329:300
Dr. B.A.J. Lister	9/29/59	United Kingdom Atomic Energy Authority, Harwell, ENGLAND	Discuss and observe radiation protection methods and procedures.	A.R. Keene and Staff	No	3705,3746 3745, 329 325:300 747:700
J. B. Owen	9/28 - 10/2/59	Dow Chemical Company Rocky Flats Plant Denver, Colorado	Discuss mutual problems concerning radiation protection.	A.R. Keene E.C. Watson	Yes	3746:300

VISITS TO OTHER INSTALLATIONS

N O N E

ENVIRONMENTAL MONITORING - RESULTS (August 24, 1959 - September 27, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	1.2	% MPC_{GI}	--
Separations Areas	Gross Beta	8.0×10^{-8}	µc/cc	-2
Pasco	Isotopic	0.4	% MPC_{GI}	+2
Kennewick	Isotopic	0.1	% MPC_{GI}	-2
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	5.0×10^{-9}	µc/cc	-3
100-F Area	Isotopic	2.9	% MPC_{GI}	--
Hanford Ferry	Gross Beta	3.7×10^{-5}	µc/cc	--
Pasco	Isotopic	0.9	% MPC_{GI}	--
McNary Dam	Gross Beta	8.1×10^{-7}	µc/cc	--
Vancouver, Washington	Gross Beta	2.4×10^{-7}	µc/cc	--
Ground Water				
Outlying Test Wells	Gross Beta	No Sample	µc/cc	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	1.0	mrad/day	--
Environs	Gamma	0.6	mrad/day	--
I-131 Separations Areas	I-131	1.8×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	2.4	curies/week	--
Active Particles - Project	--	1.6	ptle/100 m^3	-2
Active Particles - Environs	--	0.6	ptle/100 m^3	-3
Vegetation				
Separations	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Residential	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	µc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	1.2×10^{-5}	µc/gm	--

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

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

1242226

EXPOSURE EVALUATION AND RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
September	0	0
1959 to Date	7	8

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
September	21,220	114	8	3
1959 to Date	233,743	900	43	13

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)
September	10,431	890	83	21	45	7.85	11.29
1959 to Date	96,956	7,660	751	168	384	6.74	15.85

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
September	1,745	0	0	0	9
1959 to Date	11,307	19	2	0	62
Fast Neutron					
September	458	10	1	0	9
1959 to Date	1,265	21	14	0	60

Bioassay

		September	1959 to Date
Plutonium:	Samples Assayed	789	6,818
	Results above 2.2×10^{-8} μc/sample	45	332
Fission Products:	Samples Assayed	805	6,742
	Results above 3.1×10^{-5} μc FP/sample	2	32
Uranium:	Samples Assayed	222	2,418
Confirmed Plutonium Deposition Cases		3	11*

*This brings the total number of plutonium deposition cases which have occurred at Hanford to 235.

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	52	5.6	35	15	2.6	39
Hanford Laboratories	29	6.7	22	43	6.9	19
Chemical Processing	27	6.8	56	36	4.3	49
Chemical Processing*	-	-	-	-	-	-
Special Incidents	-	-	-	-	-	-
Random	1.5	1.2	2	-	-	-

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

Thyroid Checks	September	1959 to Date
Checks Taken	0	0
Checks Above Detection Limit	0	0
Hand Checks		
Checks Taken - Alpha	31,632	316,574
- Beta-gamma	41,211	273,659
Skin Contamination		
Plutonium	23	206
Fission Products	37	357
Uranium	10	100

CALIBRATION

	Number of Units Calibrated September	1959 to Date
Portable Instruments		
CP Meter	1,030	8,701
Juno	328	2,732
GM	1,499	12,514
Other	226	1,830
Total	3,083	25,777
Personnel Meters		
Badge Film	1,524	8,359
Pencils	1,463	10,502
Other	407	3,708
Total	3,394	22,569
Miscellaneous Special Services	527	3,745
Total Number of Calibrations	7,004	52,091

AR Keene

Manager
Radiation Protection

AR Keene:kc

1242228

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - SEPTEMBER, 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 4.08 which is considered about average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 15,444 hours. This includes 12,802 hours performed in the Technical Shops, 995 assigned to Minor Construction, 188 hours to other project shops, and 1,459 hours to off-site vendors. The total shop backlog is 30,568 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 5.6% (1090 hours) of the total available hours.

Distribution of time was as follows:

	Man-Hours	% of Total
Fuels Preparation Department	2347	15.2
Irradiation Processing Department	2187	14.2
Chemical Processing Department	368	2.4
Hanford Laboratories Operation	9951	64.4
Construction Engineering & Utilities	483	3.1
Miscellaneous	108	.7

Promotional opportunities were offered to and accepted by a Shop Estimator who transferred to the Inspection Operation, CE&U and by an Instrument Maker who was upgraded to the Shop Estimator position. Two open requisitions are on file, one for a Machinist to replace the man upgraded and one for a Glass Technician to replace a man who is resigning in October.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with 13 medical treatment injuries.

RADIOGRAPHIC TESTING OPERATION

The index of activity for the Radiographic Testing Operation was 185 for September. This figure can be compared to the index for August of 131 and the all-time average of 209. Productivity appears more near normal and it is believed will steady down in the vicinity of the average.

1242229

A total of 3,407 tests were made, of which 835 were radiographic (including x-ray and gamma-ray) and 2,572 were supplementary tests. Out of a total of 1,885 man-hours, 557 (29.6%) were used in connection with radiographic tests, and 1,328 (70.4%) were used on supplementary tests. The supplementary test work included: autoclave, borescope, dimensional measurements, eddy current, penetrant (O.D. and I.D.), pickling, surface treatment (alkaline cleaning and vapor blasting), and ultrasonic (flaw detection and thickness measurements).

The number of pieces handled this month totaled 3,207 items. The feet of material represented by the foregoing amounted to 31,830 feet. Increased efficiency permits handling both more pieces and testing more footage.

Successful pickling and autoclaving of the PRTR process tubes was demonstrated on September 11th. A satisfactory tube surface, inside and out, was produced which was reproducible and full-scale treatment of the process tubes was started. A two-day cycle was established, which has been maintained except for three days. During this period, 44 tubes have been pickled and autoclaved. Of this number, 11 tubes have proven acceptable as meeting all requirements. An additional 9 have a very slight amount of staining associated with the pickling process. Further evaluation will likely show these to be acceptable also. 5 tubes have a doubtful appearance and will require reworking. Finally, 14 tubes are out of straightness specification and will require straightening.

An unexpected development in the autoclaving process was excessive distortion or warping of the tube after treatment. Tests made to date point to two contributing factors: unequal stress distribution in the tube arising from tube fabrication, and distortion of the autoclave giving unequal support to the tube at temperature. Some success has been achieved in minimizing the bow first and for correcting afterwards by autoclaving with the tube preferentially oriented in the autoclave.

To maintain continuity of testing of the zircaloy sheath tubes, three engineering assistants were obtained on loan from Materials Development Operation for a two-month period. This additional help will assure meeting the testing needs of Ceramic Fuel Element personnel.

Testing Statistics

Component	No.of Tests	Ft.of Weld or Material	No. of Pieces	Description
CE&U	579	300	150	PRTR Calandria; radiograph weld neck flanges on PRTR; prototype test fac.(Phase II); x-ray weld qualifications coupon for PRTR Proj.; radiographic liaison,PRTR.
				Ultrasonic TK meas. on 13 vacuum TKs on oil circuit breakers.

Testing Statistics (Cont'd.)

Component	No.of Tests	Ft. of Weld or Material	No. of Pieces	Description
CPD	98	91	36	H.S. Column T-H3 x-ray long girth seams on shell box & boot pipe welds; radiograph welds on fabrication of vessel concentrator tube bundle; x-ray S.S. Jumper.
FPD	8	1	1	Radiograph steel clad fuel element for weld integrity.
HLO	2,681	31,397	2,979	9/16" O.D. x 8' long, zr-2 clad, UO_2 fuel rods; .505" O.D. x 30" long Al-Pu Co - extruded rods; radiograph NaK samples; radiograph Thorium - NaK Capsules 5-1/2" x 1/2" O.D.; 3rd Palm fab.program; zirconium PRTR tubes; .680" I.D. x .035" wall x 7' long, zr-2 tubes; fluorescent penetrant test 13 valve seats.
IPD	41	41	41	Fluorescent penetrant test pigtails from rear face of F-Reactor.
Totals	3,407	31,830	3,207	

FACILITIES ENGINEERING OPERATION

Projects

There were 22 authorized projects at month s end with total authorized funds of $8,470,600. The total estimated cost of these projects is $9,611,600. The following new project was authorized during the month - CAH-870, Facilities for Recovery of Radioactive Cerium, 325 Building - $350,000. The following projects were completed during the month - IR-243, Relocation of 200-E Testing Equipment, and IR-247, Normal Electrical Service - Experimental Animal Farm, 100-F Area. The following projects were returned from AEC without action due to shortage of funds - CGH-832, Full Scale Physical Constants Testing Reactor, and CGH-859, 327 Building Modifications. The following project is awaiting AEC approval - CGH-860, Access for PRTR Fuel Elements. No proposals for new projects were submitted to AEC during the month.

The attached project report details the status of individual projects.

1242231

Engineering Services

Title	Status
Isolate Crane Conductors, 314 Bldg.	Installation work is approximately 80% complete.
326 Building Retention Waste Sump Modifications	Field work in progress.
Temperature Control for Fish Troughs Biology Operation	Field work complete.
Additional Lab Hoods & Air Exhaust Modifications	Existing hoods will be installed. Exhaust fan on order.
Graphite Storage Building	Work essentially complete.
Glycol Heat Exchangers - 325-A Bldg.	Design complete. Exchangers and valves on order.
Improve Process Ventilation, Labs 204 & 206 - 3706 Building	Field work in progress.
Hood Ventilation in 183-KE Building	Field work essentially complete.
Increased 440 volt Electrical Service - 325 Building Basement	Work complete.
Alterations to Door Mechanism Shielded Personnel Monitoring Cell 747-A Building	Design is complete.
Compressed Air System, 231-Z Building	Existing compressor relocated. New unit on order.
Air Conditioning Room 4 141-H Bldg.	Design complete. Procurement in progress.
Fuel Extraction Facility for PRTR	Design complete.
Ventilation - 314 Building	Engineering proposal complete.
Electrical Modifications - Room 24-A 326 Building	Engineering proposal complete. A work determination is in progress.

Drafting & Design Services

Design and drafting work in progress includes the following:

1. PRTR prototype loop - "As-Built" - 314 Building.
2. Test set-up design - fuel, fuel and foil holders, and graphite - 305-B Building.
3. Fuel Rod filling machine - machine delivers specified amount of oxide to each tube during compacting process.
4. Ceramic Fuels Development work - miscellaneous designs as required.
5. Maniplulator Model II "As-Builts".
6. Control rod redesign for experimental control rod in MTR.
7. Remote operated dissolver and gas sampler. Complete with encapsulating equipment, 327 Building.
8. Calandria revisions during fabrication - PRTR.
9. Shielded mechanical properties testing facility - 326 Building.
10. In addition, miscellaneous small design drafting orders are in progress.
11. Non-destructive testing equipment modifications.
12. PRTR Process tube ram and cutter.
13. Door operator - shielded personnel monitoring cell - 747 Building.

Work is being performed on layout and details of projects CGH-834 - Modifications and Additions to High Pressure Loop - 189-D Building, and CGH-838, Fission Product Volatilization Studies Test Facility - 292-T Building.

Maintenance & Building Engineering - Landlord Functions

Costs - August - $100,607 July - $81,810

Fiscal year 1960 expenditures total $182,417 which is 11.6% of budget. Expenditure forecast was 11.7% of budget.

Analysis of Costs - Utilities costs were higher than anticipated. This is to be expected since the process utility demands of HLO components occupying non-HLO space is quite difficult to predict. Maintenance costs were low reflecting a lull in unusual maintenance.

Unusual Maintenance

Item	August Cost	FYTD
H&V correction	$ 989	$ 1,819
Relocation & alteration	199	490
Move furniture	64	237
Miscellaneous		181
Paint		392
	$ 1,252	$ 3,119

The annual physical inventory of uninstalled capital equipment assigned to the landlord was conducted, and all 215 items were accounted for.

The #2 exhaust fan in 329 Building was damaged when the corroded inlet cone was drawn into the impeller. The repair is estimated at $1,200. The cone material was coated with acid resistant paint. Apparently the flow of chemical fumes had eroded the coating and exposed the metal to attack. Stainless steel cones are being used for replacement.

Painting of the 328 shop roof interior has been contracted to Tri-State Painting Company of Portland for $5,300.

Miscellaneous

Approximately 180 drawings including sketches, work sheets, and form drawings were completed during the month by Drafting.

Approximately 15,900 square feet of prints were reproduced during the month.

The total estimated value of the 12 requisitions issued during the month was $53,000. Material procurement and control is being performed by HLO projects and plant operation.

TECHNICAL INFORMATION OPERATION

The Supervisor, Document Accountability, attended a meeting called by AEC Security to get agreement on a method of handling documents intended for the Bovay Company. Documents intended for Bovay will be routed directly to Bovay. The method of handling will be the same as that used for charging documents to HOO Responsibility Stations.

The procedures for the preparation, marking and control of documents containing Atomic Weapon Data are still not complete. Two basic technical problems -- what specifically constitutes Atomic Weapon Data at Hanford, and what Sigma categories apply to Hanford's activities. The OPG on Atomic Weapon Data has been completely re-written to take care of procedural problems but the technical problems will have to await a revision of the "Guide to Atomic Weapon Data at Hanford".

New criteria were received for the classification of Hanford separations process information. In general, all information on the Redox, Purex and UO_3 processes, except that which would disclose production information or product specifications, is now unclassified. In addition, the non-production and non-military reactor fuel separations process technology, processing rates and costs, and Research and Development are unclassified providing classified production information is not disclosed. The new criteria will be distributed to the field for immediate use. Suitable topics will then be prepared for inclusion in the Hanford Classification Guide.

The first report pertaining to waste disposal sent to HOO Information Division for review was released.

A new AEC Manual Chapter on the "dissemination of published and unpublished unclassified AEC technical information to foreign nations" has been received. The number of foreign requests continues steady. During September requests were received from England, Norway, Canada, India, West Germany, and East Germany.

There was a sizable backlog (18) of unfinished Research and Development reports in Technical Publications at month's end. A former employee of the group, now working in Chemical Research Operation, will work alternate Saturdays to help out. It remains to be seen whether this will be sufficient, but the situation is a considerable improvement over that at the end of August.

A records disposal schedule has been worked up by Records Management to accompany the HAPO microfilming proposal (which includes Technical Information's plans to microfilm its document holdings) to Washington. Under the schedule, reports may be destroyed as soon as a suitable microfilm copy has been made. The microfilm copy will be retained indefinitely. The primary benefits of the program to Technical Information are improved operating efficiency in the use of current and active records.

The Manager, Technical Information, attended a meeting in Washington of the Steering Committee of the AEC's Technical Information Panel. The meeting was primarily concerned with (1) setting up the agenda for the regular Panel meeting in November, (2) reviewing the Commission's program for machine retrieval of information, (3) revising the by-laws of the Panel and, (4) evaluating the effect on Commission and Contractor information programs of some major policy changes in the categorization and distribution of documents via the Standard Distribution Lists.

Work Volume Statistics

	August	September
Document Distribution and Files		
Documents routed and discharged (copies)	16,882	16,205
Documents issued (copies)	9,748	12,044
Documents sent offsite (copies)	3,934	3,492
Document reserves filled (copies)	636	916
Documents picked up and delivered	19,968	19,273
Document Accountability		
Holders of classified documents whose files were inventoried	305	461
Documents inventoried in Files (copies)	11,479	16,669
Documents destroyed or retired (copies)	3,359	1,167
Documents revised (copies)	1,109	1,188
Documents pulled and documents filed (copies)	10,451	11,017
Documents reclassified	262	234
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	208,972	209,011

1242235

	August	September
Reference and Publication		
Books cataloged (new titles)	247	219
Books added to the collection (volumes)	469	358
Ready reference questions answered by professional staff	159	137
Literature searches by professional staff	101	109
Reports abstracted (titles)	240	267
Formal reports prepared (titles)	12	10
Offsite requests for HAPO reports (copies)	217	328
Reports released to CAP (titles)	23	15
Library Acqusitions and Circulation		
Books ordered (volumes)	264	276
Periodicals ordered	81	93
Books circulated (volumes)	1,204	1,737
Periodicals circulated (issues)	2,824	2,752
Inter-Library loans	72	78
Films borrowed or rented	23	25
Industrial film showings	37	43
Bound periodicals added to the collection		217

Library Collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No.of books	27,547	8,250	1,483	1,980	39,260
No.of bound periodicals	12,576	1	1,431	96	14,104
	41,123	8,251	2,914	7,076	53,364

Classification and Declassification

	August	September
Documents, including drawings and photographs reviewed for downgrading or declassification	9	32
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	26	87
Documents submitted to Declassification Branch, Oak Ridge	5	13

Manager
LABORATORY AUXILIARIES

1242236

JL Boyd:jw

BUDGET CLASSIFICATION Improvements To Production & Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory	$1,000,000	$1,000,000	100	17	5-22-58	--	2-24-59
			3-23-59	100	25	6-4-59	6-30-60	6-30-60

USING COMPONENT: Physics & Instruments R&D

FEO ENGINEER: D. S. Jackson

REMARKS: Rejection of several pipe fittings and pipe and tube lengths for failure to pass corrosion tests have hampered the contractor's fabrication of stainless steel tanks. However, sufficient steel and fittings were available to fabricate the three tanks that will be installed beneath the reactor building floor and below the crib pump pit. The possibility of providing corrosion passed fittings and pipe, to replace the rejected items, from AEC stocks was investigated. The vendor (Gunderson Brothers, Portland, Oregon), however, feels that the handling charges assessed by the Commission for this material are excessive. The crib hold-up tank, two reactor dump tanks, and the steel portion of the large shielding doors and its accessories were delivered to the job site on 9-25-59. The contractor has placed most of the reinforcing steel for the reactor room floor and is completing installation of all lines and conduit imbedded in the floor preparatory to pouring concrete in the first half of October. The concrete floor slabs were poured in the equipment and change rooms of the service

USING COMPONENT

FEO ENGINEER

REMARKS:

CG-731 (Continued)

building. The steel roof trusses for this building were received and installed permitting the contractor to proceed with the mechanical and electrical work in those rooms. The steel roof decking has been delayed and will not be received until the end of October. This will delay interior plastering. Interior framing and roofing were nearly completed on the control building. Electrical and mechanical work progressed without delay. All ductwork and electrical conduit have been installed. The windows were installed and the roof insulation is nearing completion. Half of the ceiling and some of the walls were covered with gypsum board.

CA-744	Metallurgical Development Facility - 306 Building	$2,650,000	$2,685,000	100	11* 12**14***	6-15-58	--	9-1-59
			11-5-58	100	11* 12**16***	3-30-59	9-1-60	9-1-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. T. Lloyd

REMARKS:

Foundations below grade are complete, fire wall construction is 30% complete. Concrete for southeast portion of building above grade is 80% complete. Structural steel for erection was started September 24. Procurement is progressing satisfactorily. Chemical processing facility design is complete. A bid package for its construction is in preparation.

* Overall project.
** Contractor's portion
*** CPFF's portion

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE or Actual COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CA-749	High Level Radiochemistry Facility		$960,000	100	100*	6-15-58	--	11-21-58
		$960,000	10-3-58	100	99*	8-14-58	1-1-60	10-30-59
		USING COMPONENT: Chemical R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS: The contractor, B.D. Bohna & Co., will complete his work by 10-5-59. His completion date is 10-2-59. The following work was completed this month: 1) Floor hardener and expansion joint seal applied, 2) Cell plugs inspected and installed, 3) Pressure and operational testing of piping services completed, 4) Vertical rising door mechanisms installed and tested, 5) Monorails tested and accepted, 6) H&V controls completed and tested, 7) Main breaker installed after repair of shipping cells inside and out, and painting of building interior continuing until end of month, 11) Electrical wiring completed except for intercom system and receipt of all parts for emergency circuit breaker which should be installed by 10-3-59, 12) Contractor is one month in default of schedule and installation of GE procured equipment cannot start until he is finished.

* FP schedule, total schedule 87% complete.

CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building		$345,000	100	90	6-23-58	- - -	12-31-58
		$350,000	4-23-59	100	73	10-94-58	2-1-60	2-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

No change on status of materials held up by steel strike. Work is progressing slowly on structural steel of column line 1. Major portion of the conduit in the new addition has been installed by the Lump Sum Contractor. Drain line has been completed by the CPFF Contractor.

CGH-819	Increased Laboratory Waste Facilities - 300 Area		$30,000	100	0	3-30-59	- - -	9-1-59
		$300,000	11-24-58	100	0	11-1-59	- - -	12-30-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

Original design is complete, however the cost is prohibitive. A more economical approach has been proposed and agreed upon by the customer. A project proposal for construction funds based on the new approach will be prepared.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CAH-827	Automatic Columbia River Monitoring Station	$39,000	$39,000	100	0	4-3-59	- - -	6-18-59*
			6-30-59	100	0	11-1-59	12-31-59	2-1-60
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS:

Construction is still delayed until completion of backfilling operations at the PRTR river pump structure. Routing of the alarm circuit between the monitoring station and the 300-L badgehouse was reviewed with Electrical Utilities Operation representatives during the month.

* A-E only.

CAH-828	Central Storage Facility - 300 Area	$40,000	$40,000	N.S.	25	4-2-59	- - -	6-8-59
			7-30-59	100	23	7-15-59	12-31-59	10-29-59*
		USING COMPONENT: Finance				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The contractor has requested a 14 extension of time on his contract because of time lost due to the recent work stoppage. The metal building has arrived on site; erection is expected to start October 5, 1959. The loading dock and one half of the floor slab are scheduled for pouring October 1, 1959.

* Based on a 14 day extension of the contract.

CGH-829	Building 325 Basement Improvements	$70,000	$70,000	N.S.	87	2-13-59	- - -	8-11-59
			2-13-59	100	81	3-2-59	12-31-59	12-31-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The low bidder, Raymond Britton, was awarded the contract for exit stairs and mezzanine partitions. Low bid was $6,330; the J. A. Jones Company fair cost estimate was $6,518. Work on this contract is estimated to be 45% complete. Stabilization of the banks on each side of the truck access door has been started by J. A. Jones.

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012

MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CAH-837	Animal Pens, Isolation and Examination Facilities	$77,000	$80,000	100	85	3-30-59	- - -	6-5-59
			3-17-59	100	80	7-10-59	4-1-60	11-15-59
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

Partitions with doors and trim are complete, roofing has been mopped, steam and water lines installed and tested. Painting has been started. Other work will probably be stopped due to no delivery of tile and glazed block. The contractor has requested that the minor construction work of making a new door opening and installing new door and frame in the present concrete wall be postponed until later.

CGH-840	Sheet Metal Shop Addition - 328 Building	$40,000	$40,000	N.S.	70	6-22-59	- - -	9-1-59
			6-18-59	100	41	6-25-59	5-1-60	12-1-59
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: J. J. Peterson		

REMARKS:

The concrete floor slab has been completed. Structural steel is complete. Wood roof deck, substituted for metal deck in order to complete the job, is complete. Electrical work consisting of lights, convenience outlets, bus duct, transformer, lighting panel and main switch is essentially complete.

CAH-848	Geological and Hydrological Wells - FY 1959	$56,600	$56,600	N.S.	30	5-12-59	- - -	7-6-59
			6-24-59	100	34	7-16-59	5-31-60	3-30-60
		USING COMPONENT: Chemical R & D				FEO ENGINEER: H. E. Ralph		

REMARKS:

Ten of the sixteen new wells have been developed, plus four existing wells redeveloped. There has been 1,050 feet of new hole completed. Three drilling rigs are in operation.

BUDGET CLASSIFICATION

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
IR-243	Relocation of the 200-E Testing Equipment	$18,000	$18,000	100	100	3-12-59	- - -	5-22-59
			3-11-59	100	100	3-16-59	4-22-59	9-15-59
		USING COMPONENT: Laboratory Auxiliaries				FEO ENGINEER: H. Radow		

REMARKS:

The heating plant has been installed and the job is now complete.

IR-246	Alterations to the Positive Ion Accelerator Facility - 3745-B Facility	$19,000	$19,000	N.S.	100	4-21-59	- - -	5-1-59
			4-20-59	100	96	5-7-59	10-20-59	10-20-59
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Work has been completed except for minor cleanup. A Physical Completion Notice is being prepared.

IR-247	Normal Electrical Service - Experimental Animal Farm - 100-F	$12,500	$12,500	N.S.	100	4-22-59	- - -	5-12-59
			4-28-59	100	100	6-5-59	9-28-59	9-28-59
		USING COMPONENT: Biology				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The work is complete except for tie-in of the 2.4 K.V. normal feeder to the Experimental Animal Farm. It is expected that this tie-in will be made by 10-15-59. The project will be closed out with exceptions.

1242241

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	$120,000	$120,000	100	100	3-2-59	- - -	5-15-59
			5-25-59	100	100	3-10-59	- - -	10-15-59*

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: H. Radow

REMARKS:

A few startup items have not yet been completed.

* Includes startup exceptions.

General Plant Projects - FY 1960

CGH-860	Access for PRTR Fuel Elements - 327 Building	$81,000	None	0	0	½ *	- - -	3 *
			None	0	0	2½ *	- - -	10 *

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The directive has not yet been received.

* Months after authorization.

CAH-864	Shielded Animal Monitoring Station - 100-F	$46,000	$46,000	0	0	N.S.	- - -	12-1-59
			8-6-59	0	0	N.S.	4-1-60	4-1-60

USING COMPONENT: Biology

FEO ENGINEER: J. T. Lloyd

REMARKS:

The AEC was given a general scope of the work, in early September as per their request, with which they were to select the type of Architect-Engineer. General Electric Company has not been advised that an Architect-Engineer has been selected. General Electric Design was given a request on August 21, 1959 for a design scope for the Architect-Engineer. This work was temporarily stopped by design because of higher priority design work, but is again in progress. The sodium crystal was requisitioned by FEO on September 9, 1959.

UNCLASSIFIED

BUDGET CLASSIFICATION: General Plant Projects - FY 1960

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH 874	Consolidation of Plutonium Metallurgy Facilities	$285,000	None / None	0 / 0	0 / 0	- - - / - - -	- - - / - - -	- - - / - - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The project proposal was submitted to Contract Accounting on September 17, 1959.

Improvements to Production and Supporting Facilities - 60-a-1

CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None / - - -	- - - / - - -	- - - / - - -	- - - / - - -	- - - / - - -	- - - / - - -
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The project proposal requesting $30,000 preliminary design money was returned by the AEC and deferred until the next fiscal year. It will be dropped from this report after this month until it becomes active again.

CGH-859	327 Building Modifications	$350,000	None / - - -	- - - / - - -	- - - / - - -	- - - / - - -	- - - / - - -	- - - / - - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

This project proposal has been returned without action, with the recommendation that it be resubmitted at a later date should funds become available.

1242243

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62932
MONTH September, 1959

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 60-a-1

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CAH-870	Facilities for Recovery of Radioactive Cerium - 325 Building	$450,000	$35,000 *	9-2-59	5	5	0	0	9-18-59	N.S.	-	-	2-15-60	9-1-60

USING COMPONENT: Chemical R & D

FEO ENGINEER: R. W. Dascenzo

REMARKS:

Work Authority Number CAH-870(1) dated September 17, 1959 authorized $4,000 to General Electric Company for technical direction of the Architect-Engineer and performance of related management services. On September 17, 1959 B. D. Bohna & Company, San Francisco, California entered into a contract with the AEC for Title I, II and partial III work. Preliminary design has been started, and the work is being done in San Francisco.

* Directive authorization.

Equipment Not Included in Construction Projects - Program Class 2900

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CG-661	Additional Heat Generation Facility - 189-D Building	$500,000	$664,000	9-18-57	100	100	100	99	12-6-56	12-3-58	- - -	8-31-59	10-15-58	4-30-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: J. J. Peterson

REMARKS:

This project is complete with exceptions. The exceptions concern the equipment supplied by the General Electric Company. This equipment meets all requirements of our purchase specification except a requirement for power decrease. A representative of General Electric Company, Spokane Apparatus Division is on site working on this problem. A revision to the project proposal requiring an extension of time will be required to correct inadequacies such as; overshooting or hunting of power during fast shutdown and excessive ripple of output voltage in order to meet research and development needs.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,140,000	4-1-59	100	100	98	98	9-17-56	4-1-58	- - -	3-1-60	7-17-59	3-1-60

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The 3 x 3 modifications are complete, the tie-ins have been made and shakedown is underway. If instrumentation operates as planned with only a minimum of corrections, testing will start the week of October 12, 1959. The reworked heat exchanger has been received and installed.

UNCLASSIFIED

AM-7300-019 (5-58)

1242244

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62007

MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000 / 12-8-58	75 / 75	0 / 0	1-5-59 / N.S.	- - - / 12-31-60	12-8-59 / 12-31-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

Some procurement delay has been encountered with the placement of instrumentation orders in the clarification of certain items during the Commission's "Review of Purchase" activity. Design of the capsule removal facility is progressing favorably and specifications for the hoist, monorail, etc., have been issued.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$10,000 / 6-7-58	40 / 40	0 / 0	6-10-58 / 2-15-60	- - - / - - -	12-2-59 / 5-15-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The project proposal submitted to the AEC on November 19, 1958 for total project funds was approved by the AEC Review Board on August 27, 1959; to date a directive has not been issued.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / DESIGN ACTUAL	CONST. SCHED. / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED or Actual COMP. DATE DESIGN / CONST.
CGH-805	High Temperature Tensile Testing Cell - 327 Building	$170,000	$150,000 / 2-25-59	100 / 100	0 / 0	8-26-58 / 2-1-60	- - - / 3-31-60	6-15-59 / 5-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

Purchase orders on the lead glass viewing window and manipulator are continuing, but a stop order was placed on the cell assembly at the request of the using component. As a stop was requested on all procurement for this project, purchase orders were not placed on the quotations received for the special plugs, cell plugs and viewing plugs. Washington Iron and Steel Company cannot now meet their required delivery date of December 1, 1959 and the project will not meet its directive completion date. In addition, Washington Iron and Steel Company will have to be recompensed for the money spent to date on this purchase order. Total project funds will be exceeded if the project is continued. After review of the using component budgetary funds, future plans for this project will be formulated.

1242245

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62[illegible]
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building	$700,000	$700,000	46	20 *	4-20-59	- - -	2-9-60
			4-8-59	48	20	4-22-59	10-15-60	10-15-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: H. Radow		

REMARKS:

Progress on the off-site fabricated pre-heaters has been held up because of lack of material for the shells. We have located stainless steel plate that could be furnished to the vendor for rolling and liaison is checking him, as well as other possible fabricators, with regard to the feasibility of utilizing this material. The heat exchanger order has been placed and this vendor is also being checked relative to the status of his raw material and what effect the steel strike will have.

* Per revised construction schedule approved by the Commission.

CGH-838	Fission Product Volatilization Studies Test Facility - 292-T Building	$75,000	$75,000	100	90	4-9-59	- - -	9-15-59
			3-26-59	100	75	4-16-59	11-30-59	11-30-59
		USING COMPONENT: Chemical R & D				FEO ENGINEER: O. M. Lyso		

REMARKS:

Fabrication of the junior cave sample train is complete. Setting up of the radiological shielding is planned to start October 2, 1959. Equipment fabrication for the shielded enclosure is nearing completion. The induction heating equipment and manipulators have been shipped.

CGH-857	Physical and Mechanical Properties Testing Cell - 327 Building	$400,000	None	0	0	1 *	- - -	14 *
			None	0	0	- - -	- - -	- - -
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The HOO-AEC Review Board approved a project proposal requesting design funds in the amount of $75,000 on August 27, 1959, but to date a directive has not been issued.

* Months after authorization.

AM-7300-019 (5-58)

UNCLASSIFIED

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 62012
MONTH September, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED or Actual COMP. DATE DESIGN	ESTIMATED or Actual COMP. DATE CONST.
CGH-858	High Level Utility Cell - 327 Building	$500,000	None	None	0	0	0	0	1*	- - -	- - -	- - -	12 *	- - -
		USING COMPONENT: Reactor & Fuels R & D							FED ENGINEER: R. W. Dascenzo					

REMARKS:

The HOO-AEC Review Board approved the project proposal, requesting design funds in the amount of $70,000, on August 27, 1959, but to date a directive has not been issued.

* Months after authorization.

CGH-866	Shielded Analytical Laboratory - 325 Building	$480,000	$10,000	8-12-59	2	2	0	0	9-5-59 *	- - -	- - -	- - -	11-15-59 *	- - -
		USING COMPONENT: Chemical R & D							FED ENGINEER: R. W. Dascenzo					

REMARKS:

Preliminary design was initiated this month.

* For preliminary design only.

		USING COMPONENT							FED ENGINEER				

REMARKS:

AM-7300-019 (5-58)

UNCLASSIFIED

1242247

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
E. D. Arndt	9-9-59	B.D. Bohna & Co. San Francisco, Calif.	Discuss project CAH-870	R.W. Dascenao	No	300, 325-A
Harold Hovland	9-14-59	Industrial X-Ray Co. Seattle, Wash.	To review film and x-ray technique with G.E.	R.B. Socky	No	300, 328 & C-25 White Bluffs
Kingsley Vannier	9-14-59	"	"	"	No	"
Sheldon Dunning	9-30-59	Sheldon Dunning Co. Seattle, Washington	Discuss project CAH-870	J.L. Boyd	No	300, 325-A

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. G. Stevenson	9-25-59	Technical Information Service USAEC Washington, D.C.	Attend meeting of the Steering Committee of the AEC's Technical Information Panel	M.S. Day H.D. Young R.K. Wakerling F.L. Cuthbert D. Puleston	Yes

1242248

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION MONTHLY REPORT

GENERAL

As of September 30th the staff of the Hanford Laboratories totalled 1302 employees, including 629 exempt and 673 nonexempt. There were 546 employees possessing technical degrees, including 335 B.S., 112 M.S. and 99 Ph.D.

COMMUNICATIONS

The Specialist, Communications attended a two-day meeting of Atomic Products Division public information representatives in Richland during the month.

TRAINING

The fifth Program of the Information and Orientation Series was completed during September.

EMPLOYEE COMPENSATION

After the September 15th offer of participation in the Savings & Security Program, HLO percent of participation increased from 86.8 to 92.4.

Negotiations were conducted with the Relations Operation Employee Compensation to establish new nonexempt and exempt positions and re-evaluate two exempt positions.

HEALTH AND SAFETY

The medical treatment frequency for September was 2.05 as compared with 1.63 last month.

There were two security violations during September, bringing the total for the year to date to 33 as compared with 36 last year.

Two Government vehicles assigned to Hanford Laboratories were involved in incidents causing $82.00 total damages. No injuries were experienced.

There were two serious accidents during the month, one involving a glove box explosion and resulting in no injuries. The other incident resulted in a smashed finger. The seriousness of this injury will not be known immediately.

PROFESSIONAL PLACEMENT

Ph.D. recruiting activity was very limited during the month with only three visits by candidates. Plans for recruiting of Ph.D.'s during the coming year were firmed up on a Company-wide basis with campus visitations to be conducted during October and November.

All arrangements were completed for EAPO participation in the Company-wide recruitment of BS/MS graduates. In addition, 17 experienced candidates visited for interviews during September and eight acceptances were received.

PROFESSIONAL PLACEMENT (Contd.)

Three Technical Graduates were added to the Training Program rolls during September and three were placed on permanent assignments. With the termination of all temporary summer employees, the total force on the Training Programs on September 30th was 83.

EMPLOYMENT

Twenty-two requisitions for nonexempt employees were filled. With the receipt of 26 new requisitions and two cancellations, there were 31 openings at month's end for which ten candidates were in process and 16 transfers pending, leaving five candidates yet to be procured.

One Serviceman was removed from the HLO payroll due to lack of work. He was later employed by the City of Richland.

Manager,
Professional Placement
and Relations Practices

TG Marshall:tr

1242250

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company Represented	Reason for Visit	Personnel Contacted	Access Res.Data	Areas Bldg. Vis.
W.C. Schwenker	9/24 9/25	Silicone Products Department, Waterford, N.Y.	Interview candidates for an open position	EP Galbraith	No	300-3702
H.W. Gouldthorpe M.W. Sims	9/29 9/30	Engineering Services, Schenectady	Engineering education and training	EP Galbraith TG Marshall PF Gast FW Albaugh LP Bupp LH McEwen	No	300-325

VISITS TO OTHER INSTALLATIONS

R.H. Scott	9/21 9/22	National Lead Ohio, Fernald, Ohio	To study methods of converting uranium scrap to oxide and to evaluate HLO plans for an oxide converter	JH Noyes HM Beers Charles Hopkins Henry Eberle	No	

TABLE II NONEXEMPT EMPLOYMENT

NonExempt Employment Status	Aug.	Sept.
Requisitions		
At end of month	29	31
Cancelled	4	2
Received	29	26
Filled	31	22
Candidates Considered		
Applications	72	65

NonExempt Transfer Request	Aug.	Sept.
Transfers		
Active cases at end of Mo.	85	83
Cancelled	0	4
New	3	4
Transfers effected	5	2

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A. Technical Recruiting Activity - HAPO - September 1, 1959 to Date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers*: Extended	Accepted	Open	On the Roll
Ph.D.	121	41	3	23	3	-	1	2
Exp. BS/MS	76	22	17	-	19	8	9	8
Prog. BS/MS	18	-	-	-	3	2	1	2

*Offer totals include offers open on 9/1/59
Ph.D. 3
Exp. BS/MS 6

B. Technical Recruiting Activity - HLO - September 1, 1959 to Date

	Cases Considered	Visits to Richland: Invited	Visited	To Visit	Offers**: Extended	Accepted	Open	On the Roll
Ph.D.	121	41	3	23	3	-	1	2
Exp. BS/MS	57	11	8	-	3	-	1	1

**Offer totals include offers open on 9/1/59
Ph.D. 3
Exp. BS/MS 3

In addition to the above activity, 2 exempt employees have transferred into HLO from other HAPO departments and 1 technical graduates have accepted off-Program placement in HLO to date.

1242253

C - Technical Graduate and Technician Training Program
Month ending September 30, 1959

	TG Program	TT Program
Number Personnel on assignment	75	8
(HAPO Tech Grad Program.....67		
(West. District E. P..... 8		
Distribution of assignments by Depts.		
HLO	28	5
CE&UO	1	0
FPD	7	0
IPD	32	3
CPD	7	0
Distribution of assignments by function		
R&D or Engineering	52	8
Other	23	

FINANCIAL OPERATION MONTHLY REPORT
SEPTEMBER 1959

Personnel

There were no personnel changes during September.

Activities

GENERAL ACCOUNTING OPERATION

A proposed revision of Article VI of Appendix "B" of Contract AT(45-1)-1350 was received from Contract and Accounting for review and comment. The revision is designed to up-date the provisions of Appendix "B" to conform with recent understandings reached with the Commission regarding allowable expenses in connection with relocating new employees and other minor changes. Comments regarding the revision have been submitted to Contract and Accounting.

A manual on Travel and Living Expenses has been prepared for issuance within Hanford Laboratories. As soon as approval is received from the Manager-Hanford Laboratories, the manual will be issued.

SS Accountability advised us of the forthcoming Survey 17, of which Part I is to consist of a verification of HLO inventories of normal uranium, mint and deuterium as of the end of October 1959. In response to this announcement, material custodians were requested to submit inventory information to be compiled which was forwarded to SS Accountability for use in preparing a detail inventory schedule for the AEC.

A report of results was issued for the physical inventory of movable cataloged equipment in the custody of Radiation Protection Operation. One thousand eight hundred and twenty eight items were physically counted valued at $688,385. Six items valued at $2,265 were added to record as compared to one item valued at $135 in the FY 1959 inventory. No missing equipment was reported in the inventory compared to one missing item valued at $300 in the FY 1959 inventory. Inventory results indicate close control over equipment and the use of proper procedures in transferring or excessing equipment. Due to the nature of the equipment it is our opinion the custodians have performed an excellent job controlling their equipment.

All field work in connection with the physical inventory of movable cataloged equipment in the custody of Laboratory Auxiliaries Operation is complete. A listing of unlocated items was forwarded to the Section Manager requesting that the equipment be located or a missing property report be prepared.

The Property Management Manual is currently being revised to incorporate new HAPO OPGs pertaining to property management in the manual. Revision to Chapter 3 pertaining to Passes - Government Material and Personal Property was prepared and distributed during the month of September.

Platinum valued at $13,401 was shipped to the AEC New York Operation for recovery of which $502 was charged to cost for loss in refining process and recovery costs.

As one of the results of the budget meeting held on September 25, 1959, additional equipment funds were made available to Hanford Laboratories to relieve the acute shortage which existed in the 2000 Program. Revised allocations have been made covering our equipment funds increase as shown below:

(Amounts in Thousands)	Encumbrances at 8-31-59	Balance For FY 1960	Total Allocation
Reactor and Fuels R&D	$ 952	$208	$1 160
Chemical R&D	198	202	400
Physics & Instrument R&D	118	72	190
Radiation Protection	61	114	175
Laboratory Auxiliaries	105	25	130
Project Overrun Reserve		50	50
	$1 434	$671	$2 105

Coding changes were made on all of our detail records and source documents, and listings of the changes were prepared and transmitted to C&AO in order that EDPM records could be changed accordingly. All changes apparently were not completed since considerable difficulty is being experienced in identifying changes on IBM runs which still carry the old coding with no detail.

Revised coding instructions for capital acquisition documents were prepared and distributed during the month.

The use of a new form was initiated which will expedite closings from the Work In Progress Accounts to Property Records. Favorable comments have been received from the field regarding this change in procedure.

COST ACCOUNTING OPERATION

The entire Hanford Laboratories Budget for FY 1960 was reviewed as a result of a request by the General Manager - HAPO. The review, which was prompted by a reduction in the 2000 Program funds received in the recent financial plan, was made to determine areas where savings could be made and to balance personnel and expenditures with program funds available.

As a result of the review, the Hanford Laboratories personnel forecasts are now less than the budgeted level submitted last spring. The current forecast (September) when compared to the August forecast reflects the following reductions in planned personnel through June 30, 1961.

Period Ended	September Forecast	August Forecast	Reduction
12-31-59	1 300	1 330	30
6-30-60	1 322	1 344	22
12-31-60	1 305	1 347	42
6-30-61	1 321	1 347	26

The total Hanford Laboratories budget was established for FY 1960 at $21,840,000. This compares with the previous control budget of $21,917,000. The difference of $77,000 is a net figure which is the result of the following:

Increase of FPD Process Technology funds	$ 5 000
Additional IPD 2000 R&D funds	300 000
Transfer of Non-Destructive Testing Program from FPD	75 000
Addition of Actinide Research (5000 Program)	100 000
Addition of Special Request funds from off-site	214 000
Addition of CWIP, EWIP and inventory funds	100 000
	$794 000

Reduction of Plutonium Recycle Program	$674 000
Reduction in Hot Semi Works Standby	26 000
Reduction of Gas Cooled Reactor funds	25 000
Reduction of Service Assessments and Supporting Services	126 000
Reduction of FPD Metallurgy funds	20 000
	$871 000

In addition, a reduction of $115,000 was made in the Hanford Laboratories Building and Utilities budget which will influence all programs by making these funds available for other, more beneficial expenditures.

Arrangements were made with CE&UO Financial during September to transfer the necessary personnel in October to HLO Cost Accounting to perform the accounting for Hanford Laboratories PA&C and equipment projects. The change is scheduled concurrent with the assignment of certain management and accounting responsibilities to J. A. Jones Construction Company. HLO Cost Accounting will perform the project accounting on a limited basis starting in October with newly authorized projects managed by Hanford Laboratories. Over a period of several months, the accounting presently performed by CE&UO will be transferred to Hanford Laboratories.

In cooperation with other financial components of HAPO, the financial procedures were established to transact business directly between each HAPO component and J. A. Jones Construction Company, effective September 28, 1959. Formerly CE&UO administered all work requested by General Electric Company of J. A. Jones Construction Company.

New cost codes established during September were as follows:

Organizational Codes
7360 Laboratory Auxiliaries - Construction Operation

Program Codes
.15 Nondestructive Testing (4000 Program R&D)

Arrangements have been made to utilize the HAPO EDP work order system for billing costs of the Radiographic Testing Operation (code 7350) to customers, effective September 25, 1959. Similar arrangements have been made with Facilities Engineering Operation - Engineering (code 7342), effective October 26, 1959. Facilities Engineering Operation - Drafting (code 7341) is presently under study for possible similar application. Simplification of work procedures and a reduction of clerical effort will result in both the operating components and Contract and Accounting Operation. The present manual system of Engineering Requests which requires special treatment will be abandoned.

A revised method of cost coding associated with Hanford Laboratories Buildings and Utilities has led to greater EDP utilization in accumulating the various types of cost for the 91 buildings occupied by personnel and equipment of Hanford Laboratories. The new system was made effective this month and results in a reduction of clerical effort in Contract and Accounting Operation.

Cost treatment of the new Washington State Use Tax within Hanford Laboratories has been determined. The basis for distribution within Hanford Laboratories will be the value of materials and equipment procured by each section. The entire tax applicable to Hanford Laboratories will be charged to operating costs, utilizing the above basis as a means of allocating the expense to the sections as an indirect cost of each section. It has been estimated that the tax for FY 1960 applicable to Hanford Laboratories will approximate $100,000.

GENERAL

All eligible employees who were not participating in the Savings and Security Program as of September 1 were given an opportunity to participate prior to September 15, 1959. Forty-one of the 130 employees not participating enrolled in the plan within the deadline of September 15, 1959.

Consolidated Reports and Statistics, Schenectady, requested that we prepare on IBM cards certain salary administration statistics in accordance with a guide for coding and punching such cards. This job is similar to that performed in October 1958. Completed punched cards are to be forwarded by October 9, 1959.

An analysis of weekly time cards for week-ending 9-6-59 and 9-13-59 revealed that 26 employees were absent for various reasons either the day before or after the Labor Day holiday. Eleven of these employees were absent due to illness the remainder due to other causes. Three of the 26 employees absent did not receive holiday pay, all others were paid in accordance with CPG 33.1.6, dated 12-4-56. OPG 3.1.2 on Holidays indicating date of issue as 7-20-59 was not received until 9-16-59, therefore, absences of a partial day before or after the holiday was paid with the approval of Level 5 supervisors.

Twenty-two HAPC OPGs have been issued in Hanford Laboratories since the recentralized system was initiated. Four more are in process.

The study of Fuels Fabrication Development SS material inventory recording procedures was completed. Recommendations have been submitted for review.

Chemical, Physics and Instruments and Reactor and Fuels recommendations for the re-identification of Vital Records were obtained and transmitted to C&AO. This was in response to a HOO-AEC request for aid in revising the program in accordance with the new definition of Vital Records.

The HLO offsite trips and incoming visits reporting structure was studied. Recommendations for its clarification and simplification have been submitted.

The HLO audit schedule for the year ended August 31, 1960 was submitted to C&AO Auditing for consolidation and transmission to HOO-AEC.

No audits are currently in progress.

1242256

INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
E. A. Evans and W. E. Roake	Separation of PuO_2 and UO_2 by Sublimation
J. D. McCormack	A Method for Measurement of Moisture in Slabs of Porous Media Such as Soil Using Radio Waves
R. W. Wirta	A Thermoelectric Generator

H M Parker

1242259